NEW Index Body Brakes Clutch Cooling Electrics Engine Fuel Gearbox Heater Ignition Propshaft Rear Axle Steering and Suspension Wheels and Tyres Miscellaneous

Ignition System

Last updated 27-Dec-2017

Centrifugal Advance Condenser Distributor Distributor Curves Electronic Ignition Fault Diagnosis Ignition Coil
Ignition Switch Ignition Theory Ignition Timing Ignition Warning Light North American 'Key in' Warning Points Types
Rotors Running-on Schematics Spark Plugs Spark Plug Wires Tachometer Timing Lights NEW Timing Marks
Vacuum Advance Vacuum Advance - Carb vs Manifold Vacuum Gauge Warning Light Won't Start Won't Switch Off!
Links
The sectioned MGB at the British Motor Museum, Gaydon

Centrifugal Advance

Centrifugal advance is obtained by turning the upper part of the distributor shaft, carrying the points cam, relative to the lower part of the shaft and hence the position of the crankshaft and the pistons in the cylinders. Because the distributor rotates anti-clockwise, centrifugal advance turns the upper part of the shaft also anti-clockwise relative to the lower part, to open the points sooner for a given position of the piston in the cylinder and hence advance the timing. The lower part of the shaft has a pair of weights restrained by springs. The faster the shaft spins the more the weights will try to fly out, up to a maximum controlled by a stop-plate. The springs give a varying amount of advance through the rpm range depending on their strength and other factors. One of those factors usually relies on there being two different springs - a weak and a strong, the weak being 'tight' on its mounting posts and the strong being loose i.e. having free play. This means that as the distributor spins up from a standstill only the weak spring is restraining the weights, so they move out a relatively large amount, advancing the timing a relatively large amount for each step increase in rpm. This movement eventually takes up the free play in the strong spring, then that is also restraining the weights, so the same step increase in rpm moves the weights out and advances the timing a relatively smaller amount than before. This gives the curve its characteristic 'knee' which can be seen - in varying positions on the rpm range and to varying degrees - in most if not all MGB distributors.

Condenser *October 2009:*

Testing

I've never had a condenser (an old-fashioned term for 'capacitor') fail in 40 years, but I've been carrying a spare in each of my MGBs for probably the whole time I have had them. Ignition Theory will explain the function of the condenser, which isn't just to prevent points burning but significantly boosts the energy in the HT and the spark at the plugs. The reduction in points burning is merely a side-effect of putting energy into the spark instead. A diode would be much more effective at quenching the spark at the points, but would greatly reduce the spark at the plugs.

When the condenser isn't in circuit the plug spark energy is much reduced but will just about jump a plug gap, but that is 'on the bench' i.e. plug out looking at the gap. Under compression

the spark finds it harder to jump the gap and fire the mixture. So it is possible that your engine will start and run, but misfire badly under acceleration. The tach will be relatively steady while this is happening, so you know it isn't anything else in the primary circuit like points, coil primary, ignition supply or connections. Note that this symptom is identical to when the HT circuit is breaking down somewhere, like at the rotor or distributor cap, because the HT voltage has to rise higher before the spark can jump the plug. But if you can reproduce the problem with a timing light connected to the coil lead and plug leads you can isolate it a bit more by watching the flashes as it happens. If the flashes start getting erratic or missing altogether on the plug leads but not the coil lead, then you know the problem is with the cap and/or rotor. If the erratic flashes are on the coil lead as well, then it will be coil or condenser. The condenser is much cheaper (and should be carried as a running spare anyway) than a coil, and you don't even have to disturb the distributor to test the theory. Simply croc-clip the condenser between the points terminal on the coil (white/black) and earth (case to earth although they are not polarity sensitive) and if that solves the problem you know it is the condenser. If not it must be the coil, although coil HT failures seem to be very rare.

It's held that while condenser capacitance (nominally 0.22 micro-farads) can drift, usually with little if any apparent effect on running, when they do fail they usually do so completely and for good. But I have heard of condensers with a poor mechanical connection between the foil and the case or wire, and these could exhibit intermittent or heat-related failure as well as complete and permanent failure. *Update August 2010:* I'm personally aware (friends) of several cases of total failure of condensers recently, in two cases they were brand-new from the usual MG suppliers having only done a few dozen miles, and there have been other reports of this in the various MG media. Ignition specialists like Simon's Best British Classics and Distributor Doctor should be a better bet for replacements.

There are two types of condenser used in the MGB - one with a short wire and bolt-through terminal that connects to the points on the 25D4 distributor used on chrome bumper cars (GCS101), also V8s (GCS108), and one with a longer wire with quick-connect 'terminal' to the points near the condenser and the end of the wire with the male spade going out through the distributor body connecting to the harness on 45D4 distributors used on rubber-bumper cars (GSC110 or GSC2109). Note that parts are usually supplied according to the vehicle year, but as the 25D4 and 45D4 distributors are physically interchangeable you must order the condenser by the date of the distributor, i.e. pre-1974 1/2 or post 1974 1/2, not the date of the car.

Testing: *Added June 2011* The easiest way to deal with a suspect condenser is to substitute it, and the easiest way to do that is clip another between the points lead on the coil and earth. If the existing condenser is working then the new one will do nothing (unless it is short-circuit, whereupon it will stop the engine!) - no harm or make any difference to the running of the engine, but if the existing one has failed open-circuit it will make all the difference. It will make no difference to a short-circuit condenser either, but by this time you should have established that is the problem as there will be no HT and no switching of voltage and current at the coil as the points open and close. The only fly in this ointment is that in these days of dodgy components your new, out-of-the-box condenser may be faulty! It's possible to do a crude go/no-go test of a condenser using an analogue (at least) ohmmeter on a high resistance range. Connect the meter probes to the condenser one way round, then quick as you can connect them the other way round. Each time you reconnect them you should see a pulse on the meter needle. Note that the pulse will be bigger on reconnecting than on first connecting, so you may not see anything happen on the first connection. Also the resistance range has to be high, a low resistance range will not show anything. This definitely works with an analogue meter, and may also give some indication on a digital. The thing to do is test your spare with your meter now, then you will know for the future!

Distributor

Distributor Types

Originally all MGBs were fitted with a points-type Lucas 25D4 distributor. The main difference in this to other types fitted over the years is the vernier adjustment that allows for fine-tuning of timing. Originally necessary in the days when fuel octane might have been a bit variable between suppliers, since the advent of unleaded it has come back into its own. If you have your timing set to take advantage of the higher 97-99 octanes and get better performance and economy, when touring in the wilds (even in the UK) you may find you can only get 95 octane and your engine will start pinking badly. The vernier adjustment allows you to retard the timing by a couple of degrees to stop the pinking, then put it back again when you can get the higher octane. However not so convenient for changing the dwell, one would normally have to keep stopping the engine, removing the cap, tweaking the points gap, refitting the cap and restarting the engine, but there is way of simplifying the process.

The V8 used the 35D8 points distributor throughout. The feature of note with this distributor is the ability to change the points gap and hence dwell with the engine running by turning a hex shaft that protrudes from the distributor body. Other than that timing is altered by twisting the distributor body - this time **clockwise** to retard and anti-clockwise to advance. However as the factory V8s are low-compression and should be set up for and run on 95 octane, one normally wouldn't need to alter it for reasons of petrol.

From November 1974 the points-type 45D4 distributor was used on all cars, to the end of production on non-North American-spec cars. The vernier adjustment was deleted, but the points installation was improved by having a tag on the points wire that pushed into a clip on the points spring, instead of the fiddly insulating washers and nut of the 25D4. Clausager says that some cars in the 1978-80 period used a Ducelier distributor, but I've never heard of one of these being found in the wild. With these distributors to alter the timing it is a case of slackening the clamp plate bolts - or the clamp bolt itself if you are at the limit of the slots in the clamp plate - and twisting the body of the distributor plate, anti-clockwise to retard, clockwise to advance. Again to adjust the dwell one would normally have to keep stopping the engine, removing the cap, tweaking the points gap, refitting the cap and restarting the engine, but there is way of simplifying the process.

For the 1975 model year onwards North American-spec cars had electronic ignition, as they were required to go for 50k without any engine adjustments, and points needed replacement every 10-12k. Initially the 45DE4 'Opus' system, it proved unreliable and many were replaced under warranty. A much better alternative which replaced the 45DE4 was the 45DM4, which proved to be very reliable, the system being used on many other makes and marques. More on these types can be found here.

Distributor Connections *June 2016*

It might seem obvious what's involved with a cursory glance at the distributor but there is more to it than one wire between the coil and the distributor. That wire carries coil current to the points, but it has to get to earth after passing through the points, and that is via an earth wire which is less obvious. Factory and after-market electronic systems have various ways of achieving this.

Points wire: But first the points wire. On 25D4 distributors the harness wire connects to a spade terminal on the side of the distributor. Internally that then has a very flexible brown cloth-covered wire connected to the points spring and hence the moving contact. On 45D4 distributors there is black plastic insulated wire coming out of the distributor that terminates in a male spade, which connects to the female spade on the harness wire, i.e. an in-line connection. Internally this wire goes to a tag which goes into a clip on the end of the points spring, and from there to the condenser. Despite being black plastic insulated this is a much more flexible wire than wiring used elsewhere on the car. The reason for these very flexible wires on both the 25D4 and 45D4 is that when driving the points plate is continually being twisted back and fore by the vacuum advance module, as the accelerator pedal moves up and down, to alter the timing, which continually flexes the wires. These wires are designed to cope with this twisting and flexing, but eventually they can fracture, which will give intermittent ignition i.e. cutting-out, and probably backfiring in the exhaust. Fortunately on cars with the electronic tachometer (i.e. not the early mechanical rev-counter) these faults will almost certainly cause the tachometer needle to be jumping about, or have dropped to zero when the ignition is still switched on and the momentum of the car is still spinning the engine. But note breaks anywhere in the ignition circuit - not just these wires inside the distributor, will result in the same symptoms. The fractures will almost certainly be inside the insulation and so not immediately visible to the naked eye. On the 25D4 the wire and spade terminal will need to be replaced, but on the 45D4 it is part of the condenser wire so a new condenser will be required.

Earth wire: The points are screwed to a points plate, which as described above is being continually twisted back and fore by the vacuum advance module as you move the accelerator pedal. Some manufacturers rely on a sliding contact between the twisting points plate and a fixed backing plate, but as I found out on a Scimitar GTE this can result in an intermittent contact and a misfire just as you accelerate to pull out of a junction, which is most unwelcome. The Lucas 25D4 and 45D4 have a very flexible brown cloth-covered wire (similar to the 25D4 points wire) between the points plate and the distributor body. This copes very well with the twisting action for many years, but eventually will fray and/or fracture giving intermittent ignition as described above, and need replacement.

Factory electronic systems: Two electronic systems were used by the factory - 45DE4 and 45DM4 - but only for later North American cars, and there is more information on both those types here. Both types have vacuum advance and hence moving trigger plates, so there can be the same problems with wires fracturing. The 45DE4 trigger has three wires, the 45D4 trigger only has two wires, but neither of them use an earth wire from the trigger plate to the distributor body.

After-market electronic systems: These generally fall into two categories - those fully self-contained under the distributor cap such as the Pertronix and Lumenition Magnetronic, and those with a trigger under the cap and an external electronic module such as Lumenition Optronic. The fully self-contained usually have two wires, and need the points plate earth wire to be intact. Those with the external electronics module like the Optronic have three wires from the trigger exiting the distributor, and don't need the original earth wire. All the wires that exit the distributor are subject to the same twisting and flexing forces, and the conductors can fracture inside the insulation. I would expect faults in any of these wires to show up on the tachometer as described above.

Distributor Caps *Added April 2010*

Reports of very early failures of rotors and condensers (sometimes within road-hours of fitting) is becoming all too common, are we also to get similar failures in distributor caps? This relatively new cap lost its carbon contact, then damaging the rotor, requiring replacement of both. The new rotor almost immediately proceeded to give intermittent misfiring shortly before total failure.

February 2015:

Another new cap failure - Lucas boxed, this time the retaining springs had punched holes through the cap and shorted out the HT.

Distributor O-rings *March 2013*

To O? Or not to O? That is the question. My blind pal Terry is just starting to fit the ancillaries to his newly installed engine and I mentioned to check that the distributor had an O-ring fitted. I described where it should be but he just couldn't locate the slot. He sent some pictures and it was immediately obvious his doesn't have one. Googling showed that a number of people said they did have one, and a number didn't, for marques other than MG as well as MG, but no clear statements on the subject (was ever thus). And one claim (in a source that should be world-famous for its mis- and dis-information) that a groove at the bottom of the dizzie body is for an O-ring is completely incorrect. There is one in the drive dog, and one between that and the distributor body. The drive dog rotates of course, and an O-ring here would get ripped to pieces if the housing extended that far, or do absolutely nothing if it didn't.

Looking in the Parts Catalogue although all the drawings show a groove and a O-ring, for both 25D and 45D, when you start reading the detail, distributors for early engines are shown having it, also later ones, but there are a batch of 25D4s in the middle that don't show it:

- 18G, GA and GB (i.e. all Mk1 cars) show it - 27H 6547
- 18GD to 18GK and 18V 581 to 585 (i.e. Mk2 with HS carbs) don't show it
- After that anything with HIF carbs, including chrome bumper cars with 25D4 distributors all show it again - 27H 6547

However in July 2016 when I had Bee's engine out to change the clutch and cleaned up the very mucky engine in the process, I've been keeping an eye for any oil trickling down the block after trips. I noticed one under the distributor, which is a 25D4 41228 i.e. for an 18V581/582 and hence shouldn't have the slot. However thinking I may be able to utilise it in some way I bought an O-ring. And on removing the distributor I was quite taken aback to find a slot! However this is a remanufactured unit, so perhaps not surprising it has the slot. So O-ring fitted. The block face the distributor clamp plate butts up to seemed clean, and there are a couple of plugged oil-ways immediately below that so it could be from there. But after a few dozen miles there is no sign of more oil, so O-ring it was. For Mk2 distributors without the slot it may be

possible to fit a thicker O-ring in the larger groove right at the top of the shaft, to bear down on the edge of the hole.

Distributor Drive Gear

4-Cylinder
V8

4-Cylinder:

At first sight it would seem that the drive dog on the end of the distributor shaft and the driving slot in the gear in the crankcase would allow the two to be assembled in either of two positions. However they are both offset slightly, by about half the width of the dog/slot, so they will only fully engage in one position. But they are so close that if turning the rotor while pressing the distributor down gently to locate the slot, it will seem to partly engage in the incorrect position. But as said, it will only fully engage in one position, which is when the distributor flange is flush to the clamp plate, and the clamp plate is flush to the block.

Whilst, as long as each plug gets its spark at the correct time, any position on the cap can be used for No.1, the 'correct' position is around 2 o'clock when looking down on the top of the cap whilst standing beside the right-hand wing. The rotor should be pointing at this lead when at TDC (Top Dead Centre) at the end of the compression stroke of No.1 piston, which is at the front (radiator end) of the engine. You can determine TDC either by examination of the valves when turning the engine by hand, or as John Twist describes below. Using the valves the compression stroke is the one where both valves are closed (up) for the majority of the up-stroke of the piston, and also for the expansion down-stroke. To avoid having to remove the rocker cover (damage to gasket, leaks afterwards etc) an alternative is to remove the plugs and turn the engine by hand with your thumb over No.1 plug hole. When you can feel compression blowing past your thumb, that is the compression stroke. When the piston gets to the top of the cylinder on that stroke, that is the firing point for that cylinder. Whichever method you use, wherever the rotor is pointing when the piston is at the top of its compression stroke, the cap contact it lines up with should be wired to No.1 plug. Thereafter the correct firing order is 1-3-4-2 counting round the cap in an **anti**-clockwise direction.

If the engine has been rebuilt it is possible for the drive gear to be inserted in as many positions as the gear has teeth, only one of which is correct. The rotor can also end up 180 degrees out if you follow the Haynes instructions for fitting the timing gears and inserting the drive gear, but the Workshop Manual is correct (see Engine for details). It can also happen if the distributor has been dismantled and reassembled incorrectly, as apart from knowing the relationship between the drive-dog on the lower half of the shaft and the rotor location notch on the upper half there is nothing else to indicate which way is correct. I have shamelessly copied this piece from a John Twist article hosted on Team.Net which describes how to correct the gear position:

DISTRIBUTOR DRIVE GEAR POSITION from John Twist:

Find top dead center, number one firing, by examining the rockers with the valve cover off, or by using one's index finger on the #1 spark plug hole while pushing the MG forward (#1 fires at the end of the compression stroke, which will blow one's finger off the hole). Use the timing marks to be certain the engine is at TDC. Remove the distributor and clamping plate. Thread a LONG 5/16"-24 stud into the centre of the distributor drive gear (find the stud in the air cleaner assy, twin SU models). Remove the slotted screw holding the distributor housing, and withdraw that part. Pull the distributor drive gear from the engine. After THROUGHLY CLEANING AND GREASING THE GEAR AND HOUSING, drop the gear back into the engine, keyway offset below horizontal, large half of the driving dog upmost, with the keyway 9:00 to 3:00. As the gear drops into place, it will rotate anti-clockwise and set in at about 2:00-8:00. The rotor should then face 1-2:00.

That is the correct position for the gear, but if you find the rotor is now (or still) 180 degrees out then either the timing gears and chain were fitted incorrectly, or the distributor is 180 degrees out. I'll leave you to decide how far you want to go in investigating this, but the easiest way of getting the rotor and leads correct will be to remove the drive gear again and rotate it 180 degrees before reinsertion. Remember that a change of distributor may well put it out again, if the new is incorrect and the old wasn't, or vice-versa.

V8: On the V8 the camshaft drives the distributor shaft directly via a spiral gear and the distributor drives the oil pump via a tongue and slot. Up to 1976 all Rover V8 engines had the tongue on the distributor and the slot in the oil pump shaft. With the introduction of the SD1 the engines for that car had electronic ignition using a 35DE8 distributor, and this had the slot on the distributor and the tongue on the oil pump shaft. Points engines e.g. Range Rovers changed to the later drive arrangement in 1978, but kept points for a further four years! See Fitting a V8 into an MGB by Roger Parker.

One benefit of either type of drive is that the distributor can be removed and a drill with suitable drive shaft inserted into the hole to drive the oil-pump directly. After a rebuild or any interference with the oil delivery system it is far better to build up oil pressure this way than cranking or even worse running the engine and hoping it eventually shows on the gauge. Have the drill on minimum speed, and I gripped the chuck firmly with my hand as well to slow it even further.

Note: The down-side is that if you crank with the distributor removed the oil pump is disabled!

Note also: That reinsertion of the distributor needs the engine to be turned to TDC on the compression stroke of No.1 cylinder, and the distributor rotor turned to point at No1 plug lead, as the distributor is like the 4-cylinder drive gear in that it will mesh in as many positions as there are teeth. As you can't see the rotor when the cap is on, or exactly where the lead is with the cap off, make a pencil-mark on the distributor body under lead 1, then remove the cap.

Distributor Adjustments

4-Cylinder: The points are so difficult to get at with the oil pipe and steering column in the way on RHD cars (it's bad enough just getting the cap off) that I always remove the distributor to check or change them. I also remove it by undoing the two screws that hold the clamp-plate to the block (pulling out the dipstick for better access) and removing distributor and clamp-plate together, rather than slackening the clamp bolt itself. This is for several reasons, the most important of which is that frequently undoing and tightening the clamp bolt can damage the shoulder on the distributor body, which

can make it jump out of the clamp when driving. Don't worry about turning the engine or the distributor while it is out, it only goes back in one way, and you are going to have to check and adjust the timing anyway, as the holes in the clamp-plate are large enough to give several degrees of variation in timing and replacing the points or even altering the gap of existing points will change the timing.

When replacing points where everything is held on with a nut it is vital to get the tags from the condenser and the coil in the right place. Basically, everything except the nut goes between the two insulators i.e. baseplate - insulator (narrow end up so it fits in and locates the points spring) - points spring - condenser tag - coil tag - second insulator (narrow end down so it fits in and locates the two tags and the points spring) - nut. If any of the points spring, condenser tag or coil tag touch the baseplate bolt or the nut the engine will not run. Other distributors have a simpler method of location where the points spring rests against an insulator that rests against a flange on the baseplate, and the condenser and coil wires are connected to the same tag that slips under a fold at the end of the points spring. Less likelihood of getting things in the wrong place.

The points gap is typically set to .014 to .016 using feeler gauges, and measured with the heel of the points on the highest part of the cam such that the gap is at its greatest. There should be light resistance with the .016 gauge and no resistance with the .014 gauge. When checking used points there will often be a spike on the one contact and a hole on the other, in this case using a feeler gauge will result in a much wider gap then intended. It is possible to clean up points with a fine sharpening stone, but once you have them off you may as well fit new ones. When the gap is correct insert a piece of clean paper between the points, close them, pull the paper slightly, open the points and remove the paper - this cleans off any oil etc that might have been transferred from the feeler gauges. Don't pull the paper all the way out with the points closed as this can leave fibres behind that can cause an intermittent misfire.

Dwell:

However dwell is a much more accurate way of checking/setting the points, and as far as checking them goes is far preferable as it is 'non-invasive' i.e. the dwell meter just clips to 12v, earth and the coil CB/-ve terminal. If removing the distributor to replace the points on the face of it you can't set the gap with dwell until it is back in the car - unless you make a bench-test rig. In its simplest form this can just be an 'arm' such as a small Allen key lightly clamped to the rotating part of the shaft with a worm-clip that you rotate with a finger-tip, and an analogue ohmmeter. One little-known feature of analogue ohmmeters is that on a regularly interrupted circuit such as points, if the distributor shaft is turned fast enough the damping of the meter needle is such that it will indicate a relatively steady average value between infinity and zero ohms (note that an ohmmeter can't be used on-car with a running engine as the ignition voltage interferes with the internal battery of the ohmmeter). This value is the percentage time that the points are closed, between 0% and 100%, which again is dwell but in percentage terms rather than degrees. Meters with a dwell capability frequently have both degree and percentage settings, and whereas dwell degrees changes markedly with the number of cylinders, dwell percentage doesn't. For example the 25D4 distributor is set to 60 +-3 degrees. Being a four-cylinder distributor each cylinder has one open period and one closed period of the points in 90 degrees (360 divided by 4). To derive percent from degrees the dwell of 60 degrees is divided by 90 and multiplied by 100 to get 67%, or including the tolerance 64% to 70%. The 45D4 has a shorter dwell at 51 +-5 degrees, and the same calculation produces 51% to 62%. By contrast the

V8 has a much shorter dwell of 27 +-1 degree, but using the same method (but dividing by 45 i.e. 360 divided by 8 instead of 4) we get 58% to 62% i.e. very similar to the 45D4 but with a tighter tolerance which is the result of a cam with twice as many lobes. The longer dwell of the 25D4 is down to the less efficient coils in use when that distributor was first designed needing a longer 'charge' time. The effect of all this is that if you have an analogue ohmmeter with a 10v (or 100v) full deflection scale, you can read the percentage dwell off that scale, even though the meter is switched to ohms (if a 10v scale multiply by 10). If you don't have a 10v or 100v scale use an appropriate scaling factor with a scale you do have, i.e. if you have a 30v full deflection scale you will be looking for a value on that 3 times higher than you would on a 10v scale. Rotate the 'arm' on the shaft of the distributor with your finger-tip fast enough to get a useable reading, and simply read off your percentage dwell. Tweak points and repeat, ad infinitum.

Confused? No worries, if you have a dwell meter showing degrees you can use that on the bench as well! This will need a battery and a load simulating the coil such as a 12v bulb, as well as the dwell meter. One side of the battery goes to one side of the bulb, the other side of the bulb goes to the points wire of the distributor, and the body of the distributor goes to the other side of the battery, such that as the distributor rotates the bulb switches on and off. It doesn't matter which way round you connect the battery to your bulb and distributor but it makes sense to use the same polarity as your car to make things simpler. As to what voltage battery to use, you may be able to get away with a low-voltage dry-cell battery, or you may need a 12v source. With the circuit connected up as described turn the distributor to open the points and the meter should show zero. Turn the distributor to close the points, and an analogue dwell meter should show full scale deflection, a digital switched to 4-cylinder and degrees should show 90 (360 divided by 4 remember?). If you find either meter shows less than this (they expect to be working at 12-14v) then you will have to use a 12v-14v battery, which again could be a series of dry cells (when using dry cells use a low wattage 12v bulb such as a 2.2w instrument bulb to avoid flattening the battery too quickly). You probably won't be able to use a battery charger on its own as these generally output rectified AC which is a series of voltage pulses at 50 or 100 Hz, and when the voltage from this is zero the meter won't be able to tell the difference between that and the points being open/closed. If you have an old 12v car battery in the garage, then connecting the charger to this and then the battery to your test rig should be fine (once it gets up to 12v), as the battery will smooth out the voltage pulses. Again rotate the 'arm' with your finger-tip to get a useable reading, of your dwell in degrees directly in this case. Tweak points and repeat, ad infinitum.

However whilst my analogue ohmmeter is damped enough to get a usable reading from finger-tip rotation of the distributor, my analogue dwell meter isn't. And if you get fed up doing the twiddle - tweak - twiddle - tweak etc. etc. you might like to make a rig to drive the distributor from a motor. I used a box to hold a drill and the distributor as shown here. The great advantage of this is that with the cap and rotor removed, and using care, you can tweak the points while the distributor is being driven and getting a continuous reading off the meter. Using a rig, try adjusting the dwell up and down and observe the bulb - you will see it getting dimmer as the dwell reduces, and brighter as it gets higher. The ultimate irony with the V8 is that the distributor is in about the most accessible position imaginable - top front of the engine, but has an external hex shaft that is used to adjust the points with the engine running anyway!

Put a little grease on the cam where the points heel rubs but don't oil the cam wiper pad that's attached to the points. Put a little oil down through the baseplate onto the advance weights and springs, and in the end of the spindle under the rotor arm. Refit the distributor, rotating the spindle by hand till it engages with the drive. If you left the clamp-plate on the distributor the timing will be close enough to start the engine and allow you to fine-tune it with a timing light. Refit the cap - No. 1 plug lead should come out of the top-front hole (2 o'clock), and the leads are counted anti-clockwise - 1, 3, 4, 2. Note that if your distributor is not in this position, or the engine does not run when it is, the drive gear may have been positioned incorrectly. Although the distributor can only engage with the drive gear in one position the drive gear can engage with the camshaft in a number of positions. You can correct the position of the drive gear as described by John Twist. Note that if the distributor is dismantled the two halves of the shaft go together in either of two orientations, the 'wrong' one will put the rotor 180 degrees out.

To determine the correct position of the rotor and leads if the engine is new to you, or has been dismantled and rebuilt, and won't start: With the plugs removed turn the engine with your thumb over No.1 plug hole until that piston starts coming up and compression lifts your thumb off the plug hole (it also comes up on the exhaust stroke but this will not lift your thumb off). When the piston is at the top of its bore on that stroke, look at the direction the rotor is pointing in, and the cap contact nearest there is the one that should be connected to No.1 plug, and the rest counted from there.

I use an electronic timing light with a dial that allows me to set a given number of degrees of advance then adjust the position of the distributor till the flash shows the groove on the pulley lining up with the TDC mark on the timing cover. This type of light is also bright enough to be used in full sunlight without having to paint the marks. With lesser lights you will have to set the timing using the specified mark on the timing cover. The TDC mark is the last one the pulley mark passes (the pulleys turn clockwise as you stand at the front of the car and look back into the engine compartment), the others typically indicating 5, 10, 15 and 20 degrees BTDC (although some only show 5 and 10 degrees). Sometimes the marks are different sizes - TDC being the biggest, 5 and 15 degrees being the smallest, and 10 and 20 being in between. On early cars the marks were below the pulley, on later cars they are above and towards the RHS, nice and convenient for watching while you twist the distributor. If the marks are missing altogether you can derive true TDC as follows:

- As above with the plugs removed turn the engine with your thumb over No.1 plug hole until that piston starts coming up and compression lifts your thumb off the plug hole. It also comes up on the exhaust stroke but this will not lift your thumb off.
- With the engine turned back a little way so the piston is below the top of its stroke, insert a probe into No.1 plug hole. A rod though the middle of an old spark plug and secured in position makes a good probe, the length of which should stop the piston coming up shortly before it reaches the very top, turn the engine forwards so the piston touches the probe.
- Attach a card to the front cover and mark on it the position of the notch in the pulley.
- Turn the engine **backwards** so the piston goes down backwards through the compression stroke, and the previous intake stroke, until the piston just touches the probe again.
- Make a second mark on the card where the notch is now, and TDC is exactly between these two marks.

Note that the pulley consists of a metal-rubber-metal sandwich and there have been some reports of the two metal parts getting out of line with each other and being useless for setting timing. If in doubt remove No. 1 plug and turn the engine till the piston is at its highest, this will either be TDC or 180 degrees off TDC, in which case keep turning till the piston goes down and back up again. The intake and exhaust valves will be closed during most of the compression stroke (which finishes at TDC) whereas the exhaust valve will be open on the exhaust stroke (the other time the piston is moving upwards). If you put your thumb over the plug hole while turning the engine it will be blown off while the piston is approaching TDC whereas it won't if the piston is on the exhaust stroke. If you find the pulley notch is **not** pointing at the TDC mark on the plate when the piston is at its highest position, then either the plate has been fitted in the wrong place or the pulley has delaminated. In the latter case it is not worth altering the marks to suit as the pulley outer will in all probability continue to move in relation to its inner.

When setting timing it is advisable to remove the vacuum pipe from the distributor and plug it, North American cars from about 1971 used manifold vacuum and you **must** disconnect the pipe before setting timing on these cars, although UK-spec cars used the original carb vacuum until about 1976. You shouldn't have to do this with carb vacuum but it won't hurt. However if you do remove it you can check your centrifugal advance is working properly by checking the total advance at various rpms as given in

Dizzie Curves. The total advance is the static advance plus the centrifugal advance. A common problem on older distributors is that the advance springs stretch, which will allow maximum advance to be obtained at too low an rpm, which can cause pinking under load. This check is done much more easily with the adjustable timing light, you will need additional marks if you only have the simple light.

You can also check the operation of the vacuum advance by sucking on the end of the tube (but be warned that the tube may contain petrol) and checking that the timing advances accordingly. You can watch for movement of the points plate if the distributor cap is off, or advancing timing if the engine is running and a timing light connected, and in this second case the idle speed should also increase and decrease as the amount of vacuum increases and decreases. If you can continually draw air through the vacuum module it is punctured and must be replaced, otherwise it will upset the carb mixture as well as giving insufficient advance when cruising, which affects performance and economy.

See also http://www.iwemalpg.com/Vacuum_gauge.htm which has information on using a vacuum gauge for fault diagnosis.

V8:

Many features are as above for the 4-cylinder but there are some significant differences. Firstly the points attach to the points plate in a fixed position, not adjustable as in 4-cylinder distributors. The coil and condenser wires attach as for the 25D 'fiddle-fit' 4-cylinder points. Grease the cam lobes (not the felt pad, and not oil) as for 4-cylinder 45D 'quick-fit' points.

The gap/dwell is adjusted by turning a hex bar that should be sticking out of the back of the body. Turn the bar clockwise (imagine looking onto the end of the bar i.e. from the back of the engine) to reduce the gap/dwell, anti-clockwise to increase it. In theory the benefit of this is being able to adjust the dwell with the engine running, but in practice I find whilst turning the bar clockwise to reduce the gap or dwell does so steadily and progressively, if you go too far and have to turn the bar anti-clockwise nothing seems to

happen for a bit and then it jumps a large amount. This is because it relies on spring pressure to take up the back-lash, but the friction is overcoming the spring tension. Turning it anti-clockwise a bit then pressing on the end of the hex bar and wiggling it up and down helps, but it is best to unscrew the bar to get more gap/dwell then you need, then turn it clockwise again to reduce it to the correct value. Gap is the same as for the 4-cylinder at .014" to .016", but dwell is only 26 to 28 degrees as it has twice the number of cylinders of course, and dwell represents the length of 'time' in each rotation of the crankshaft the points are closed.

Distributor rotation is **clockwise**, and not anti-clockwise as for the 4-cylinder. Firing order is 1-8-4-3-6-5-7-2, where the front cylinder (i.e. the furthest forward) of the left bank (on the right as you look in from the front) is No.1. An easy way of remembering is that No.1 cylinder is closest to the distributor. Odd cylinders are on the left bank, even on the right bank.

The distributor clamp is a much more positive design than on the 4-cylinder, being a fork that presses down on a flange on the distributor body, both being large and robust. Unless the clamp bolt is unscrewed a large amount the V8 distributor can't jump out like the 4-cylinder can (although see below about the oil pump), although it can lose the timing just by being loose, of course.

The distributor shaft is fitted with a skew gear as well as a drive dog on the end. The skew gear engages with the end of the camshaft, so can be fitted in as many positions as there are starts in the skew gear. Therefore unlike the 4-cylinder distributor, which can only go back in the correct position no matter how the distributor and crankshaft have been turned while the distributor has been removed, on the V8 you will almost certainly lose the original position if the distributor is removed. To regain the correct position:

- Turn the crankshaft so that timing cover pointer is over the 6 degree BTDC mark on the crank pulley and No.1 cylinder is at the top of its bore.
- Orientate the distributor such that the vacuum capsule is at the front of the distributor and pointing to your right as you face the engine.
- Turn the rotor so that it is pointing at the cut-out in the distributor body (should be pointing at the left-hand wing). This allows for the 30 degrees that the rotor will turn through as the skew gears engage.
- Turn the oil pump spindle such that it's orientation is as close as can be judged with the drive dog on the end of the distributor shaft.
- Insert the distributor, and watch for the rotor turning as the skew gears engage. If the distributor body doesn't fully seat down onto the timing cover, turn the crankshaft either way until it drops fully down.
- Turn the crankshaft back to 6 degrees BTDC, and turn the distributor body so that the points are just opening. Lightly tighten the clamp ready for static and/or dynamic timing.
- Check that No.1 lead is fitted to the cap such that its contact is by the rotor when the cap is fitted. If it isn't, move the leads round, following the firing order in a **clockwise** rotation. This should put No.1 lead just below a half-way line across the middle of the distributor.

However it's not that critical, one tooth either way doesn't make that much difference on the 8-cylinder, with the distributor fully in just look at which cap contact the rotor will be pointing at with the cap fitted and put No.1 lead to that, counting clockwise from there.

As mentioned above the distributor shaft dog engages with the oil-pump drive shaft, so it is the camshaft that drives the distributor, and the distributor that drives the oil-pump.

Remember that with the distributor removed, or lifted away from the timing cover more than a certain amount, cranking or running the engine will **not** develop any oil pressure.

What should I set my timing to? *January 2016* What follows relates to high-compression engines. Low-compression as in the factory V8 are probably best left with the factory figures, as even on 95 octane you are almost certainly not going to be able to adjust by ear listening for pinking. If you do, then you may over-advance so much it stalls the starter.

Each engine has a published figure, but that assumes the engine is unmodified and in good condition, the distributor is the original type and in good condition, and you are using the original 4-star leaded petrol. Meeting all of those is highly unlikely - 4-star is only available in very few outlets, and most engines these days are running with some wear if not an incorrect distributor. Even if you did meet all three, the original timing specs were conservative - tolerances between individual engines of the same type meaning some were more likely to pink than others, and the factory selected a 'worst case' figure to limit warranty claims. This meant that some engines from new could be run with more advance than the 'book' figure without pinking, to give better performance and economy. I found that with a new Marina in the 70s, which I used to set-up using a vacuum gauge. But when I got my roadster I found that even on unleaded I couldn't run any more advance than book, so didn't bother using the gauge anymore. On unleaded, even the higher 97-99 octanes, I found I had to retard slightly from book, and so-called octane-boosting additives didn't make any difference.

And the upshot? Unless you are prepared to spend quite a lot of money and time buying and setting up a programmable ignition system, or on a rolling road, the best you can do is to advance the timing just short of getting pinking at any combination of throttle-opening, revs and load. In fact Haynes says "Small readjustments can be beneficial. ... accelerate in top gear from 30 to 50mph and listen for heavy pinking. If this occurs, retard the ignition slightly until just the faintest trace of pinking can be heard under these conditions". This does mean that if you live in and set-up for Lincolnshire, then when touring in Wales, the Scottish Highlands or the Lake District you are quite likely to get significant pinking from the higher loads of climbing hills. You will have to 'play it by ear', and this is where the 25D4 distributor with its vernier adjustment comes in - it is very easy to make small timing adjustments just by twiddling the knurled wheel. Typically 10 clicks per degree of adjustment, giving +- 12 degrees from a central position. Turning the wheel to make the threaded stud protrude further retards the timing, and turning it to protrude less advances it.

Added December 2009: Out of interest early battery ignition systems used a low tension system which basically had the contact breaker points (the igniter) **inside** the cylinder, a simple coil with one winding instead of the later type with primary and secondary windings, and no condenser. When ignition was required the igniter contacts (inside the cylinder) were opened mechanically, which broke a series circuit, which causes a spark. The inductor results in a bigger spark than a simple resistor would, and a condenser is not fitted as the system requires the largest spark possible inside the cylinder.

Electronic Ignition

Factory Systems
From mid-1974 (i.e. all rubber bumper) North American cars had either the 45DE4 'Opus' electronic ignition (see here for info on the Opus as fitted to Jaguar V12, Aston Martin V8 and Cosworth V8) or the 45DM4 CEI electronic ignition with remote amplifier. They were necessary to meet the emissions requirements of the day, giving consistent results over many thousands of miles (I recall cars of the era having to travel 50k miles with no maintenance other than things like fluids, and having to be in spec at the end), unlike points which deteriorate over distance due to mechanical wear. But with good parts and correct initial setup I find that points easily last 6k to 10k miles without drifting out of the limits for dwell and hence no readjustment (my last 45D4 with their +-5 degrees tolerance for dwell lasted 15k).

The 45DE4 Opus system was very troublesome (it was nick-named 'Opeless') and often replaced with the 45DM4 under the original warranty, I find it amazing that there still seem to be a small number of Opus systems in existence! This Lucas Fault Diagnosis Manual contains some faulting information for the Opus system, but it seems to be for a version that had a separate pickup and amplifier and a different ballast arrangement so may not be that much use. Both factory systems use a (nominally) 6v coil with harness ballast the same as the points operated system on rubber bumper cars for other markets. The Opus system has an additional ballast resistor for the electronic ignition module. Neither of these systems are 'electronic ignition' in the sense of giving a more powerful spark, they are simply 'electronic trigger' systems where the mechanical points are replaced by a magnetic or optical trigger controlling an amplifier, which switches the current in the coil much as mechanical points do. The Opus system has a fixed dwell (unlike the later 45DM4 CEI system) although I believe it is higher than points dwell as it was designed for higher-revving V8 and all V12 engines to give a satisfactory coil recharge time at peak revs, as well as no contact bounce. This has the side-effect that it will cause the coil to run hotter than if points had been used, but as it was only ever used with the 6v coil and external ballast these will still run cooler than a 12v coil with points ignition. See here for information on coil temperature

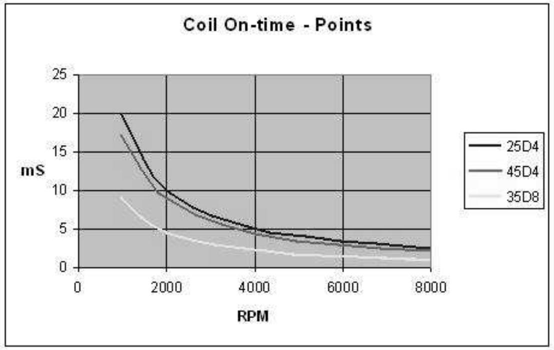
The 45DM4 CEI system uses more sophisticated electronics to give 'variable dwell'. The 45DM4 system was used by a large number of manufacturers, albeit with differing physical installation, and the MGB system has been said in the past to be a Delco D1906. At the time of writing the modules may still be available from various sources in China, Google 'DM 1906'. If yours is different physically you can check the other Delco items and other manufacturers e.g. Lucas to see if you can find it. An alternative is NAPA TP45SB (March 2010: Google can't seem to find NAPA) but there has been a suggestion that the 'TP' in the NAPA number denotes Transpo as a source, check the prices of each. However if the fault is in the pickup you have bigger problems replacing it, and you wouldn't want to splash out on a new module only to find it made no difference (see below). *Update March 2010:* Leacy are showing the AB14 amplifier module (i.e. the DM1906 in a case and with the required leads) as part number BAU1922, at a price of £117, and a 45DM4 distributor for a 1980 California MGB at the same price.

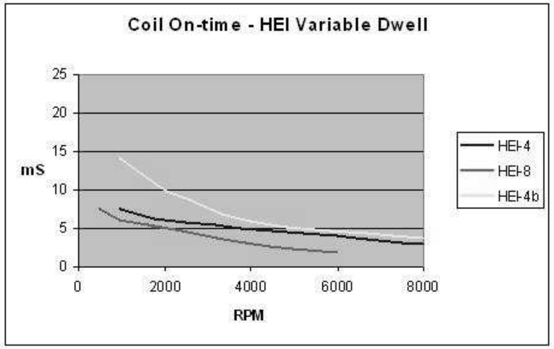
After-market Systems
The Lucas Fault Diagnosis Manual states "the standard ignition system will quite adequately meet the requirements of a six-cylinder engine up to about 8000 rpm". The following table compares the coil on-times between 25D4, 35D6 and 45D4 points systems and GM HEI variable dwell systems - that module being the core of the factory 45DM4 system as well as many after-market systems:

Points Ignition Coil On-Time	45DM4 Ignition Coil On-Time	
	rpm	

rpm	25D4 mS	45D4 mS	35D8 mS	4-cylinder	8-cylinder	mS
1000	20	17	9	1000	500	7.5
2000	10	9	4.5	2000	1000	6
4000	5	4.3	2.3	4000	2000	5
6000	3.4	2.9	1.5	6000	3000	4
8000	2.5	2.1	1.1	8000	4000	3
10000	2	1.7	0.9	10000	5000	2.3

Or to put it another way:





On the left are the three points distributors used in the 4-cylinder and V8 MGBs. On the right is the chip that is used in the HEI system of the 45DM4 MGB distributor (and many commercial variable-dwell ignition systems, HEI-4) and if the same chip were used on the V8 (HEI-8). These are 'typical' coil-on figures from the manufacturers spec, but the maximum can be as high as indicated in HEI-4b i.e. significantly higher at lower rpms, and approaching that of points.

These figures also show that a dual-point distributor is just adding complexity for no gain - other than a higher temperature coil - as the additional coil on-time simply isn't needed for a good spark at any rpms likely to be found on an MGB engine. And if you think about it its USP is exactly the opposite of a variable dwell system - they can't both be 'right'!

But if you are determined to replace your points system, read on. Aftermarket devices such as the Pertronix Ignitor and Lumenition Magnetronic are similar to the factory systems in that they are electronic triggers and replace the points. However with modern electronics they can

be made small enough to fit entirely inside the distributor cap. Lumenition Optronic seems to be much the same, except it uses an optical trigger instead of the magnetic of the Magnetronic and requires an external power module similar to the factory systems. All these systems are the same as points in that they are Inductive Discharge systems, using a 'switch' to break the circuit through the coil and generate the spark. Electronic systems popular in the 70s like Sparkrite were Capacitive Discharge which used an oscillator to charge a capacitor to a high voltage, then discharged the capacitor into the coil to generate the spark. This results in a high voltage at the coil LT terminals, and a dangerously high voltage at the HT terminals, which if open-circuit i.e. not connected to a spark plug could cause injury up to and including death. Whether these much higher energy systems result in anything useful is debatable. IMHO they may make the difference between starting and not starting under the most adverse conditions of weather and poor maintenance, or consistent firing of the much weaker mixtures used in modern engines, but that's about it.

Often after-market systems cause problems for the electronic tachometer, particularly with the earlier RVI current-triggered type (see here for some suggestions on resolving this). Other down-sides are that when they fail they often do so suddenly and totally, they are difficult or impossible to diagnose or repair other than by substitution, and expensive to replace (see above). By comparison points and condenser are cheap to carry as spares, and easy to diagnose and replace at the roadside. ***Updated July 2010:*** A while ago a very much cheaper version of the 'under cap' electronic module from Simon's Best British Classics came to my attention. At around £20 these are about a third or less than the price of the Pertronix, Aldon and Magnetronic versions so it becomes feasible to fit one and carry another as a spare. However on the MG Enthusiasts BBS some people swear by them, and others swear at them after repeat failures. One of these people had two Pertronix fail, another had external unit types fail. Yet another had two from SimonBBC fail, but these were blue (like David Blake's junked item below) whereas current stock appears to be red. However the descriptions for the various types are a bit confusing. Some for the 25D4 say they are for 12v coils and no external ballast, which they all were from the factory anyway, whereas some for the 45D4, which were all ballasted from the factory, don't mention this. And at least one says if used on a ballasted coil it will be damaged, similarly if jump-starting from another car! In various places it says 12v coils must be fitted and the ballast bypassed, but not everywhere. I've contacted the vendor and he informs me that as long as the red wire is taken to a 12v supply, for example the white wire at the fusebox on cars with ballasted ignition, then the module will be fine (See here to confirm whether you have a ballasted or a non-ballasted system, which you really need to do if intending to fit one of these units regardless of how your car might have come out of the factory). It's a pity he can't make this clear on the site. If you do replace your 6v coil and ballast with a 12v coil, then you are throwing away some of the benefits of electronic ignition. Original 12v coils have higher reluctance, which means they need a longer coil recharge time for a given HT spark than 6v coils with a ballast, so you are getting a weaker spark at peak revs. A 12v coil will also run hotter than a 6v coil, unless the ignition module has variable dwell.

The other issue concerns 45D4 distributors, which had two different types of points (and hence points mounting plates) - one sliding (with a pin) and the other non-sliding (no pin). Other vendors supply two different modules depending on the points type, but not this site. Again information from the vendor is that the module is really intended for the non-sliding type, but can be fitted to the other type "if the pin is bent out of the way". ***Updated November 2010:*** There is a warning on the site concerning jump starting, recommending that the flat battery is charged either from the other vehicle (or a charger) then the jump-leads removed before attempting to start the car, or the ignition module can be destroyed. This is quite different to the usual jump-start instructions and could take some considerable time to charge the battery enough to start the car. The page also indicates that the unit is not protected against reverse connection, and voltages over 14.2v may damage the module. However the MGB Workshop Manual states that voltages can be as high as 14.7v for an alternator and

15.5v for a dynamo. In the case of the dynamo the voltage regulator is temperature dependant, output voltage increasing as ambient temperature falls, and that 15.5v is at 50F/10C. As temps even in the UK can get quite a bit below that system voltages could be even higher. The instructions also state that the unit cannot be used with a ballasted system - the ballast must be bypassed. One of the suggested ways of doing this is to run a 12v ignition wire direct to the coil +ve, but if you do that without changing the coil to a 12v type the coil will overheat in use. All-in-all quite a few points against use of the system, for all it's cheapness.

Added December 2007: One of the more informative and educational postings to Youtube comparing Pertronix, points and 123. It shows the Pertronix jittering almost as much as points, although that could well be a factor of different amounts of wear on the two old distributors as compared to the new 123, I would have preferred to see the Pertronix and points on the same mechanically refurbished distributor. After replacing the timing chain and gears (obviously not a factor on this distributor machine) on my V8 noticeable jitter beforehand had almost completely disappeared, and that on a distributor with at least 100k on the clock and probably nearer 200k. Note the Pertronix distributor seems to 'advance' in the opposite direction to the points and 123, and the very obvious steps in advance of the 123 as well as its total lack of jitter at higher rpms, although it seems to have significant erratic jitter at lower.

Unfortunately the 123, despite being a beautifully engineered bit of kit, is designed to a fundamentally flawed concept, and very expensive at £300. The only useful bits on it are the fact that you get a new body i.e. bearings, and a solid-state trigger. But you can get those elsewhere for £45. It's a waste of all that modern technology to simply reproduce the original curves, which were all that could be obtained with the technology available 60 years ago, can only give a rapid increase in advance initially then a slower increase, and at best were only ever an approximation of what the engine really needed. With modern fuels, engines this old and many with modifications, the original curves are even less relevant. One vendor said that he recommended the generic version over the MGB-specific (that were available at the time) as the curves were 'better' for today. Another vendor has said that the curves don't match the specifications anyway, and it needs setting-up on a rolling-road (which he happens to have ...) to get the best out of it! It's like someone designing a new engine with the latest mechanical, ignition and fuelling technologies, but configuring it to deliver 110 ft.lb and 63BHP at 3000rpm, and 27mpg, and charging double the price of a rebuilt original! Far better are programmable systems where you can set the advance rev point by rev point for your specific engine and fuel and store a number of maps, one of which when combined with a new distributor body and electronic trigger is only half the price of the 123.

Added January 2008, updated October 2008:

Dave Blake had purchased a distributor on eBay that seems to have been a standard 45D4 but with an electronic trigger (seen here) instead of points. He recounted on the BBS considerable problems trying to get his engine to work properly, eventually resolved when I suggested replacing the trigger with points and a condenser! Dave was going to bin the trigger but kindly sent it to me instead. It is of the same type as Pertronix/Aldon/Magnetronic i.e. magnetic and contained entirely under the cap, but is of a different unspecified manufacture, I tried to find out what without success, but subsequently info from Gary Falkiner indicates that it is also used in a Land Rover conversion kit. It has the same two wires leading out to the coil as the others i.e. one red to the coil +ve and one black to the coil -ve, but the rotor is different on both Dave's and Gary's in that the magnets are integral, the others have a separate magnetic ring that fits over the cam, then a standard rotor goes on the end of the shaft as normal. The separate magnetic ring definitely preferable, as with this integral unit if the rotor should need replacing you would have to get this special one with the magnets, and without knowing the manufacturer whether you would be able to obtain one from eBay is anyone's guess. The

alternative would be to scrap the unit and go back to points ... I put Dave's on my bench tester and found that it triggers 30 degrees before points in the same distributor. Whilst this variation could be compensated for from a timing point of view fairly easily by simply twisting the distributor in the clamp, one is left with a change in phasing i.e. the relative positions of rotor and cap contact when the trigger fires. And on my test distributor with a cut -away side I could see that when you start to add vacuum advance, the rotor was moving away from its cap contact, so the spark was having to jump a larger and larger gap. Eventually it would fail to do so, or jump elsewhere, causing erratic HT and misfire when fitted to an engine. Why it is like this is anyone's guess - poor manufacture? Wrong rotor? Who knows? Dave was fortunate in that he **was** able to retro-fit points and a condenser, it could have had a trigger plate that wasn't compatible. Gary reported that he had to retard the timing by 15 degrees to get back to the same point as before, showing that his phasing was also significantly different to points. Initially it seemed to run well but after a bit of use it was noticeably inconsistent, and kept picking up iron filings on the magnetic collar which may have been affecting things. In the end he went back to points as well!

Added February 2008:
Another problem that has just come to light when replacing points with one of the 'under cap' systems concerns the condenser fixing screw. As part of installation you remove the condenser as it is no longer required, but the screw has to be refitted to secure the braided earth wire which is still needed with these 'under cap' systems. After installation the engine was run but was giving very poor and erratic results. Eventually the cause was found to be the condenser fixing screw was too long and being hit by the centrifugal advance mechanism. Probably a non-standard screw in this case, but something else to be aware of.

Coil Current: Many moons ago someone, rather smugly I thought, said electronic triggers are better than points as they have zero 'contact' resistance i.e. better than points even if they (the points) only dropped a tenth of a volt. At the time I wondered if he had ever measured the volt-drop across an electronic trigger, because one of the many things I remember from my electronics theory days is that semi-conductors exhibit a forward-bias volt-drop when conducting. This doesn't vary with current as in a conventional resistor, but instead differs according to the semi-conductor junction material. I remembered this as 0.3v for germanium diodes and 0.7v for silicon, pleasingly repeated here. However those are diodes, the switching in these devices will be done by some kind of transistor. Again from my theory days 'Darlington pair' transistors are used to increase switching current capability, and we are talking about 5 to 6 amps for an ignition coil. These have twice the base to emitter volt-drop than single transistors as there are two in series, but there are two parallel paths from the source voltage to the load. In theory this would halve the effective resistance and volt-drop from source to load, but each one consists of two junctions in series so what the overall volt-drop would be is difficult to gauge and I haven't found any statements on the subject. But these devices use Hall-effect transistors which are different again. This document indicates Hall-effect switches drop 1.5v when sourcing and 0.4v when sinking. 'Que?' as Manuel might have said? I don't really know either but the diagrams seem to indicate sinking is the mode used in ignition triggers, i.e. sinking current from a load (the coil) to earth. Being a simple chap and far more reliant on practice than theory, there was nothing for it but to measure it - and the results were very interesting. A set of old points, used as removed i.e. the contact faces not cleaned up, gave about 0.5v, so quite a bit. But the electronic trigger gave fully 1v! I also noticed it is a fixed-dwell device just like points, and not variable dwell like the 45DM4 or some after-market triggers. These Reopus FAQs indicates that the original Opus system also gave a 1v drop, and when the MGB changed to the ballasted ignition and 6v coil in rubber bumper cars, and North America got electronic ignition, the UK cars got a coil with nominally 1.5 ohms primary resistance (16C6) whereas North American coils were nominally 1.4 ohms (15C6) precisely so as to offset this reduction in voltage and current. Very late in production in 1980 North American coils were changed again to a 32C5 for which several sources give a nominal primary resistance of 0.8 ohms! By this time they had the 45DM4 distributor and electronic ignition system, it would be interesting to find the volt-drop in these, as well as other electronic triggers such as Pertronix and Aldon Igniters, and Lumenition Magnetronic.

The points volt-drop was measured on a bench test rig with old points so I thought I'd check the V8 with relatively new points, and I was a bit surprised to see almost as much at just under 0.4v, so I decided to dig in a bit further. I was measuring the voltage between the two most accessible points, which was the -ve coil stud and the distributor body. But this includes the points wire spade to coil tag, points wire, connection to points, points themselves, points base to points plate, distributor earth wire, and its connections to the points plate and distributor body. When I started breaking these down the results got very interesting indeed:

coil stud to points wire spade	0.03v
points wire, coil to points	0.19v
points wire terminal to points spring	0.03v
points	0.08v
points base to distributor body i.e. distributor earth wire	0.02v

So the biggest volt-drop by far is in the wire from the coil to the points! That in the points themselves is half that, and ignoring the points the remaining volt-drop, which will present no matter what type of trigger is used, is 0.27v, more than three times the volt-drop in the points themselves!

Variable vs Fixed Dwell: The factory 45DM4 CEI system, and various after-market systems, use variable dwell. This is a relatively constant 'on' period or coil recharge time regardless of rpm, and a long 'off' period at low rpms which shortens as the revs increase. With points the coil is energised for about 60% of the time throughout the rev range, which gives a much longer coil energising time than is needed at low revs. Variable dwell only energises the coil for as long as is needed before each HT pulse is required, regardless of rpm, of about 5mS per HT pulse. But a points system at, say, 2000 rpm is energising the coil for about 10mS per HT pulse, and nearly three times that at idle. This means the heating effect of a variable dwell system is only a small fraction of that of points or other fixed dwell systems across most of the rpm range. However the difference decreases as the revs increase, and at maximum revs the energising time in variable dwell systems becomes higher than points - at 6000 rpm a 4-cylinder coil is energised for about 3 mS, and a on V8 at 5600 rpm for less than 2 mS. This is more than enough as the V8 will all too easily rev into the red zone if you don't pay attention to the tach.

Programmable: *December 2013* Fairly new to the market are two programmable modules that are inserted between the trigger and the coil - Aldon Amethyst and Accuspark Stealth. A pal has some experience of the former but from the blurb they seem to be similar in that that allow you to develop your own set of curves by specifying the amount of advance at a number of rev points. However it looks like that Amethyst manages the vacuum advance - and boost retard if you have a supercharger - and hence is also mappable, whereas with Stealth vacuum advance remains as before i.e. is fixed by the distributor vacuum capsule. Another difference is that whereas Amethyst is compatible with points or any electronic ignition module, the Stealth information implies that you must have an under-cap electronic trigger. See also this from the Amethyst designer, who did the initial development on a 1967 MGB.

Said pal put an Amethyst on his supercharged MGB and tinkered with the rev points increasing/reducing until he ended up with a 'curve' whereby each rev point was one degree short of causing pinking. He ended up with a very unusual (by mechanical distributor standards) curve, but the whole point of being able to configure your own is that it can be tailored to exactly what your engine and fuel grade require right across the rev range. By

comparison a conventional distributor is a relatively crude device, pretty-much only able to have a steeper increase at lower rpms, and a shallower one at higher. The upshot was a noticeably faster car using the 'seat-o-pants' meter.

I understand the 123 was upgraded to include a programmable setting, but only one, and it is an 'all or nothing' device in that if fails you are stuffed. But if either of these programmable modules fail you can bypass them and run the coil directly off your trigger. Both Amethyst and Stealth require you to disable the centrifugal advance on the distributor so bypassing the modules prevents any additional centrifugal advance, which would reduce performance and economy and increase running temperature, but at least it would allow you a 'limp home' mode. Amethyst installation instructions say to set the distributor to your normal static advance, whereas the Stealth instructions imply that you set it to TDC which would hit performance and economy and increase running temperatures even more. However I don't really see why the distributor with Stealth couldn't be set to the static figure just like Amethyst. Bypassing Amethyst would disable vacuum advance as well, but that can be dealt with by simply transferring the vacuum pipe back to the distributor capsule. At the time of writing the 123 is very expensive at £300, the Amethyst significantly cheaper at £200, and the Stealth half the price of the Amethyst at £100, but you have to add the cost of an electronic trigger to the Stealth. Incidentally Accuspark claim ***"Electronically adjust intial*** (sic) ***timing by up to 9 degrees via laptop, no need to adjust distributor with timing light"*** but this is incorrect, or at the very least misleading. With both these modules you can only set the **additional** advance with a computer, not the absolute figure. You still have to position the distributor in the block to give the correct initial advance - either to the static figure or to TDC, which can only be done in the normal way i.e. statically with a test-lamp or meter, or dynamically with a timing light.

Fault Diagnosis *October 2015*

Cutting-out
Cranks but won't start

Cutting-out - either momentarily i.e. similar to a misfire, or stopping the engine altogether: The first thing to do if you have an electronic tachometer instead of the mechanical rev-counter, is look at the tach, and that is before doing anything at all i.e. switching off the ignition or dipping the clutch, so the momentum of the car is still spinning the engine. If the tach has dropped to zero, then the problem is in the ignition LT circuit. If it still registering, and just dropping as the car and engine slows, it will be ignition HT or fuel, or possibly the condenser. If you do have a rev-counter then it is probably best to investigate the ignition system first, as the adage has it - "90% of SU carb problems are caused by Lucas ignition".

If the tach does suddenly drop to zero then look at the ignition warning light (if it has been working normally that is!) as well. If that is glowing then you have lost the voltage supply to the ignition system. In most cases this means a fault in the ignition switch or its wiring, but on 1977 and later cars with ignition relay it can also be caused by the ignition relay and it's wiring.

If the ignition warning light is **not** glowing, try another ignition powered circuit such as the indicators - you will probably want to be indicating to pull over anyway! If they don't work either, then it's probably going to be a break in the wiring between the ignition switch or relay and the fusebox.

Due to changes over the years and markets the indications of the ignition warning light and indicators can point to different causes, I've tried to summarise these below:

Year/market	Warning light	Indicators	Likely area
62-64	on	(no)	brown to ignition switch, ignition switch
	off	no	white from ignition switch to fusebox
	off	yes	white from fusebox to coil etc.
64-67 Mk1	on	(no)	brown to ignition switch, ignition switch
	off	(yes)	white from ignition switch via tach to coil etc.
Mk2 67-72 UK	on	(no)	brown to ignition switch, ignition switch
	off	(yes)	white from ignition switch via tach to coil etc.
Mk2 67-72 NA	on	(no)	brown via bullet connector to ignition switch, white to bullet connector
	off	(yes)	white from bullet connector via tach to coil etc.
73-74 UK	on	(no)	brown to ignition switch, ignition switch
	off	no	white from ignition switch via bulkhead 4-way bullet connector to fusebox
	off	yes	white from fusebox to coil etc.
73 NA	on	(no)	brown via bullet connector to ignition switch, ignition switch, white from ignition switch to bullet connector
	off	no	white from ignition switch bullet connector via bulkhead bullet connector to fusebox
	off	yes	white from fusebox to coil etc.
74 NA	on	(no)	brown via ignition switch multi-plug, ignition switch, white via ignition switch multi-plug
	off	no	white from ignition switch multi-plug via bulkhead bullet connector to fusebox
	off	yes	white from fusebox to coil etc.
74½-76 UK	on	(no)	brown to ignition switch, ignition switch
	off	no	white from ignition switch via bulkhead 4-way bullet connector to fusebox
	off	yes	white from fusebox to coil etc.
74½-76 NA	on	(no)	brown via ignition switch multi-plug, ignition switch, white via ignition switch multi-plug
	off	no	white from ignition switch multi-plug to fusebox
	off	yes	white from fusebox to ignition ballast etc.
77 UK	on	(no)	brown via ignition switch multi-plug, ignition switch, white via ignition switch multi-plug to ignition relay, ignition relay, white/brown ignition relay to fusebox
	off	no	fusebox white/brown connections
	off	yes	fusebox to ignition ballast etc.
77-on NA	on	(no)	brown via ignition switch multi-plug, ignition switch, white to ignition switch multi-plug

	off	no	white from ignition switch multi-plug to ignition relay, ignition relay, ignition relay white/brown to fusebox
	off	yes	white/brown from fusebox to ignition ballast etc.
78-on UK	on	(no)	brown via ignition switch multi-plug, ignition switch, white via ignition switch multi-plug to ignition relay
	off	(yes)	white/brown from ignition relay to ignition ballast etc.

Click on the year and market for the relevant schematic.

Where the 'Indicators' condition is shown in brackets i.e. as (no) or (yes) it means that given the 'Warning light' condition it should always be this way, unless you have more than one fault.

'Coil etc.' and 'ignition ballast etc.' refer to the remainder of the ignition LT circuit i.e. through the ignition ballast (where provided), coil and points or electronic trigger to earth. Where the ignition warning light is extinguished and the indicators etc. still work the problem will lie in this part of the system. As well as disconnections in the wiring between fusebox, ignition ballast, coil and distributor, systems with points and after-market under-cap triggers rely on an earth wire inside the distributor that connects the points or trigger plate to the distributor body. With vacuum advance the points plate is continually being twisted back and fore as you change the throttle position, and this earth wire as well as the points or trigger wires as they pass through the body of the distributor, can fracture the conductors inside the insulation.

June 2016: Systems with an after-market electronic system where the electronics module is external to the distributor such as Lumenition Optronic use three wires from the trigger to the module and one of these is an earth or 'common' wire, so the original earth wire is no longer used. However any of the three wires can suffer from internal fractures due to the points plate twisting with changing vacuum as with the other systems.

Cranks but won't start: This can be caused by ignition problems, but also by fuel problems and other mechanical issues. If the car was running normally up to the point of non-starting then it is more likely to be ignition or fuel related. If you have been doing any work on the car then think carefully about what you were doing and where, even if it was nothing to do with ignition or fuel, as you may have disturbed something else. If the car is new to you, or it has been rebuilt since it last ran, it could be absolutely anything. Nevertheless if an engine has air, fuel, compression and a spark in approximately the right quantities at approximately the right time it should start and run - even poorly. The MGB is not a temperamental engine like some, and will often run when in the most appalling condition.

Static tests: With points ignition diagnosis of ignition system faults is relatively easy. With electronic ignition it can be much more difficult, usually substitution with another system is the only way. However in most cases if you completely disconnect the electronic system from the coil you can simulate points by temporarily connecting a condenser between the coil CB or -ve terminal and earth, and connecting an earth to the CB or -ve terminal to simulate the points being closed, and removing it to simulate the points being open. But if you have a very low resistance coil i.e. less than 1 ohm you will have to substitute the coil at least for a conventional 12v or 6v coil or you can end up drawing too much current which can damage the coil and wiring.

With the ignition on and the points closed you should have voltage on the coil SW or +ve, and an earth on the coil CB or -ve. On chrome bumper cars you should have 12v on the coil

SW or +ve. However rubber bumper cars had an ignition ballast resistance in series with the coil and the effect of this is to reduce the ignition voltage at the coil +ve to about 6v - as long as you have the correct 6v coil. If you have a 12v coil in series with a ballast resistance you will see about 8v. If you see other voltages there could be a problem with the coil, the ballast, or the wiring connections back towards the ignition switch or relay.

If you have 12v on both LT terminals of the coil then the circuit through the points and distributor earth wire is broken. Test the points spring and moving contact, and if that shows an earth then the wire between the points and the coil is broken. If it shows 12v - and the points are closed - then the earth wire inside the distributor is broken.

If you have voltage on the coil SW or +ve and an earth on the coil CB or -ve, then turn the engine by hand until the points open, or hold the points open by hand. You should then see 12v on both terminals of the coil. If you still see 0v on the coil CB or -ve then remove the wiring from the coil CB or -ve. If that terminal now shows 12v then the wire between the coil and points is shorting to earth, this may be from faulty or incorrectly installed points or a short-circuit condenser. If the coil CB or -ve terminal still shows 0v then the coil itself is open -circuit. Another check is to measure the current passing though the coil, which with ignition on and points closed should be nearly 4 amps.

If all that looks correct the coil should be generating HT sparks. Remove the coil lead from the distributor cap and connect it to a plug laying on the block, then manually flicking the points open and closed should show sparks. If not the coil may be faulty, or possibly the condenser is open-circuit. In this latter case the points will be sparking and spitting excessively, to confirm temporarily connect another condenser between the coil C or -ve and earth. If this reduces the arcing and spitting and you now get the plug sparking then change the condenser. Check the points gap/dwell is correct.

Cranking tests: If manually operating the points generates HT sparks from a plug connected to the coil, then crank the engine while monitoring the voltage on the coil CB or -ve, and you should see between 5.5 and 6.5 volts. On the coil SW or +ve you should see about 10v on all cars but it depends on having a fully charged battery and the correct distributor, points gap, ignition ballast wiring and coil. If you only see about 8v on a rubber bumper car and battery condition is good the coil boost circuit is probably faulty, although this by itself shouldn't be enough to prevent the engine from starting unless other aspects are poor. However you will need either an analogue meter to see these voltages, or an averaging digital instrument, other digital instruments may have the reading flicking all over the place.

When you have HT at the coil lead then reconnect it to the distributor and refit the cap. Try cranking again, this time with each plug led in turn connected to a plug laying on the block. If none of them spark then the distributor rotor, or possibly the cap is breaking down. If some do and some don't then again it could be the cap, or individual plug leads breaking down, or faulty plugs, swapping plugs between leads should show which. An alternative is to use a timing light and watch the flashes, although bear in mind that a 12v light with inductive pickup may need a separate power supply to work correctly while cranking.

Timing: If all plugs and leads are sparking, then check the static timing. Setting this to about 10 degrees Before Top Dead Centre should be enough to start any MGB engine. With the ignition on connect a voltmeter between the coil CB or -ve, and with plugs out turn the engine until the notch on the crank pulley is under the 10 degree pointer on the timing cover. The last pointer the notch passes should be TDC, a smaller pointer immediately before that should be 5 degrees BTDC, and a large pointer immediately before that should be 10 degrees BTDC. With the pulley notch at 10 degrees slacken the distributor clamp bolt or clamp plate bolts and twist the distributor clockwise and anti-clockwise watching the meter switching between 12v and 0v, which is as the points open and close respectively. You should find that as you turn the distributor clockwise the voltage goes to 12v as the points open, and goes to 0v as you

turn it anti-clockwise and the points close. If you find it is the other way round then the distributor is 45 degrees out and needs to be turned one way or the other until you get the correct voltage swing. Then with the voltmeter at 0v i.e. points closed, slowly turn the distributor clockwise until the points just open and the voltage goes up to 12v. Tighten the clamp plate bolts - but don't overtighten the bolt on the plate that clamps the distributor body. Make sure the 4-cylinder distributor body flange is flush with the clamp plate when the clamp plate is fully bolted to the block. This ensures the distributor is fully seated into the drive gear, as it can partially seat when 180 degrees out.

Plug lead orientation: The distributor on the MGB rotates anti-clockwise as you look down on the top of the cap, and the firing order is 1, 3, 4, 2 with the cylinders being counted from the water-pump end to the flywheel end. Start by determining where in the distributor cap No.1 plug lead goes, then count the rest from there. To determine where No.1 goes turn the engine to TDC on the compression stroke of No.1 cylinder, and see where the rotor is pointing. Normally it points to about 2 o'clock, but if the timing gears have been fitted incorrectly, or the distributor shaft has been dismantled and put back together incorrectly the rotor will be 180 degrees out. Also if the 4-cylinder engine distributor drive gear has been inserted to the engine incorrectly the rotor could be in as many positions as there are teeth on the drive gear (eight or nine). The V8 distributor is different in that the drive gear is on the end of the distributor shaft, so more care is needed to refit the V8 distributor to the engine.

It also needs to be borne in mind that on a 4-stroke engine each piston passes through TDC twice for every combustion cycle - once on the compression stroke and once on the exhaust. To set it to the correct see here. As long as you fit No.1 plug lead in the cap position that aligns with the rotor position and count the rest from there, the engine should start and run, even if the rotor is not at 2 o'clock. If you want to correct the rotor position then see here.

There is yet another possibility for incorrect timing and that is if the wrong crankshaft pulley has been used, or it is a damped pulley and it has started delaminating - which is where the outer part that carries the timing notch moves in relation to the inner part that is keyed to the crankshaft. To check for this see here.

Even after all that if the engine has been dismantled, reassembled and won't start it could be something fundamental like valve timing or compression.

Ignition Coil

Should I have a 12v coil or a 6v coil?
How do I **tell** which I have?
Isn't the coil used on rubber bumper cars a 9v coil?
Should I have a ballast resistor?
How do I tell if there is one on the car?
What about a coil with an internal ballast resistor?
Why did they change to 6v coils anyway?
Should I reverse the coil connections when changing the car's polarity?
Should the coil point up or down?
Is my coil too hot? *Added January 2013*

All frequent questions as part of a lot of confusion on this subject. Coil manufacturers don't help I have come across one coil where it was labelled '12v', but then also said it needed an external ballast resistor! As we shall see this is completely contradictory.

The first question to get rid of is "What about a coil with an internal ballast resistor?": It matters not a jot whether a coil has an internal ballast or not, a coil is either a 12v coil or a 6v coil (and I shall come on to the differences between these in a moment). Originally all coils were 12v and contained nothing but many thousands of turns of copper wire. Subsequently manufacturers produced 6v coils for 12v systems, which when connected to an appropriate system (i.e. one that includes a ballast resistance in the circuit) produce improved ignition performance, whilst still needing to supply 12v coils for older systems. Now I don't know whether someone had the bright idea of putting a ballast resistance in the same can as a 6v winding and calling it a 12v coil, hence only having to produce one winding unit instead of two, or whether they worked out that it was cheaper to produce 12v coils that way anyway. But in any event you do end up with a coil that gives slightly better performance at high (much higher than a factory MGB ever produced) rpms, although it makes absolutely no difference to how the coil is used or what car it can be used on. So in most cases if any supplier starts asking or talking about internal ballast ignore it.

Chrome bumper 4-cylinder cars had a 12v coil with a direct ignition feed (white). Rubber bumper cars and all V8s had a 6v coil connected to the 12v ignition feed via a ballast resistance. This resistance is not an identifiable component but a length of resistance wire contained within the harness. The resistance wire itself is usually pink with a white tracer, but has a white or white/brown tail at the supply end, and a white/light-green on a 4-cylinder or white/light-blue on a factory V8 tail at the coil end. This is how the cars came out the factory, but if replacing the coil it is important to know if a PO has bypassed the ballast resistance or a rubber bumper or V8 for some reason, or even added one to a chrome bumper 4-cylinder car. Using a 6v coil in a 12v system i.e. with no ballast resistance will result in overheating of the coil and burning of the points. Using a 12v coil in a 6v system will result in reduced HT spark. You can't go by the colour of the wiring, there are some unfeeling butchers out there, you have to do a simple electrical test. Remove the wires from the coil on the points-side, usually black/white. Connect a voltmeter on its 12v scale to the other coil terminal and turn on the ignition. On all cars you should see battery voltage i.e. 12v. Now connect an earth to the points terminal...

- If the voltage stays at 12v or only drops a couple of tenths, there is no ballast resistance in circuit which is correct for a chrome bumper. There **should** be a 12v coil but you will have to measure the primary resistance to see if it is or not (see next section).
- If the voltage drops to about 6v it looks like there is a ballast resistance in circuit and there is a 6v coil which is correct for a rubber bumper or all V8.
- If the voltage only drops to about 9v it looks like there is a ballast resistance in circuit, but with a 12v coil, which is incorrect. The ballast resistance could also be faulty or incorrect. You will have to measure the resistances of the ballast and coil to see which.
- Note you could have a 6v coil used without a ballast, but you will have to do a resistance or current measurement to detect that incorrect combination.

It is possible to tell the difference between 12v, 6v and other coils by measuring the primary and secondary resistances (between the spade terminals, wires disconnected) as follows:

Coil	Primary Resistance (ohms)	Secondary Resistance (ohms)	Designations
12v	3	5.4k	DLB101, GCL101, GCL110
6v (15C6, UK)	1.5	6.5k	DLB102, GCL111
6v (16C6, NA)	1.4	?	DLB102, GCL111
Typical 12v Sport	2.4	8.3k	DLB105
6v Sport	1.5	?	DLB110
45DM4 (32C5, NA)	0.8	5.8k	DLB125

Note 1: Resistances nominal e.g. the 12v can measure from 3.1 to 3.5 ohms and the UK 6v 1.43 to 1.58 ohms
Note 2: DLB101 has the screw-in HT connector, GCL101 and GCL110 the push-in.
Note 3: Resistances for the 'Typical 12v Sport' are as measured from a coil (no part number) in my possession. DLB105 seems to be the current (ho ho) part number, and various places quote this as 3 ohms primary and 9 kilo-ohms secondary, i.e. not as 'sporty' as the one I have.
Note 4: The DLB110 6v Sport coil must be used with an external ballast on a 12v system such as the MGB. The original harness ballast of the rubber bumper MGBs is about 1.5 ohms, and I have seen external 'component' ballast resistances ranging from 0.9 ohms to 1.6 ohms recommended for use with this coil. This range will give a significant difference in current hence performance and coil temperature - higher resistances reducing performance, lower increasing coil temperature. (Whether there is a usable and measurable performance gain from 'sport' coils is another matter ...)
Note 5: The 32C5 must only ever be used with a variable dwell electronic ignition module or it almost certainly will overheat.

There is lot of conflicting and confusing information on the web regarding coil and ballast resistances. Haynes and Clausager differ in some respects, and even the Leyland Parts catalogue for September 76 on i.e. ballasted ignition isn't immune as it specifies GCL110 for other than cold climates and the USA, but every other source I have seen says that is a 12v coil i.e. for unballasted i.e. chrome bumper cars. The distinction between the three original types of 6v coil seems to have been lost as far as replacements are concerned. Some sources specify a GCL132 coil for ballasted systems but others say this is a 9v coil and not a 6v. I've not been able to find a resistance quoted for this coil, but the implication is that using a 9v coil on a 6v system will result in lower spark output. However reference to 9v could simply be down to incorrect interpretation of coil voltage measured on a running engine. The ballast resistance should measure about 1.5 ohms, taken between the white/light-green or white/light-blue removed from the coil +ve and the white or white/brown at the fusebox.

Added November 2009: Another useful test of whether you have the right combination of coil and ballast is to do a current test. The Leyland Workshop Manual quotes the 'ignition on' current at 3.9amps, which equates to 12v across a 3.1 ohm coil, and a 6v coil with harness ballast is very similar on my V8. If a sport coil is fitted this will rise to about 5 amps for chrome bumper and 4.5 amps for rubber bumper. If the current is higher than that, e.g. 8 to 10 amps, then you could have a 6v coil with no ballast, when you should have a 12v coil. If the current is 3 amps or lower then you could have a 12v coil plus ballast, when you should have a 6v coil. Of course you could have the correct combination, but a faulty coil, ballast or connections somewhere, which needs further investigation with a voltmeter.

However it also quotes a running current of 1.4 amps at 2000 rpm, but this doesn't equate to the calculated figure when you take the higher running voltage and the relative points closed and open times into account, which should be (say) 14.5v, 60 degrees closed and 30 degrees open i.e. 67% closed, which should give 3.1 amps. In fact 1.4 amps **is** what is displayed on my **analogue** voltmeter, which will be mechanically averaging 'ignition on' current (points closed), zero current (points open), plus any other currents and voltages generated as the points open and close i.e. induced currents. A perfectly valid and useful test, but digital instruments may give a completely different figure, or may not 'settle' and give a steady reading at all. My V8 with 6v coil and harness ballast also gives very close to 1.4 amps running, it's only during cranking that the coil current on a ballasted coil should be significantly higher.

Click the thumbnail to see the ballast wire from a 1980 roadster.

Early, positive-earth cars had coils with terminals labelled 'CB' and 'SW'. Negative-earth cars had coils with terminals labelled -ve and +ve. The CB terminal is connected to the distributor **C**ontact **B**reaker (aka points) and the SW to the ignition **SW**itch. The -ve terminal is connected to the distributor points and the +ve to the ignition. Note that if a positive-earth car is converted to negative earth, e.g. to enable an alternator to be fitted, the coil terminals should be reversed i.e. CB to the ignition and SW to the distributor. The engine will still run without this reversal but the spark will be adversely affected. *November 2009:* Conversely, and prompted by a comment from Peter Caldwell, if fitting a modern coil to a positive earth car the white ignition feed goes to the -ve terminal and the points wire to the +ve.

Isn't the coil used on rubber bumper cars a 9v coil? No. This has come about from connecting a voltmeter to a rubber bumper coil on a running engine and not understanding what the meter is telling you. You **will** see about 9 or 10v on an analogue meter (digitals can be different or give no usable reading), but that is because the meter is averaging the voltage with the points open which will be 12v with the voltage when they are closed which will be something less. To see the true picture you have to measure the voltage on the coil +ve with the engine stopped, points closed, and ignition on. The ballast resistance should be of a similar resistance to the coil, so with the correct coil and ballast resistance on a rubber bumper MGB you should see about 6v, not 9v, hence it is a 6v coil. If you **do** see something significantly different to that then there is something wrong with your coil, ballast resistance or ignition supply voltage.

Why did they change to 6v coils anyway? The main benefit of the 6v coil is that it enables the ignition to generate a more powerful spark during cranking. Even a tip-top battery will have its voltage reduced during cranking, typically to around 10v, because of the very heavy load of the starter motor. On a 12v system this means the primary current and therefore the HT spark will be reduced. But by using a 6v coil and a special starter solenoid, the ballast resistor is bypassed during cranking and the maximum available battery voltage will be connected directly to the coil, i.e. 10v, which results in a **stronger** HT spark than when running. This is beneficial to all cars under extreme conditions i.e. very cold, thick oil, battery in less than perfect condition due to age or short journeys in winter with lights, heater etc always on. The more powerful spark was even more important on North American emissions controlled engines which were harder to start. Note that all 18V engines had the 2M100 starter with the coil boost contact, but it was unused until the start of rubber bumper production. All V8s had the 6v coil system. There is also said to be another benefit of 6v coils and that is they have lower inductance than a 12v, and hence lower 'reluctance' to build up flux, therefore a shorter time to build up full flux for the next spark, and so a greater ability to supply a full spark at higher revs. However the rev limit of the MGB didn't change over its life and the change was more of an industry standard thing than aimed specifically at the MGB. Since the V8 with twice the cylinders, half the dwell, and hence half the reflux duration of the four cylinder has no problem delivering much the same peak rpm, Jaguar V12 engines even more so, this aspect is largely irrelevant. Whilst the plug gap was able to be increased from 25 thou to 32 thou with the introduction of 6v coils this may be much to do with the change from the 25D4 distributor to the 45D4 and perhaps an improved resistance to breaking down at high HT voltages, than greater energy from the coil. The special solenoid has an extra spade terminal which puts out a full 12v on the white/light-green (white/light-blue on factory V8s) wire to the coil when the solenoid is energised. This wire goes to the +ve terminal of the coil, together with the same coloured wire from the harness ballast. A 6v coil also generates half the heat of the 12v coil the other 'half' of the heat is generated in the wiring ballast resistor, but again this is neither here nor there. Many people replace the starter with a modern geared or 'Hi-torque' unit and many of these don't have the additional contact to boost the coil voltage on starting. Whilst under most condition the car should still start pretty well,

under adverse conditions it can make the difference between starting and not starting. There are a number of ways to get round the lack of 'coil boost' contact, see here.

Updated May 2010: **Should I reverse the coil connections when changing the car's polarity?** It's often recommended, but is it really necessary? And what are the benefits and drawbacks? This Lucas document (p11) states that a negative polarity should be presented to the insulated plug terminal with positive to the plug body. This is because electrons (which travel from negative to positive, unlike conventional current or charge flow) would rather jump from the hotter central electrode to the cooler body than the other way round, which requires about 10% more HT voltage to get the spark started. Negative HT also results in less erosion of the rotor, as one quarter of the amount of metal is transferred from each cap contact to the rotor over a given length of time, instead of all of it being transferred from the rotor to the cap contacts. Remember HT voltage will rise until the plug fires, then more-or-less stops there for the duration of the spark. Typical measured HT voltage for a 25 thou plug gap will be 6 to 10kV, 10% being 600v to 1000v of course. So it would make sense to reverse the coil LT connections when reversing the battery. But another feature of the coil is that the 'other' end of the HT winding doesn't go to the can as you might suppose, but is connected to one end of the LT winding. Originally this would have been the points terminal (CB), and the reason is that when the collapsing flux generates the HT voltage in the HT winding it also generates 200-300v in the LT winding. Connected as originally this voltage is added to the HT voltage to boost it, known as the auto-transformer effect. Reverse the LT connections to correct the HT polarity and you lose this boost. So which to do? As reversing the coil connections when reversing the battery adds 600 to 1000v, but loses 200-300v auto-transformer effect, it is better to reverse the LT connections. But it would be better still to buy a negative earth coil and retain both effects, which is what the Lucas document recommends.

How can you determine the polarity of a coil? You could measure from the HT terminal to each LT terminal, and the one with the lower resistance i.e. the junction between the two windings should go to the points. But that is looking for 3 ohms difference in over 5000 ohms, which would need a digital instrument with at least 4.5 digits to reveal. You could do an open-circuit bench-test and see which LT polarity jumps the largest gap (a cold gap, so HT polarity difference won't matter), but that will result in some very high voltages in the coil which probably isn't wise. A test with a controlled gap in the HT circuit is no good as the voltage will stop rising when the gap fires. You **may** be able to tell by looking at the two induced voltages on an oscilloscope. If that on the HT lead is negative with respect to earth (as it should be), and the LT terminal connected to the points is also negative with respect to the LT terminal connected to the ignition supply, then the implication is that the required auto -transformer effect is also present, but I have not tested this. I did wonder whether you could use the effect mentioned above whereby the auto-transformer action tends to reduce the current displayed on an analogue instrument, but because the induced voltage in the LT winding will always be opposite to the battery current, no matter what coil you have on what polarity car or which way round, the reduction will always be present. You can probably assume that an original coil from a positive earth car marked SW and CB is a positive earth coil, and that from a late car marked + and - is a negative earth, but that doesn't help one jot with replacement coils, where even if you can get one marked SW and CB there is no guarantee it's internal connections are for positive earth. Note that at least one edition of 'MGB Electrical Systems' is incorrect in that it states "On negative earth cars as long as the distributor is connected to the + terminal (of the coil) the test should be unnecessary". On a negative earth car the distributor (i.e. the earth supply to the coil) should be connected to the - terminal of the coil, and the 12v ignition supply (the positive supply to the coil) should be connected to the + terminal. A number of sources talk about using a graphite pencil tip held in a spark gap, and when the polarity is correct there will be a brighter spark or 'flare' from the pencil tip to earth. However having tried that I found it very inconclusive, there is a much better way using an analogue meter between the coil lead and earth. You still need a spark gap e.g. a spare plug connected to the coil lead laying on the block and not just an open-circuit lead, then remove the distributor cap and flick the points open and closed by hand. With the correct polarity the meter (with -ve connected to the coil lead and +ve to earth) should show an upward flick as the points are opened, and a downward flick as they are closed again. This opposite flick is because the coil is a transformer, which will generate a voltage in the output when current commences flowing just as it will when it ceases, but only when it ceases and the condenser is in circuit because the points are open will it generate the higher voltage needed to fire the plug. One source recommends connecting the meter across a plug in the engine and cranking, but because of this upward flick as the points close the meter will waver and it won't be clear whether it is the opening of the points or their closing that is causing the downward flick.

When all is said and done, whilst when some documents were written ignition systems may have needed every volt they could get, in an MGB ignition system there should be more than enough energy to be able to ignore all these variations. However it could just possibly make the difference between starting and not starting if any one or more of points, plugs, condenser, rotor, cap or leads are in poor condition. It's even less of an issue with modern electronic HV systems, for a start 'wasted spark' ignition systems fire two plugs at the same time (both being fired when either plug needs a spark hence the spark to the other plug is 'wasted') but these systems always fire one plug one way and the other plug the other, so plug polarity with this system can't be an issue. Some manufacturers apparently fit different plugs for +ve HT than to -ve, but this is more about saving money in terms of the amount of platinum on each electrode than plug performance. Yet another source claims that on a system with dual polarity HT i.e. wasted spark you can double the life of the plugs by rotating the plugs between positive and negative HT positions. If that really is the case, then we could do the same simply by reversing the coil LT leads every now and again! But it doesn't seem to be worth the bother against a few quid for new plugs every 10k. Speaking of which, I bought a set of Bosch Super 4 4-electrode plugs way back in February 1999, since when they have done about 34k miles (April 2016), and still show no signs of electrode erosion. Double the price of 'conventional' plugs, but since they have done 3.5 times the recommended life and still look as good as new, good value.

Added January 2011: **Should the coil point up or down?** From time to time this question crops up, and there are various comments about oil-filled coils being used pointing downward so the oil cools the HT connection. On one recent discussion someone who should know better roundly castigated everyone saying they should read the Workshop Manual, because the answer is in there, when it isn't - directly at least. What **is** in the WSM that is interesting is a description of a test-rig, where it says the coil must be mounted at 45 degrees, with the CB terminal uppermost, so that it's internal connection is **not** covered with fluid and any internal tracking between the iron core and the primary lead will be revealed. One would have to know that oil is used in HV systems to resist tracking (a spark will jump an air-gap more readily than it will jump an oil-filled gap) to work out that if the CB internal connection must be uncovered during testing to reveal any faults, then it should be covered in use to resist any tracking developing. Thus, the coil when mounted on the inner wing of 4-cylinder cars or radiator mounting panel of V8s should point downwards. Early MGBs (possibly just 3-bearing) have the coil mounted horizontally to the engine, so perhaps the terminals of the coil should be vertical with the CB (-ve for later coils) in the lower position. Incidentally engine-mounted coils will get hotter than inner-wing mounted coils, as they will be picking-up significant mechanical heat as well as electrical. Which brings me on to:

Added January 2013: **Hot coils.** There has been some discussion on this in various places for a while now, and it's a fascinating and complex subject given the apparent simplicity of the points/condenser/coil ignition system. Coils, like alternators and many other components, do run hot to the touch and are designed to be able to cope with it. The question is, how hot is normal, and how hot is too much? I'd say that if the average person can keep their hand on it, it's probably not too hot. If they can't, it probably is too hot. But that's very subjective, and the

real arbiter should be whether there is a problem with the running of the car or not. If not, and it just seems hot when you touch it, then ignore it. If there IS a problem with running then there is definitely something wrong somewhere, but it might not be the coil. One thing for us in the UK to remember is that these cars run perfectly well in desert states in America at ambient temperatures of well over 100 degrees Fahrenheit. The coil is behind the radiator (if not bolted to the engine), and so is obviously expected to work correctly at the highest engine compartment temperature that Abingdon expected. If someone in the UK is having a problem, especially at the moment, then it's being caused by a definite fault.

Contrary to what one person writing elsewhere is insisting, the minimum resistance of a 12v coil is **not** 3.5 ohms. The Leyland Workshop Manual specifies 3.1 to 3.5 ohms (i.e. 3.5 ohms is the **maximum**), Sport coils can be as low as 2.4 ohms, and coils for electronic ignition systems can be much lower than that. The writer is getting hung-up on the fact that if you connect 12v to a 12v coil then with about 4 amps flowing through it developing 48 watts of heat it **will** overheat. But all that means is that you shouldn't leave the ignition switched on with the engine stopped. If you need to do that for diagnostic purposes on other components then disconnect one side of the coil, remembering to reconnect it afterwards.

This isn't the ideal time of year to investigate typical coil temperatures as the lower ambient temperatures will be dissipating the heat faster than on a hot summer's day, so coils should be running cooler anyway. I've checked both mine - V8 with a ballasted system and roadster with an un-ballasted - and after running for about 20 minutes in 8 to 10C ambient they were only round 40C, which is only warm to the touch. I know the roadster (never tried the V8) gets much hotter than that in high summer, but I don't get any running problems with either.

Update May 2013: On one day with an ambient of about 15C the V8 coil was 52C, and on another with an ambient of 21C it was 58C. So with each increase in ambient there is a similar increase in coil temperature, as expected.

Update July 2013: In the midst of this heatwave I've been checking both cars again. The V8 at an ambient of 27C saw the lower part of the coil at 62C (the upper was a little cooler), so again a correlation between the increase in the ambient temperature and the increase in the coil temperature. Whilst 40C (10C ambient) is only warm, 62C is very much hotter to the touch. The engine compartment temperature varied between 40C bowling along the M6 round Birmingham at 9:30am, 45C coming back at 1:30pm, and in some stop-start traffic round Solihull with the fans on it got up to 58C. With the roadster at 26C ambient the upper part of the coil was at 67C (in this case the lower part was a little cooler). Higher than the V8 as before, but a slightly smaller difference than at lower ambients. The engine compartment in stop-start traffic round Solihull got up to 50C.

Update July 2016: Over the last two days of 30+C ambients I've been checking the V8 (the roadster is part-way through a clutch change). On both afternoons the engine compartment got up to 64C (measured closed with a probe through a grommet) and stopped with the bonnet open the coil measured 68C. No problems hot starting - either immediately or after a few minutes, so what the problem was in 2014 (intermittent problems in May, June and July even though it wasn't as hot as it is at the moment) I don't know.

If you think your coil IS too hot, or you have running problems, then you might like to read on for some specific tests you can do.

Some have wondered if a faulty tachometer could cause it. It's highly unlikely, with either early or late versions. It would have to be capable of injecting additional current into the ignition system, which given the internal circuitry is not possible, without showing some effect at the tach at the very least. Whilst both tachs can affect the ignition system under certain fault conditions, they would cause a significant misfire or stop the engine running altogether, and it would show on the tach. Neither would another cause be the condenser going short-circuit, as the most obvious indication of that again would be misfiring at best (with an electronic tach jumping around all over the place) or complete failure of the ignition at worst.

There are two factors involved in how hot a coil gets. The first is how much energy is being put into it which is a factor of its resistance, the voltage being applied to it, and hence the current flowing through it - the heating effect. The second is how fast it is dissipating that heat. How hot the coil will get over time depends on the temperature difference between the coil casing and the surrounding air in the engine compartment. On starting a cold engine they are both the same, so no dissipation, so the coil starts to heat up. As it does so it starts to dissipate heat, and the hotter it gets with respect to its surroundings the faster it will dissipate heat. Eventually the dissipation rate equals the heating effect from the current, and it reaches a stable temperature. A coil with a massive finned heat sink in arctic conditions will probably barely get warm. Wrap it in foam or fibre-glass insulation and it will almost certainly overheat. Under normal circumstances the coil is always capable of dissipating more heat than is being generated, if it didn't it would just get hotter and hotter until it burst into flames or burnt out.

But how should you measure it? Metal probes will only be picking up heat from the part of the probe that touches the surface of the coil, the rest of the probe surface will be radiating it and averaging the reading, so things like oven and personal thermometers are unsuitable, although you could put a piece of polystyrene insulation over the probe and a small area of the coil surface. You could use junior's ear thermometer perhaps, but I have no experience of those. You could also use an infra-red thermometer with laser pointer, but bear in mind the temperature is not being taken at the laser dot but over a much wider area, so the lens of the infra-red detector will have to be pretty-much on the coil to avoid picking up lower-temperature objects around it and averaging the result downwards. Perhaps those LCD strips would be the most consistent, but then they seem to have a relatively low range of a dozen or so degrees Centigrade, you would need to know which 'ball park' you were in to start with. The ultimate coil temperature will also depend on the air around it, i.e. the engine bay temperature. All in all not very conducive to getting comparable readings from different people using different methods on different cars. I measured mine with an infra-red thermometer placed right on the coil.

The Workshop manual says chrome bumper cars have coils of 3.1 to 3.5 ohms (cold, higher when hot), and with a switch-on voltage of 12v Ohms Law gives us 3.9 amps with an average coil, which is what is specified in the Workshop Manual, and this current is the first thing to check. This would generate 50 watts of heating effect (voltage squared divided by resistance) and **is** going to generate too much heat in the coil over a long period and can damage it. (If you need the ignition on for a long period with the engine stopped for any reason, remember to disconnect the coil as the points are usually closed when a running engine is switched off and allowed to come to rest on its own). If the current is significantly higher than 3.9 amps you need to measure the coil primary resistance, with the wires removed from the terminals. A low resistance coil will carry more current and get hotter than it should. If the current is lower, then you could have bad connections or bad points which will be causing a low HT voltage, but the coil itself will be running cooler than normal.

However, that's at switch-on. When running with points (electronic ignition systems are usually very different) the 25D4 distributor is only energising the coil for 67% of the time (derived from a dwell angle of 60 degrees in a 4-cylinder distributor i.e. 90 degrees per open/closed cycle). But now we have typically 14v as the system voltage so the heating effect is 42 watts (voltage squared divided by resistance times percentage energised divided by 100), but even that is not the full story. The coil is a transformer and has inductance and the effect of inductance is to cause the current to rise over a short period of time when voltage is connected, not instantaneously, so the heating effect is reduced still further. The Workshop

Manual quotes a running current (i.e. the average of no current for some of the time, partial current for some of the time, and full current for some of the time) of only 1.4 amps at 2000 rpm which implies only 9 watts heating effect. However the readings in the Workshop manual will have been made many years ago, and hence on an analogue meter, and the reverse EMF generated as the points open tends to kick the needle back a bit and give an artificially low reading. Nevertheless if you connect an analogue meter on its current scale in series with the coil and run the engine, this **is** the current you should see. If the static current was correct but the running current is too high or too low, you need to check the points gap or dwell. If your points gap is too small you will get a high dwell, higher current reading and the coil running hotter. If too large you will get a low dwell, lower current reading and the coil will run cooler. Dwell is a dynamic (i.e. with the engine running) method of measuring points gap and avoids putting feeler gauges that might be oily against the points contact surfaces. With the correct gap you should get the correct dwell, and vice-versa, but there are some faults that means this isn't the case. Going back to current, on a running engine a digital meter may well show something completely different or no usable reading at all, depending on model and type. That's for a 25D4 distributor. With a 45D4 the points are only closed for 57% of the time, giving a slightly lower average current and hence lower heating effect.

Rubber bumper cars are significantly different. They have a lower resistance coil of 1.4 to 1.6 ohms i.e. half that of the chrome bumper, but it is in series with a ballast resistance of a similar value which means the current through the coil ends up being much the same as on a chrome bumper car. So with the same current, but half the resistance, you get half the heating effect in the coil. The other half of the heating effect is being developed in the external ballast resistance so not contributing to coil temperature. You should see more or less the same static and running currents in the ballasted system as in the unballasted, with the same causes if the current is higher or lower. There could also be faults in the ballast resistance so this should be measured from the white or white/brown at the fusebox to the white/light-green at the coil +ve, again with the wires removed from the coil terminals.

I did a bench test, with a 12v coil in series with a 6v coil and its ballast, connected to 12v. This is a static test i.e. no points making and breaking the circuit, but having the two in series halves the static current and makes it similar to that in a running engine. After an hour or so in an ambient temperature of 10C the coils had stabilised, with the 12v coil at 30.3C, and the 6V at 21.9C. Subtract the ambient, and you end up with the 12v coil having gained 20C and the 6v coil 12C. This verifies that the 6v coil has about half the heating effect of 12v coils, but more importantly my running tests indicate that the engine bay temperature in summer is going to have significantly more effect on coil temperature than the current flowing through it.

This table compares the coil energising time and hence heating effect for various points ignition systems found on the MGB:

	25D4		45D4 CB		45D4 RB		35D8	
RPM	1000	5000	1000	5000	1000	5000	1000	5000
Dwell degrees	60.00	60.00	51.00	51.00	51.00	51.00	27.00	27.00
Heating effect (Watt/seconds)	43.56	43.56	37.02	37.02	19.15	19.15	20.28	20.28

Note that if you use a rubber bumper coil without a ballast you will get almost 100 watts of heating effect.

That's for points. A number of electronic ignition systems have what's called a 'variable dwell' feature, which gives a shorter coil energising time than points over most of the rev range, and hence the coils run significantly cooler at anything other than peak rpm. This is the heating effect in a 0.8 ohm 32C5 coil with the North American 45DM4 variable dwell electronic ignition system:

45DM4			
RPM	990	3990	6000
Heating effect (Watt/seconds)	4.41	17.76	23.74

It can seen clearly that at anything other than high revs the heating effect of this system is significantly less than that of a rubber bumper points system, and far less than a chrome bumper system at any likely rpm to be encountered. However the 32C5 coil originally provided with this system should really only be used with a variable dwell electronic ignition system or it can overheat. If a points distributor is substituted the heating effect will rise to 26 watts if a ballast is in circuit which should be OK, but if unballasted it will rise to 180 watts which almost certainly won't be.

Other electronic systems may not be variable dwell but still give a shorter 'on' time, and hence less heating effect, than points. However I've seen a claim that fixed dwell ignition systems actually have a **higher** dwell than points, and in December 2013 someone on the MG Enthusiast bulletin board posted that he measured his Lumenition Magnetronic at 72 degrees. This is 15% longer than a 25D4 and 40% longer than a 45D4, which will increase coil temperature significantly, perhaps to the point where it does start causing problems in very hot weather. It's said to be so there is still a good spark at maximum revs. But the V8 has half the dwell i.e. coil recharge time of the 4-cylinder and has no problem revving into the red, which is the equivalent of 10,400 rpm on a 4-cylinder! Also Lucas state in their Fault Diagnosis Manual that the points system is perfectly adequate for a 6-cylinder engine up to 8000 rpm, so a higher dwell certainly isn't needed for any likely 4-cylinder MGB.

I've also seen a claim that variable dwell saves horsepower. Well, yes, but if you do the maths at mid rev range that works out at 0.015HP! And that reduces the with higher revs.

Ignition Switch

Ignition Switch Connections
Ignition/Steering Lock
North American 'Key in' Warning
Ignition Keys

Ignition Theory

See also these pages from Tjellvar Harbom in Sweden

Graphs of ignition voltage waveforms to accompany this text.

The purpose of the ignition system is to ignite the fuel/air mixture at such a time that the resulting burn (not explosion, which can happen due to pre-ignition or detonation and is harmful to the engine) causes expansion of the gases which forces the piston down and so turns the crankshaft. Ignition is generated by a switch (the points) interrupting current flow through a transformer primary (the coil Low Tension circuit) which generates a pulse of several thousand volts in the transformer secondary (the coil High Tension circuit) which jumps an air gap inside the cylinder (the spark plug) and ignites the mixture.

There is a condenser or capacitor connected across the points when they are open and this component is vital to the ignition system. Its main purpose is not, as many people think, to protect the points from burning (although it does this as well) but to cause the coil to generate a good strong spark at a known time (how to identify condenser failure). Because the coil is a

transformer it will only generate a voltage in the HT (and hence a spark) when the current through the primary is changing, not when it is steady. The faster the current change and the greater the voltage swing in the primary the higher the output voltage generated. When the points are opened, instead of the current immediately ceasing to flow through the coil as you might think, it continues for a very short time while it 'charges up' the condenser with the voltage spike that would otherwise arc across the points. It is only when the condenser is charged that the current ceases to flow. Furthermore the condenser and coil, when the points open, are interconnected in such a way as to form a tuned L/C circuit (L = inductor or coil, C = capacitor or condenser) and this causes the current in the coil primary to oscillate rapidly (about 15 thousand times per second) back and fore with a peak-to-peak voltage swing of about 400v. The effect of this is to generate an output pulse, and hence a spark, of about 10 thousand volts that lasts for about 2 thousandths of a second (i.e. 2 milliseconds, or 2mS). Not very long, you might think, but at 3600 rpm any one cylinder is firing 30 times a second i.e. every 33mS, so at that speed the spark lasts for 22 distributor degrees, which is 44 crankshaft degrees! By comparison, the spark duration without a condenser is only about 0.2mS i.e. one-tenth as long.

The secondary effect of the condenser is to cause the spark to occur at the correct time. With the condenser in circuit the high-frequency oscillation that occurs immediately the points open means that the output voltage and hence the spark commences just 0.02ms, or 20 millionths of a second, after the points open. Even at 5500 rpm the effect of this delay is less than 1 crankshaft degree, something that is easily compensated for by the centrifugal advance of the distributor. This high-frequency oscillation also protects the points because the voltage spike that occurs the instant the points open decays to zero again (as part of its first cycle of high-frequency operation) in about 20 millionths of a second, and this nips the spark off. Without the capacitor the spark only ceases when either the voltage drops sufficiently or the points open sufficiently, and this takes about 2mS. During this time the points are arcing, which, as well as eroding them and causing spikes and pits, means that some current is still flowing through the coil for the duration of the arcing, which delays the main collapse of the flux and hence delays the output voltage pulse and therefore the spark. This delay is again about 2mS and does not vary much with rpm. This 2mS delay effectively retards the spark during cranking by about 1 crankshaft degree, i.e. not very much. But the delay increases to about 24 crankshaft degrees at 1000 rpm, 48 at 2000 rpm, etc, which means that as well as only having a very short duration spark, it is also very retarded even at quite low speeds.

The capacitor has a value of about 0.2uF and this value is critical for a good HT spark. Experimentally varying the value by quite small amounts shows little variation in voltage waveforms on the LT or HT or visually in the spark but a there is a definite reduction in the strength of the audible 'crack' heard at the spark plug.

You can see the effect of a weak or failed (open-circuit) capacitor in this simple test (only do this with conventional points/coil ignition): Remove the distributor cap, remove the king lead from the cap and tape it to a length of wood. Turn on the ignition, flick the points open and closed by hand, and see just how far the spark will jump from the end of the king lead to the block. It should be at least 1/4" and maybe as much as 1/2" even with a non-sport coil and make a good 'crack' sound. This shows the effect of having the condenser in circuit. Now close the points and interrupt the points lead somewhere else e.g. on the coil terminal to show the effect of NOT having a condenser connected across the break in the circuit. You should find that as well as much arcing at the coil terminal, the spark at the king lead will barely jump a normal plug gap, let alone 1/4" or 1/2". You also get a very 'thin' spark, and it makes very little noise. This is how an open-circuit condenser causes poor or non-running as well as burned points. Note that a short-circuit condenser will prevent the engine running at all as it effectively shorts out the points and prevents any spark being generated.

Experimentally varying the system voltage applied to a 12v coil at the SW or +ve terminal shows a fairly linear reduction in HT pulse duration as the voltage reduces, but the HT voltage at the plug does not start reduce until the supply voltage has been reduced to something less than 6v. This is because the HT voltage measured at the plug is controlled by the plug gap - as soon as the HT voltage rises high enough to jump the gap it will do so, which stops the HT voltage rising any further. The voltage at an HT lead that is *not* connected to a plug with a 12v supply at the coil, is much higher, and reducing the supply voltage shows a fairly linear reduction in voltage as well as duration.

Ignition has to occur at a fairly critical time (hence 'ignition timing') in the piston cycle, and has to be altered according to what the engine is doing at the time - e.g. starting, cruising, accelerating, low rpm, high rpm. The distributor has to manage most of this by itself, but usually with a little help from a vacuum line from the inlet manifold or carburettor. Quite a task for an electro/pneumatic/mechanical device invented 70-odd years ago. There have been many different distributors used over the years, each with different characteristics. Many of the changes in later distributors were to cope with increasingly stringent emissions regulations, which usually had a negative effect on performance. In general, the earlier the distributor the better the performance.

- Starting is easier when the spark occurs later in the cycle - anything from 0 to 10 degrees Before Top Dead Centre (BTDC) - the static timing figure.
- Once the engine has started and is idling the timing is advanced - typically to 11 to 15 degrees BTDC. This advance (called centrifugal advance) is achieved by weights spinning in the bottom of the distributor. They try to fly outwards due to centrifugal force, and this movement is used to alter the relationship between the points cam and the drive shaft, which causes the points to open and close a little earlier in the cycle.
- The weights are restrained by springs, so that they move gradually as engine speed increases, maximum advance being achieved at anything from 2,200 to 6,000 rpm, adding anything from 17 degrees to 32 degrees to the static timing figure. Each weight has its own spring and the two springs usually have different characteristics. We need this progressive timing advance because the fuel/air mix burns at a constant rate irrespective of engine speed, and if the timing were not advanced as rpm increased, the burn would occur further and further into the piston down-stroke, converting less of its energy into motion and more into heat. This is wasteful of fuel and potentially damaging to the engine.
- When the car is accelerating with large throttle openings, more fuel/air mix is being drawn into the cylinders and ignited, so greater pressures are generated inside the cylinder. There is a point at which the pressure becomes so great that when the spark ignites the mixture, instead of the normal burn, we get an explosion or detonation. This explosion occurs while the piston is still moving upwards and puts great stresses on the engine, and can burn holes in the top of the piston. Fortunately this condition is frequently audible as a metallic 'pinking' or 'pinging' sound when the engine is under load e.g. labouring up a hill. If you hear this you should back off the throttle to stop it, changing down if necessary, and investigate the cause as soon as possible. It is often caused by over-advanced ignition or weak springs in the distributor advance mechanism. With the distributor cap off you should be able to manually twist the rotor arm and spindle in an anti-clockwise direction, against spring pressure, and it should return fully when released slowly. If it does not return at all, or does not return all the way, one or both of the springs may have become detached or stretched. Spring sets for specific 25D4 distributors have been available from Distributor Doctor in the past, but for 45D4 only if you can specify the characteristics of the springs you want. Other places may be able to set-up a distributor with the characteristics you specify. Check that the spindle twists easily, lack of lubrication can cause stiffness and incorrect advance. To prevent this pinking or pinging many cars have a vacuum pipe between the carb (early cars) or inlet manifold (later cars) and the distributor. At large throttle openings the vacuum reduces and this is used to lessen the amount of advance by rotating the baseplate, and hence the position of the points in relation to the cam.
- When the car has reached cruising speed, say 2500 rpm on a light throttle, there is much less likelihood of detonation and the engine will run more economically with maximum advance. The vacuum from the manifold or carb is at its highest and this is used to advance the timing still further from that set by the centrifugal advance. Note that manifold vacuum brings maximum advance into play at idle, and reduces it as the throttle is opened. Carb vacuum has no advance at idle, maximum at light throttle, and reduces it as the throttle is opened further. Vacuum advance adds anything up to 14 degrees to 24 degrees to the centrifugal advance.

Points Types *Added January 2008*

Points Gap/Dwell

Despite there only being two types of points distributors for the 4-cylinder MGB there are at least four points types - two for each.

25D4 use either a fiddly one-part (GCS101) or an even fiddlier 2-part (GCS107). These **may** be interchangeable, but I can't guarantee it as I haven't tried. On both types there a number of parts that go to make up the electrical connection and it is essential that these are assembled in the correct order (click thumbnail) or you can end up with very weak ignition because the condenser is not connected, or no ignition because the points are shorted out. Lucas variants of the GCS101 have a red cam follower, and the Lucas GCS107 a black. Colour may vary for other manufacturers, I have seen white. Quality may also vary with other manufacturers! Both position the cam-follower pivot over a pin on the points plate for location, and have an adjuster notch at the connection end. The 25D distributor has a spade connector on the side of the body to which the coil wire attaches. Inside, between this spade and the points, there is a very flexible cloth-insulated wire with very fine conductors inside, to cope with the continual bending which comes from the twisting of the points plate under different amounts of vacuum advance. There is another of these wires between the points plate and the distributor body, which provides the earth path for ignition current. The tags are crimped round the cloth insulation for physical strength as well as avoiding sharp bends at the edge of the tags as the wire flexes. If either of these cloth-insulated wires fray they can give intermittent ignition, usually when you alter the throttle and hence the vacuum advance, and sometimes ignition fails altogether. They do not seem to be available separately (although look to be new in rebuilt distributors), it has been suggested that 'solder wick' aka 'desoldering braid' may make a suitable alternative, but I'd advise crimping connectors to these and not soldering, for obvious reasons (I hope!). The condenser is a separate component.

45D4 have 'quick-fit' points which as the name implies are quick and easy to **connect** (although just as fiddly to fit to the points plate and adjust for correct gap) and there is less chance of getting the connections, at least, wrong. The points include a felt wiping pad which rubs on the cam, the cam must be **greased** not the pad, and not oiled.

Additionally for the 45D4 there are 'non-sliding' (GCS118) and 'sliding' (GCS124) variants. These are not interchangeable as there are significant differences in the points plate. The Lucas GCS118 are similar to the 25D GCS101 in that they have a red plastic 'cam follower' the pivot of which fits over a pin on the points plate, however the adjuster notch is at the pivot end instead of the connection end so whilst they may be interchangeable the wrong combination would be more awkward to fine-adjust. The Lucas GCS124 has a blue cam-follower, a brass peg under its pivot that locates in a hole in the points plate, and the adjuster notch is back at the connection end. These points have a 'sliding' moving contact that can move up and down relative to the fixed contact as well as to and fro as normal. There is a slotted plastic lever under the pivot which engages with a fixed pin on the distributor. As the moving part of the points plate twists back and fore under changing vacuum, the fixed pin moves the slotted lever back and fore. The lever has a cam on its upper surface and there are pegs on the bottom of the cam follower. As the lever is moved back and fore this causes the moving contact to move up and down relative to the fixed contact. Because the points are closed approximately half the time there is a 50-50 chance that they will be closed when the moving contact is moved up or down. This slides the two contact surfaces across each other, and even without sliding the two contacts will make and break on different parts of the contact surfaces. Both these effects help keep them clean and free from the spike and pit that afflicts fixed points.

Note that the part numbers given above are original Lucas numbers. Copies may have a similar number but have a prefix or suffix letter or number, for example Halfords refer to the GCS118 as 'GCS2118'. When I ordered (they don't keep them in stock and require payment with order) these they came in a Unipart box marked 'GCS3004' and 'Made in Turkey'! I shall be fitting these this year, it will be interesting to see if they are as good the old ones, which have remained in tolerance for dwell for several years and about 18,000 miles and given no trouble. There have been many reports of problems with after-market points, like the cam follower wearing down very rapidly which causes ignition problems and requires frequent readjustment. If you can get Lucas items over the counter I would do so - check the points themselves are stamped 'Lucas' and 'Made in England' (may also include references to a patent and registered design) or 'Made in UK', but beware counterfeits at parts shows and the like.

The 45D distributor still has the cloth-insulated earth wire as with the 25D, but the ignition points wire is integral with the condenser wire and the 'quick-fit' connector, and passes through the body of the distributor (via an integral grommet) to a flying spade connector to which the coil wire attaches. This wire has to cope with the same amount of flexing inside the distributor cap as the 25D wire does, and although it is more flexible than standard wire it is not as flexible as the cloth-insulated type. As such it is probably more liable to suffer from a fractured conductor than cloth insulated, but being integral with the condenser at least it is readily obtainable. Note that the conductor can break **inside** the plastic insulation, so on visual inspection it seems OK, but gives an intermittent connection when flexed and in some cases the conductors can be pulled right out of the insulation.

Points Gap/Dwell

All three types have a feature to make gap-setting slightly easier, which consists of a V-notch somewhere on the points base and a matching V-notch or pip on the points plate of the distributor. By only lightly tightening the points fixing screw you can use a flat-bladed screwdriver in the V-notch to nudge the gap up a bit or down a bit until it is right, then fully tighten the screw. I always use .014 and .016 feeler gauges as go and no-go, rather than try to judge the right amount of 'grip vs slip' with a .015. And if you put a .016 feeler gauge between the contacts when first tightening the screw, you will be pretty close to the correct figure. If that is too big then use a .015, and so on. However dwell is a far more accurate way of setting and checking points gap, more info here.

Just for completeness, the points for the V8 35D8 distributor.

Bee's points have done at least 12k and possibly as much as 15k miles. I've never touched them since I first fitted them, although I check the dwell at every service and they have been within tolerance every time, which is why I've never had to touch them. Nevertheless I decided I didn't want to go on until they actually did fail, and I felt I had proved (to my own satisfaction if no one else's) that points aren't the trouble they are made out to be. When I took the old points off there was no sign of any spike and pit, which is surprising as they are the earlier 45D non-sliding type which usually suffer from it, there was just a relatively slight indentation in the larger fixed contact. I did notice that they were coated in oil or grease from the felt rubbing pad, so whether that had acted as a spark quench I don't know. Then again one would expect oil or grease on the points to be a bad thing, but it's always gone like a train. The old ones were stamped LUCAS, whereas these are unstamped in a Unipart box marked 'TURKEY'. I hoped that refers to the country and isn't a comment on their quality ...

Rotors

Rotor problems:

There seems to be a problem with current rotors, at least from some manufacturers, breaking down after a short period of use. The problem could be caused by the round-headed rivet as on the rotor on the left in this image (click thumbnail) being too close to the distributor shaft when fitted. If the line of the rivet is **outside** the circular base of the rotor body, i.e. more than halfway from the centre of the rotor contact to its tip, it should be OK. Note the rotor on the left in this case is from an aftermarket electronic ignition system and has magnets to operate a Hall-effect trigger in the collar at the bottom and hence is deeper than normal.

December 2009: You can test a rotor for breakdown as follows. Remove the coil lead from the distributor cap and the cap from the distributor. Turn the engine until the points are closed, if not already so. Turn on the ignition, hold the free end of the coil lead about 1/8" away from the brass part of the rotor while you flick the points open. If a spark jumps the gap the rotor has broken down. **NOTE:** If the rotor has **not** broken down then a very high voltage will be developed at the coil lead so an insulated implement should be used to hold the lead, even by its insulation.

January 2010: Note that it is normal for a rotor to show burning along its curved edge as the plug jumps a gap between it and the contact inside the cap as well as at the plugs. Note also that the burning is usually along a significant part of the curved face as the relationship between rotor and cap contact changes with vacuum advance (see 'phasing'). Ideally it should be central with a clean area at either end, but I've never seen this in practice, it being biased to one end. Potentially this means the rotor could just have passed (or not quite reached) the cap contact as the spark occurs. If this gap gets too big it could stop plugs firing, and note this effect has been seen with some electronic triggers.

April 2010:

Another failure, this time within hours of installation. This has a domed rivet a bit further away from the shaft, but not as far as some. Distributor Doctor discusses this problem putting it partly down to a more conductive insulation medium, and a long rivet which is too close to the spring (which is against the shaft). He puts the higher conductivity down to a higher carbon-black content, but carbon-black - despite the implication in its name i.e. carbon rods being used in arc-lamps and dry-cell batteries - when used as a dye as here, is non-conductive.

Two other forum threads on the problem from British-Cars.net and the Marlin Owners Club. However the original poster on the British-Cars.net includes a photo of three failed rotors, one of which looks to be the problem style, but another looks to be an original 'no rivet' style and the third is very similar to the Distributor Doctor's TR style with the 'rivet' miles away from the shaft. There has to be suspicion of some other problem in that case, maybe excessive plug gap causing a raised HT voltage.

March 2013:

In the last year or so 'red' rotors have become available from people like Distributor Doctor and Simon's Best British Classics which have an improved insulator in red material and no rivet, and these are the ones to go for. However at Stoneleigh in February I was struck by just how many people had red rotors for sale, and it occurred to me that the unscrupulous will almost certainly start making inferior rotors with red insulators. I go to Distributor Doctors site while writing this update and sure enough that's exactly what he says is now happening. So go for the supplier, not just the colour.

Rotor Phasing

I first wrote the following in response to someone who wanted to fit a Crane system with electronic trigger but had lost the information on how to adjust the position of the trigger to obtain the correct 'rotor phasing', which is the relationship between cap, rotor and trigger. It is not normally an issue for points systems.

When vacuum advance is applied the points plate moves clockwise relative to the dizzie cam and the rotor arm, and this causes the spark to occur at different relative positions of rotor and cap. You can see the effects of this movement by looking at the edge of the rotor arm. You should see that quite a large part of it shows some burning, this is normal. If the phasing were incorrect the spark could occur before the rotor had reached the cap contact, or after it had left it, and hence you could lose HT. In fact I notice from one of my rotor arms that the burning goes from the middle right up to one edge. This could be causing loss of HT at one extreme of vacuum advance or the other, but since I have never noticed a misfire I assume my points must be right at the limit of correct phasing. Ideally the full range of movement would, occur within the centre section of the rotor arm leaving small unburnt areas either side.

I have a bench rig that I use for testing centrifugal and vacuum advance of distributors so it was relatively easy to connect the coil direct to a plug and with the distributor cap off use a timing light to show me where the rotor arm is when the points open. Of course, the timing light flashes four times in each revolution, hence 'freezes' the rotor arm in four positions instead of one. I would imagine you could get a similar effect on the engine as follows: Remove the plugs to make life easier for the starter and battery and connect the output of the coil to a plug laying on the block somewhere. Disconnect the vacuum advance pipe. With the cap on, wrap a piece of stiff wire around the body of the distributor with one end laying up the side of the cap right in line with one of the plug leads - doesn't matter which one, whichever is easiest to see, then remove the cap being careful not to disturb your wire 'pointer'.

Crank the engine and with a timing light connected to the coil wire (note that a 12v timing light may need to be powered from a separate battery or car to work reliably when cranking) point it at the rotor and you should see it 'frozen' in four positions. Adjust your trigger so that your pointer wire is near the **trailing** edge of the rotor arm contact. If it is too near the leading edge then when vacuum advance kicks in the rotor arm will move away from the plug lead contact in the cap when the spark occurs and could interrupt the HT.

Depending on how hard you can suck you may be able to create enough vacuum to move the points plate, in which case you should see the rotor arm appear to move in a clockwise

direction in the flash of the timing light. If you have a MityVac, or can get your fingers or a lever in there without getting in the way of the rotor arm, twist the points-plate against the spring-loading of the vacuum module as far as it will go and make sure your wire pointer is still within the width of the rotor arm contact.

August 2013:

If you have access to an oscilloscope then you may be able to see the effect of the rotor moving away from the cap contact by there being an increase in HT voltage between minimum vacuum advance and maximum vacuum advance - click the thumbnail to see the likely effect of this. Peak HT voltage is more a factor of the air gaps in the system - usually considered to be the plug gaps - than advertised coil voltage, but there is the (normally) small gap between the rotor and the cap contact to be considered as well. If your rotor moves away from the cap contact during HT pulses then this gap gets larger, and the measured HT voltage will increase. You don't need to make electrical contact between the oscilloscope probe and the HT lead (indeed it would be unusual for anything other than an engine analyser to be able to cope with voltages of 10kV or so), just physically attach the probe to the outside of the insulation somehow, and that should be enough to pick up radiated energy with the oscilloscope switched to a suitably **low** input voltage.

I also wondered about the effects of centrifugal advance on phasing. I came to the conclusion that because the relationship between cam and points doesn't change with centrifugal advance like it does with vacuum advance, then the phasing doesn't change either, and indeed was able to confirm that on the bench.

Added January 2010: Note that with a fully electronic distributor like the 123 both centrifugal and vacuum advance will change the phasing i.e. the relationship between rotor and cap because the distributor shaft is solid (no weights or springs) and both cause the trigger point to be advanced electronically.

Schematics

12v Coil and Mechanical Rev-counter (1962-1964)
12v Coil and Inductive Tach (1964-1972)
12v Coil and Voltage Tach (1973-1974 1/2)
6v Coil (UK 1974 1/2-1976 and all V8)
6v Coil (North America 1974 1/2-1975)
6v Coil and Ignition Relay, UK Cars 1977
6v Coil and Ignition Relay, UK Cars 1978-1980
North America 'Opus' Electronic Ignition (45DE4 with integral amplifier, 75-on)
North America CEI Electronic Ignition (45DM4 with remote amplifier, 75-on)

Spark Plugs *Amended and updated October 2011*

Spark plugs for MGBs
V8 Heads
Spark plug gap
Spark plug coding
Spark plug condition
Stripped threads!
And subsequent thread repair

On the question of whether to fit resistor plugs or not there is some confusion as to whether resistor plugs should be used **in place of** resistor plug wires or can be used with them. NGK quotes:

> As well as reducing electrical noise for radio, television and mobile telephones etc, many modern ignition systems require resistor plugs to stop electrical noise from interfering with the vehicle's on-board electronic control units (ECUs). If non-resistor plugs are used in place of resistor ones, the result can be malfunction and in some cases immobilisation of the vehicle. Resistor spark plugs should always be fitted, therefore, where specified. NGK resistor spark plugs contain a single ceramic monolithic resistor of approximately 5000 ohms. Because of the type and construction of the resistor (i.e. no springs), the problems of vibration and sudden changes in temperature that can occur with some other brands do not apply. The function of the resistor is to reduce electrical noise generated by the ignition system. The most effective place to situate a resistor in the high tension circuit is as close to the spark plug as possible. This makes the spark plug an ideal place to house the resistor. Because the resistance value is only approximately 5000 ohms, there is no detrimental effect on engine performance, power output, vehicle emissions etc. It is also a fact that many motor sport world champions only use NGK resistor spark plugs. In nearly all cases - apart from some very old low output ignition systems - resistor spark plugs can be used in place of the non resistor versions.

So the upshot is that for a factory MGB either resistor plugs or non-resistor plugs can be used equally well but if you have done a V8 conversion with EFI and hence an ECU you should use the plugs recommended for the original application, which may well state that resistor plugs should be used. And despite NGKs suggestion that other manufacturers products may suffer from vibration-induced problems I would say that what NGK says can be applied to any reputable manufacturer. But as with anything if you find your car runs better with one make then use it.

Spark plugs for MGBs
4-cylinder: The original Leyland Workshop Manual recommendation for the 4-cylinder engines was Champion N-9Y (and hence its derivatives i.e. RN-9Y for resistor plugs, RN-9YC for copper-cored, or RN-9YCC for double-copper-cored), or equivalents NGK BP(R) 6ES, Bosch W(R)7D(C), Unipart GSP4362 to name but three. I'd always used Champion in all my cars until a roadster service years ago when I removed the plugs to check the gap and I succeeded in snapping the insulators off three of them! I'd never broken one before, and after the first I was hyper-careful with the alignment of the plug socket, but still managed to break off two more. When I examined the insulator closely I noticed that instead of the ribs describing nice curves as they always had before, these had flat tops and sides and hence sharp angles between sides and base - a recipe for fracturing I'd have said. Since then I never used them again, sticking to NGK and Bosch, even though they may well have changed the insulators since. *December 2017:* Based on this picture from a pal Champion have gone back to rounded ribs, but see if you can spot a far more significant change. Quick-fit for very low compression engines? Or to be used with very heavy plug leads?

In February 1999 I bought a set of Bosch Super 4 4-electrode plugs for the roadster, since when they have done almost 40k miles, and still show no signs of electrode erosion. Double the price of 'conventional' plugs, but since they have done 4-times the recommended life so far (November 2017) and still look as good as new, good value. However also in November I started noticing Bee sounding a bit rough at very small throttle manouvering speeds. As part of looking into that I decided to replace the plugs (conventional single-point) which improved things, but didn't completely remove it so investigations continued.

V8: The original Champion recommendation for the V8 was L92Y, which equates to Bosch W8BC or NGK BP5HS. This is complicated by all sorts of extra characters having been

added to the codes to denote plugs with things like resistors, single and double copper-cores, Yttrium etc. but also by manufacturers recently adopting three-digit codes instead of mixed characters, but you should still be able to find them using the earlier designation. I'd also (inadvertently this time) left single-electrode plugs in the V8 for about 25k, and although running seemed fine hot starting eventually got difficult. No visible erosion or excessive gap on these either, but swapping them for a new set solved the problem, so maybe visible condition isn't everything. How long those plugs in plug condition charts have been used for that show the centre and side electrodes eroded very badly, can only be wondered at.

V8 Heads There is a particular issue with the V8 in that the plug body is deeply recessed into the head, with very small clearance around the hex. So small that my original 1/2" drive plug socket of 1.1" outside diameter wouldn't fit the hole. I managed to find another of a slightly smaller diameter (1.087" OD) that fitted, but only just. Since then a pal has mentioned someone he knew had to use a 3/8" drive socket, I've checked mine and that fits as well (1.070" OD). So if you are having trouble finding a 1/2" that fits, try a 3/8". I have investigated the smaller-bodied 16mm (instead of 21mm hex) plugs, as used in my past SD1s, but there don't seem to be any with an equivalent reach (BP5FS has been suggested but is shorter at 10.9mm so compounding the thread-strength problem), and they all seem to be tapered seat instead of gasket seal, so not suitable without recutting the seats.

October 2017: Having replaced the heads on the V8 I find even my 1.087" socket binds in one head, and doesn't fit at all in the other, and although I mention above 'my' 3/8" drive fitted, try as I might I can't find such a socket today, only for the smaller 16mm hex plugs. I'd buy one, but not without checking the OD first, and Halfords don't have them. I had modified a box-type spanner when I rethreaded one plug in an old head as it ended up slightly canted over and the socket no longer fitted, and I was fortunate that I still had this in the back of the car (which was in the paint shop) when I came to fit the plugs to the new heads for the first time. But that's awkward as being short-reach with a tommy bar one has to unscrew the plug one flat at a time.

Back home and after Vee was back on the road I needed a more permanent solution. Next ploy was to weld a bolt head to the top, so I can use a standard socket. Searching for a suitable bolt I found the results of a previous experiment which was a 3/4" bolt head welded to the end of an original axle level/fill plug, the ones with the tapered square hole which are such a pain, subsequently replaced by current-stock plugs which have an Allen key hex socket - and found that was a perfect fit for the plain-end of the box-spanner! That still left the hex part too large to fit in the recesses, which are a range of sizes, so I worked along them one by one filing down the corners of the hex bit by until it fitted them all. Works well, a 3/4" socket on a sort extension loosens them, then the plug spanner can be turned by hand as it gives a good grip, then the plug can be lifted out. Replacing the plug is turned by hand first, then with the spanner by hand, then final tightening - carefully! with the socket.

Spark plug gap: Originally 25 thou for the 4-cylinder, changing to 35 thou with the 45D4 distributor in September 1974 and rubber bumpers. This **may** be because the 45D4 is better at resisting HT breakdown than the 25D4, or it may simply have been a general change in what (then) modern HT systems could produce and withstand. Increasing plugs on a 25D4 to 35 thou may be OK, but then again it may not - and there is no point at all in increasing the gap above that. The V8 was always 35 thou. The greater the gap the higher the HT voltage rises before the plug fires, which increases the stress on the other HT components, increasing the risk of breakdown and misfiring or maybe not starting and running at all. Buying massively thick and expensive HT cables is pointless, as the rotor and cap remain the 'weakest link' as far as the spark jumping a gap is concerned. No standard, road-going MGB should need any more than standard coil, leads (at least, modern silicone rather than the original carbon string), plugs, ignition system (or anything else for that matter). It's going to make no difference to a well maintained car, and if you have a running problem then you should be investigating the cause of that and not try to work round it.

Spark plug coding: Ever wondered what all those letters and number mean? Well you can find out here for Champion, NGK and Bosch. So both 4-cylinder and V8 engines have 14mm thread and 21mm hex, but the 4-cylinder has 19mm reach whereas the V8 has only 12.7mm. There is also a small heat-range difference, the V8 being slightly 'cooler' (perhaps unsurprisingly) i.e. more insulator in contact with the metal surround to give better heat transference. NGK seem to have a wider and finer heat range to Bosch, with Champion between the two, surprisingly, as can be seen here. The heat selection for a plug is a balance between getting hot enough in a given engine to burn off combustion deposits, but not so hot it damages the plug, as can be seen here. If you have a standard engine, with standard plugs, but they are oiling-up in normal use, then that is an indication there is something wrong with the engine i.e. bad rings/bores or valve stems/guides/seals. Selecting a 'hotter' plug in an attempt to keep them clean is not the right way to go.

Spark plug condition:

Or 'read your spark plugs'. Lots of examples of specific engine problems (and change interval exceeded - ooops) here from Bosch. However the images are almost monochrome as far as I can see, these are my roadster plugs which I reckon are pretty good. They had just done 400+ miles to North Devon and back, removed to check the condition following head gasket replacement which including resetting the carbs, so some hard work up hills as well as some time on a motorway at 70-80. Back two maybe a smidgen richer than the front, so the rear carb weakened a tad. As the HS nuts are awkward to get at with the air cleaner cans on, I made a box spanner, which worked a treat.

Update September 2011: **Stripped threads!** I hadn't thought about it before, but V8 plugs have the standard fine thread, they are short-reach instead of the longer reach of the 4-cylinder (although apparently later heads have 3/4" reach instead of 1/2"), and of course are in an alloy head, so much more care needs to be taken to avoid stripping the threads. Needless to say I didn't think about that until I stripped one! I've never used torque when tightening, but whilst some sources say you only need 15-22 ft.lb. for 14mm gasket-seal type (as opposed to tapered seat) in aluminium as opposed to 26-30 ft.lb. in cast iron, others give the same figure for both. There is also a question-mark over applying anti-seize to the threads - some recommend it, but only if the plug body is black or plain steel, if applied to pre-coated or nickel-alloy bodied plugs the torque should be reduced by 30%-40%. It's also advised in various places not to remove plugs from a hot aluminium head as this in itself can weaken the threads. But then another site says you can remove them overnight-cold, or just switched-off hot, but not in between, because they have different rates of cooling contraction and the head grips the plug tighter at cooling temperatures.

I think the one thing that people **do** agree on is that in any engine you should always start the plug by hand no matter what, screw them in as far as you can with a plug socket on them still by hand - with a short extension in the case of the recessed plugs on the V8 - until they bottom, and only use the socket wrench (OK, maybe a torque wrench!) for final tightening.

Unfortunately I did remove a couple of plugs from a pretty warm engine, at a pals house in order to fit a Colortune to see if a rich mixture was the cause of Vee being difficult to hot-start. Annoyingly I didn't need to do this, as immediately before I had checked the lifting-pins and if anything they were a smidgen weak, certainly not rich. But I did, to no avail as the colour was blue with orange flecks which is apparently correct (although I find them difficult to read and much prefer the lifting pins, but others say they find **those** difficult to 'read'). On replacing the plugs I always put them in by hand until they bottom, but using the socket wrench No.1

wouldn't tighten after a couple of clicks which was a bit concerning, so I stopped anyway. It was only after that I realised I hadn't changed the plugs for some nine years and 25k miles, and although visibly in good condition that is a loooong way past the 10k change interval. So I changed the plugs (which was a bit of a saga in itself, having bought new using a Bosch number I had written in my Workshop Manual years ago, only to find they were the wrong ones, and I had a brand-new set in the boot anyway!) but tightening No.1 by hand as usual it just kept turning, it never bottomed. I looked at the plug I had taken out but there was no aluminium on it, so removed the new one and the threads were completely filled with a spiral of aluminium!! I was devastated. But nothing to lose, I screwed it again carefully until I could just feel some extra resistance, and fired up the engine. I was quite surprised it didn't pop out, not even when I blipped the throttle quite hard, although I can hear a faint ticking which is probably a small combustion leak. Got it up to temperature with the fan cutting in and out, switched off, and restarting both then and a few minutes later and on subsequent occasions has been instant, so the ancient plugs do indeed look to have been the original cause. But what do I do now?

Helicoiling should fix it, but can it be done in situ on the V8? Does the head need to be removed so you can all the aluminium chips out from the retapping process as well as for access? I really didn't want to do that as the last time I had a head off one of the bolts snapped, and that had to be drilled out and the block retapped, which was pretty traumatic. I'd rather undo the engine mounts and lift and/or tilt the engine to give the required access, coat the tap with grease to catch as many chips as possible, and put grease-coated cloth or cord inside the cylinder with the piston at the top to catch as much as possible of the remainder, and take my chances. And how do I get the car to an engineering place to do the helicoiling anyway with the plug as loose as that?

Looking at No.1 plug I reckon that I can fit a plate between the two exhaust manifold bolts neither side of it, with a metal tube behind the plate over the insulator and bearing down on the body to press it against the head. However the plug is at a compound angle to the plate, being tilted upwards as well as backwards, making the cutting of the end of the tube a pretty precise requirement. As far as the tube goes I remember I have a couple of old (very old, one of them at least came to me from my Dad nearly 45 years ago) box-spanner type plug spanners, the type you use a tommy-bar with. These are swaged out to make the hex, and the other, round, end is a perfect fit over the ceramic insulator to press down on the metal part. As far as attaching the outer end to the plate goes, rather than cutting the end of my 'tube', if I drill a hole through the plate and oval it in the correct way, I can get the correct alignment of the tube over the plug. I mark out and cut a plate (ex-BT equipment blanking plate from 1975 or so) to fit the space and the bolt holes, and project the end of the plug onto the back of that to get the centre of the hole for the tube. Drill and cut a round hole, then with the tube inserted through the hole cut the bottom right and top left out further bit by bit to get the correct angle on the tube, and centred over the plug. I remove the top exhaust manifold bolts each side, put the bolts through the holes in my plate with the thick washers **behind** the plate, and refit the bolts. This spaces the plate out by 1/8" or so (and hence will press down hard on the plug when the thick washers are finally fitted on the other side) while I tack-weld the tube to the plate in a couple of places. Carefully remove the plate and tube, and blob weld round the tube on both sides of the plate. I'm confident the weld will take to the steel tube OK, but the plate has some kind of yellow (passivated zinc?) anti-rust coating so I'm not so sure about that. However by having blobs both side of the plate, the worst that will happen is that the tube could rotate in the hole, but not while it is pressed against the plug. Check the plug is screwed in as best it can, fit the plate and tube over it and bolt down, and fit the plug lead. The rubber end of this projects past the outer end of the tube, so can easily be fitted and removed with the plate and tube in place, even though the plate and tube will have to be removed to remove the plug. However since that is only a once per year activity at best, that's not going to be a problem. Start the engine and no ticking this time, so run it down to Halfords to see if I can exchange the plugs. No problem, they have to order them and I have a choice of "£4 each for delivery tomorrow, or £2.70 each for deliver in 3-4 working days?" so I say "The latter please, I've got ten years ...". I also get £5 back against the incorrect plugs, the only bit of good news in this whole sorry saga.

So now I need to give it a bit more running including motorway blasts, and decide whether I can trust it up to the Lake District for our annual walk in two weeks time or not. I could live with it failing on the way back as I'll simply get it AA Relay-ed back home, but it would be a bit of a buggah if it failed on the way up. If it's near home then get it brought back and use my pal's car instead, if it happens near the lakes then get a tow from the other car going on the trip, then Relay-ed back home afterwards. But seeing as how the plug didn't blow out when not held at all, I don't really think there is going to be a problem now it is being pressed against the head by the tube and plate, which should press even harder when the tube gets hot and expands. (In the event it ran beautifully there and back, 420 miles, 34mpg). Subsequently the pal above, who does part-time MOT-ing at a local (to him) garage, says he knows they have had to helicoil heads in the past when a plug thread has stripped, and he can borrow their kit overnight. It'll have to wait until October though, when he is coming past on his way to Wales for an overnighter then coming back past next day. Watch this space!

Update October 2011: **Thread repair:**

Said pal brings the repair kit. This involves a lot more than simply Helicoiling, it is a special kit for spark plugs as they bottom onto the insert, so needs a flat and smooth surface, whereas standard helicoiling usually has a bolt going through a plain hole in another part before going into the thread so it doesn't matter that breaking off the tang on the helicoil insert leaves a rough part sticking up. I fed a rag in through the plug hole with the piston near the top, then pumped some grease through the plug hole onto the cloth, so that hopefully any chips that escaped from the cutter would be trapped by the grease on the cloth. **Make sure** you have very long-nosed pliers, or a pick, to hoick the cloth out again. You are going to be doing this after cutting the oversize hole for the insert, but before fitting the insert, so it will be easier to get out than feed in. **Make sure** the piston is low enough to allow the cutter to go all the way into the head (until the end of the cutter thread is just below the outer face of the head, not screwed all the way through so it drops into the cylinder ...) without fouling the piston.

The first part of the process is to screw the thread cutter into the remains of the thread. The first portion of this is the same thread as the original hole, and when that is fully screwed in it pulls the cutter itself into the head to cut the oversize thread for the insert. It also **should** ensure that the new thread is exactly on the same alignment as originally ... but read on. Both parts have flutes as for cutting taps, which I completely filled with grease to catch the chips. The first part starts with thread straight away, rather than the short plain bit you find on a plug, and this made it impossible to start by hand as I just couldn't find the start of the threads, whereas I could still screw the plug straight in. In the end I just put the wrench on the end of the cutter pressed down a bit and went for it, and it seemed to pick up the thread OK. Once started it screwed the rest of the way in by hand, i.e. was not tapered, and this was where the second problem occurred. The trouble is that with a stripped thread there may not be enough original thread left to pull the cutter part in to cut the oversize thread, which was what happened to me. This was exacerbated by the main cutter thread also being parallel and not tapered, which makes it difficult to get started, compounding the problem of the stripped original thread. It would have been better if both parts had been slightly tapered - the first to cut a new thread only slightly oversize so as to stand a better chance of pulling the main cutter through, and the main cutter also tapered to make it start easier. As it was I had to press down on the end of the

cutter as hard as I could whilst turning it with the wrench before the oversize part would start to cut in, and this may have caused the subsequent problem I had. As usual half a turn or so to cut the thread, then back off a quarter turn or so to break the chips off. After several turns you really need to remove the cutter, clean the chips out and regrease, as all the chips seem to be pushed forwards into the flutes of the narrower part of the cutter. This actually gets **more** important as you go on, as the narrower part gets pushed further and further into the combustion chamber. Initially the chips are retained by the plug hole, but right at the end the last chips will be free of the plug hole and without grease in the flutes would drop into the cylinder. I didn't realise this at the time, but cleaning the oversize hole once I had removed the cutter I caught a big dollop of grease and chips which was hanging on the edge of the hole inside the combustion chamber.

However before that, while the thread cutter is screwed fully into the head, and the upper threads are just below the surface of the head, you slide the seat cutter over the thread cutter and turn it with the tommy-bar until you can see a clean seat all the way round the hole. Why is this needed if the new thread is exactly on the same alignment as the old? Read on. And in any case as the cutter is angled, I'm thinking it is really intended for tapered-seat plugs, and not gasket seal as these are. Then it is a case of removing the seat and thread cutters, winding the piston back up so I could hoick the cloth out which was daubed in grease and had caught a few more chips, and finally cranking the engine with coil disconnected to hopefully blow out any remaining chips.

Next stage is to insert the ... insert. Pick the correct length insert which should be as close as possible to the old, but shorter not longer, however **not** shorter than the threads of the plug, as these could pick up carbon which will make the plug difficult to remove in future. Dip the end of the insert tool into oil, turn the insert onto the end of the tool two turns, then carefully screw the insert into the head. The insert should bottom in the head quite easily, turning by hand, then use the driver to screw the insert tool into the insert, which expands it slightly to make a gas-tight seal to the head. When that starts turning freely remove the insert tool, and you are ready to replace the plug. Another thing I noticed is that the loose inserts screw onto the plug easily, which means when they have been expanded into the head they are slightly larger internal diameter, so the plug is now slightly loose in the head. This may be deliberate, and indeed plugs do usually wobble in the threads slightly until they bottom, but I would have expected the insert to have been a tight fit on a plug until it had been expanded into the head.

I screwed the plug in by hand as usual until it bottomed, no more wobble than normal, but couldn't get my usual plug socket on for final tightening, and this is the third problem I have mentioned a couple of times. Looking onto the end of the inserted plug, which sits in a hole in the head casting, I see that instead of being exactly in the middle of the hole as normally, it is slightly offset to one side! The hex of the plug is completely enclosed by a hole on the head casting, with only a very small clearance around it, and the new thread had obviously cut at a slight angle to the original. I feel sure this is down to my having to press down as hard as I could on the end of the cutter to get it started, because (a) the first part was running in stripped threads and (b) the cutter part was effectively a plug tap instead of a taper. I suspect this is a known issue, which is why they include the seat cutter as part of the kit. When I first had the V8 the plug socket I had always used on the roadster was too big to fit in the hole, but fortunately I was able to get one slightly smaller, but even that only just fits and the chrome coating has worn off over the years. I reckoned if I thinned the wall around part of a socket I would be able to get it on the plug, turning it one flat at a time. I didn't want to attack my main socket as that would weaken it for the plugs on other cars, but I do have yet another box-spanner type plug spanner. I ground two of the hex edges of that down and down, but still can't get it on the plug. Then I remove the plug altogether and try to fit it in the hole in the casting, to find that is too big as well! So I reduce the remaining hex edges a little until it fits in the hole, and by that time it will go over the plug, and I only need to tighten it a couple of flats, removing, turning back and refitting one flat at a time. So no big deal, I'll just have to carry that in the toolkit along with everything else! In the fullness of time, when the engine has to come out for the clutch or whatever, I should be able to grind back that part of the hole a little to allow my usual plug socket to fit.

Finally reconnect coil and plug leads, crank up, no grease smoke out of the exhaust, or misfiring from chips caught in the valves, or combustion leak from the plugs, so hopefully all is well!

Spark Plug Wires

An article by Les Bengtson
And my own experiences

One area of interest to most owners is ignition tune up. Most people understand about replacing points, condenser, rotor, distributor cap and spark plugs, but very few understand how to check the spark plug wires to find out if they also need to be replaced.

There are two basic types of spark plug wires-copper and silicone. (*Also carbon-string which pre-date silicone. Ed)*. The copper wires are great for conducting the high voltage current from the coil to the distributor cap and from the cap to the spark plugs. They have a long life and seldom need replacement. When they do, it is normally due to the insulation of the wire breaking down and causing some of the high voltage to leak. In most cases, they will still conduct electricity, but at a reduced voltage. There is only one real problem with copper wires-they create a minor radio transmitter and produce electrical interference with TVs and radios.

To correct this problem, silicone wires were introduced. These wires have some degree of internal resistance which surpasses the radio/TV interference. The silicone wires became more popular back in the late 60s and early 70s as the car producers began to offer more sophisticated radios. FM was becoming popular with the masses as the stations expanded and cassette and eight track tape players became popular. Prior to this time, people with the very expensive (back then) radio systems had to fit resistors to each individual copper wire to suppress radio interference. With the silicone wires, none of this extra suppression was required. The only drawback to the silicone wires was that they wore out. In the early versions, rather quickly. Today, silicone wires, much changed from the earlier versions are the standard. Unfortunately, they still do not last as long as a good set of copper wires and need to be inspected to see if they are functioning properly.

The first step in inspecting the wires (of both types) is to check to see that they are clean. Dirty build up on the exterior of the insulation may allow some of the current to be lost. It can also speed the breakdown of the insulation leading to current leakage. Examine each wire and, if dirty, clean with either waterless hand cleaner or dish washing detergent. Dry and wipe clean before reinstalling. It is best to remove one wire at a time to prevent mixing them up. Most old hands will be able to install the wires on a bare cap and get them in order with no problems. But, we all make the rare mistake and doing one wire at a time will help to keep the mistakes rare.

The next thing to check is that the ends of the wires are firmly attached to the spark plugs, the distributor cap and the coil. Four cylinder, in line engines are not the smoothest running of beasts and, sometimes, a wire will work its way loose. This is especially a problem at the cap, but Bob and Gil found two wires loose at the spark

plugs on two different cars when they were helping me a couple of weeks ago. Always check to see that all connections are properly seated.

The next test requires darkness. You need to start the car with the hood open and run it while looking for blue sparks off the wires or a blue glow surrounding them. This indicates the current is leaking through the insulation and the full current is not being carried to the distributor cap and then to the spark plugs. In really bad cases, this can actually light up the right side of the engine compartment. WARNING: It is dangerous to work around the engine compartment in the dark with the motor running. Put your hands in your pockets when performing this inspection and do not take them out until you are ready to turn off the engine. Running the car in the garage will help to cut down the ambient light, but make sure the door is open to prevent the build up of carbon monoxide.

If you see blue sparks, you need to replace the wires with a good quality set of replacement wires. The ones by Robert Bosch seem to fit the B very well and last well. They are available from BAP and other sources. One problem with the silicone wires is that they do not work well with the screw in, side terminal caps on the Mark I cars. This is not a significant problem. If it is a show car, get the copper wires, which were originally correct for this model. If it is not a show car, the 68-74 distributor cap will fit the distributor and allow you to use silicone wires that push into it. You will also need to install a different coil, one with the push in style terminal, but this would be a good time to install a Lucas Sports Coil anyway, right?

If the car seems to be running well, this is all the testing you need to do. If, however, you seem to have a miss, there is one further test you can run. This requires an ohm meter. An ohm meter measures resistance and is normally a feature found on volt meters. In fact, most volt test meters are actually Volt-Ohm Meters (VOMs). Good quality analogue meters may be had for under $20 at Radio Shack and other sources. Some dwell/tach meters also have a volt and ohm feature. I prefer to have a separate VOM as it allows me to do tuning using both the dwell/tach and the VOM when necessary.

The first thing to do is turn on the meter and set it to ohms or resistance function. Then, touch the two probes together and watch to see the meter's needle swings to zero. This shows that there is zero resistance as it should be. Some of the more expensive meters have a zero function where the probes must be held to zero and the scale adjusted to zero. The less expensive models do not have this feature and it is not needed for this type of work. Having confirmed that the meter is working properly, remove the distributor cap from the car, having disconnected the spark plug wires from the plugs and the coil wire from the coil. A small piece of masking tape on each wire with the number of the cylinder the spark plug wire came off of makes reattaching easy.

Then, take one probe and stick it into the spark plug end of the wire. You can probably insert it between the metal terminal and the boot to hold it in place. Then, you touch the probe to the terminal inside the distributor cap. This tests both the cap and the wire. Make a note of the resistance reading, then check the other plug wires in the same manner. Finally, check the coil wire from the end that goes into the coil to the carbon brush in the top, center of the cap. All of the spark plug wires should have about the same resistance. If one is very much lower or higher than the others, the set may need replacing. If one shows infinite resistance, the set may need replacing. How to determine whether it is a wire or a cap problem?

Simple. Remove the wire showing the infinite or high resistance from the cap and measure it again. If it now shows resistance similar to others, it is a problem with the distributor cap. Firmly seat the wire again into the cap, making sure it is fully engaged and check again. If it still shows a problem, the cap is at fault. If, however, when you test the wire by itself, it shows high or infinite resistance, the wire is bad and the set should be replaced. This is where the “lifetime warranty” pays for itself. Take the wires back and exchange them for another set. I go one step further and keep a spare set of wires on hand and, when I need to exchange them, install the spare set and return the old set in the box.

The final question is how long will the silicone wires last. The best examples may do as long as three to four years. Often, however, the Arizona heat and high under hood temperatures will have them breaking down in two years or so. Testing the wires while doing a tune up only takes a short time. Good wires will give better fuel economy, reduce pollution and not leave you stranded when the car does not start. Time well spent.

My own experiences: In 1973 I bought a new Morris Marina, and ran it for six years. That came with original carbon-string leads of course, and after a few years I started getting ignition problems, checked the resistances and they were all over the place. So I bought a set of silicone-cored from Halfords and had no more problems. When I bought the roadster in 1989 the plug leads were a mixture, so I bought a set of silicone again from Halfords. Many years later one day it wouldn't start, and after some time I found it was because the brass connector at the coil end of the king-lead had some kind of blue coating, that I couldn't scrape off, and seemed to be acting as an insulator, so I bought a new set and since they have been fine.

When I got the V8 in 1994 again it had a mixture of leads, I enquired of the MGOC and was surprised to discover they had the original carbon string type, even more surprised to discover they were **dearer** than the silicone equivalents, and bought the silicone. Try as I might and no matter which way round I connect the leads, the best I can end up with is one slightly shorter than really it should be, although it is just about OK taking a direct run at the plug. The other problem is that because the distributor is at the top of the engine, and canted sideways, the leads feeding the right bank run closer to the bonnet than the left bank. The original leads had right-angle connectors on all the right-bank leads which keeps them low enough, but the new ones are all straight, turn back on themselves and are pressed up against the bonnet which I don't like. However amongst my many retained bits I have four right-angle connectors, the leads push into those, and they push onto the cap so all is hunky-dory. And after (currently) 23 years and 100k miles they still look and work as good as new.

The other thing to be aware of on the V8 is that cylinders 5 and 7 are next to each other in the firing sequence as well as being next to each other on the engine, and at the back so the leads are quite long and run parallel to each other. The factory seems concerned that the firing of 5 could induce enough voltage into lead 7 to initiate premature firing of that cylinder, so show the two leads 5 (red) and 7 (blue) being separated in the combs by lead 3 (green), as shown here.

Timing Lights

I am aware of two types:

The older type is the 'in-line' type which simply connects in series with an HT lead and has no separate voltage supply. This type tends to have an orange neon discharge tube, which really needs to be used in low ambient light levels and with clean white paint marks on the pointer and pulley marks.

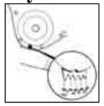
The more sophisticated type has a pick-up which clips onto the HT lead (observing the direction of spark travel from coil to plug in the lead and arrow on the pick-up) and a separate 12v power supply. This type tends to have a white Xenon flash tube, is far more powerful, and is usually effective in bright sunlight. The power supply can be picked up from any convenient 12v point like the brown, white or purple at the fusebox and a handy body earth, it certainly doesn't need to be taken back to the battery. More sophisticated still is the adjustable light with a variable control which can be adjusted until the TDC mark on the pulley is pointing to the zero mark on the pointer as shown by the light, then the amount of advance can be read off the variable control dial. This type allows you to check the centrifugal and vacuum advance curves very easily without having to paint lots of extra marks on the pulley or pointer. Even more sophisticated versions come complete with dwell and voltage readings but I prefer to use a Gunsons Digimeter for those as it also includes RPM, current, ohms, continuity and diode ranges. **Update 1:** After a couple of years the Gunsons packed up and an email to the manufacturer elicited no response. Bought a Draper DMM5 at Stoneleigh spares show which was quite a bit cheaper the only (slight) drawback being it doesn't have a 250v range like the Gunsons. **Update 2:** After a couple of years the Draper packed up! I'm now mulling whether to buy another DMM5, or to splash-out on a Gunsons analogue unit at twice the price hoping it might be more reliable. I have two analogue instruments (no tach or dwell unfortunately) which I have had for 40 years and 30 years respectively which still work perfectly, although they don't contain any electronics like the Gunsons analogue almost certainly does. **Update 3:** Subsequently at Stoneleigh one year I spot an NOS Gunsons analogue multi-meter including rpm and dwell, which - for several years so far! - has been fine.

I've heard of mains-powered types which may be more powerful at home ... but not much use when you are out on the road where the other types can be used as a very valuable faulting aid as well as for setting the timing. Simply attaching the light as normal will show by their flashing whether there is HT present or not during cranking (but see below), e.g. in the event of a non-runner. With the 12v type if you get flashing when clipped on to the coil lead, but not on one or more of the plug leads, then that is symptomatic of rotor (no plug leads flashing) or distributor cap (some plug leads not flashing) breakdown. You should get the same indications with the in-line type but they are much more fiddly to connect and disconnect and if one of the leads becomes disconnected the HT spark will go to earth any way it can including through you!

August 2010: Purely by chance I decided to try and work out what a typical cranking speed is, based on counting the number of flashes of a timing light in a given period of time, as my tachs don't seem to work when cranking. Connected up my adjustable light to No.1 plug, left the choke in (cold engine) and activated the anti-runon valve to prevent it starting, cranked and got no flashes ... odd, it was running perfectly last time out. Connected it to the coil lead and got flashes ... very odd. I then discovered that if I cranked it for long enough, both would flash, but irregularly. Points gap was fine, as was the condenser, and a plug laying on the block. Engine started and ran, so it remained a mystery. Then lying in bed next morning I suddenly realised it was probably the lower system voltage during cranking - 10v or less as opposed to the 14v or so when running not being enough to power the electronics. Break out my old series-connected neon light and sure enough it flashes away just as it should. Embarrassing, I've been recommending for years that this is the first step in diagnosing a non-starter, and while initially convinced I had done it myself in the past, reading back in my notes I see that I had to resort to the neon light then as well, as the powered light gave erratic results! So for diagnosing a non-starter, either use a series neon light, or connect the powered light to an alternative 12v source such a spare battery or another car. Maybe it's also the reason for the tachs not working when cranking.

NEW Timing Marks *April 2017*

4-cylinder:



Several different arrangements over the years, but confusion between the WSM, Haynes and what is found in the wild. Prior to the 18V in 1971 the marks are always below the pulley, on the 18V they are above and angled towards the alternator so they can be viewed while twisting the distributor.

V8:

The markings are on the pulley, both BTDC and ATDC, with a single pointer. However replacement front covers don't have the tapped holes for the original pointer, so a new one has to be fabricated attached by two water-pump bolts.

The accuracy of the timing marks can be checked, and the V8 pointer set correctly, with a depth-gauge such as this. The centre is knocked out of an old spark plug and a rod similar to this length of dowel inserted, such that it is a sliding fit in the plug body. Basically you set the rod such that the rising piston on, say, the compression stroke contacts it before TDC, and make a mark on the pulley adjacent to the timing pointer - using the TDC pointer on 4-cylinder engines. Then do the same on the expansion stroke, but turning the engine backwards until the piston contacts the rod after TDC and make another mark, and TDC is between the two marks. But because the plugs on MGBs are angled relative to the top of the piston I wouldn't like to fix the dowel in position and turn the engine until it is stopped by the dowel for fear of breaking off the dowel inside the cylinder. If a metal rod was used I'd be concerned about scratching the top of the piston, so I've opted for a sliding rod. Make one mark on the pulley before TDC, position the engine there, and push the rod down to contact the piston, and make a mark on the rod. Now withdraw the rod so you can advance the piston beyond TDC, and make fine adjustments to the engine position lifting and pushing the rod each time, until it goes in to the same mark as before. Now make the second mark on the pulley, and again true TDC is exactly between the two.

Vacuum Advance *Added January 2008*

General description:

As described above the vacuum module is part of the system that changes the spark timing according to various conditions pertaining at the time. Specifically, it adds more advance under cruising conditions and a light throttle, and less under acceleration i.e. a heavier throttle. There is a difference between the vacuum and hence amount of added advance at idle depending on whether the vacuum source is a carb or the inlet manifold, but that is purely an emissions measure and doesn't affect running, off idle the conditions are the same.

The vacuum module consists of a flexible diaphragm in a chamber which is open to atmosphere on the distributor side and sealed on the suction side. The suction side has a port which was originally piped to the rear carb on 4-cylinder cars, but moved to the inlet manifold on North American models from August 1971, and other models (e.g. UK) in September 1976. V8s were always

connected to the nearside carb. On the vacuum side of the diaphragm there is a coiled return spring. The strength of this spring determines how far the actuating lever will move the points plate under a given amount of vacuum. How much this spring is compressed at rest, in conjunction with its strength, also controls how much vacuum is required to start moving the diaphragm. Inside the spring is a stop-bar, the length of which determines the maximum amount the diaphragm can move, and hence the maximum additional vacuum advance that can be applied. An actuating lever is attached to the distributor side of the diaphragm, which locates on a pin on the points plate inside the distributor, to twist it clockwise (on the 4-cylinder, anti-clockwise on the V8) as the level of vacuum increases, which causes the points to open sooner and so advance the timing. As vacuum advance is applied the relationship between the points (or other trigger) and the rotor is changed, so the HT spark will occur when a different part of the rotor is adjacent to the cap contact (see 'phasing'). This is why rotor contacts are usually an arc, some longer than others. If changing the vacuum advance characteristics i.e. increasing the amount of vacuum advance that is applied make sure the rotor arc is long enough or you could get HT problems at one extreme of vacuum advance or the other, if the rotor contact starts moving away from the cap contact when the spark occurs. If replacing a rotor, make sure the new one has at least as wide an arc as the old one.

The module for the 25D distributor had a knurled adjuster wheel on a threaded rod which allows the whole module to be moved in and out of the distributor body by a certain amount. This effectively alters the static timing, and hence the starting point for both centrifugal and vacuum advance curves. Originally this was to cope with varying grades of fuel which might be encountered when touring, when the majority of fuel supply was from small independent suppliers (originally chemists!) and fuel quality and octane rating could be very variable. With the spread of national and international chains of filling stations and standardisation and quality control of fuel grades many years ago the need for this adjustment vanished, which was probably one of the reasons why the 45D was introduced with a fixed vacuum capsule (another being cost-reduction as ever). However it is relevant again with the very low octane rating of standard unleaded (95) compared to the original 4-star leaded (99+), and even Super unleaded may only be 97 or 98 octane from some suppliers. Whilst national and international chains of petrol stations usually have both grades, the smaller independents particularly in rural areas often don't. So if you have your timing set to run on Super, you will usually get significant pinking on 95 with a high compression engine, and I have had to adjust the timing when touring Scotland in the past. If I'd had a 25D installed at that time it would have made it much easier, as it was I had a 45D so it was out with the spanners. It depends on how many serrations you have around the edge of your knurled wheel and hence how many clicks for a full turn, but typically about 10 clicks equals one degree of timing adjustment. Mine has 35 serrations, and can go through 7 full turns, which gives plus or minus 12 degrees timing adjustment from a central position.

The characteristics of the module are stamped on the upper casing as three groups of numbers e.g. '7 15 8'. In this example vacuum advance will start to be applied at 7 in. Hg. of vacuum, maximum vacuum advance will occur at 15 in. Hg., and the maximum amount of advance that will applied is 8 degrees. This is 8 **distributor** degrees, which doubles when read at the crankshaft i.e. to 16 degrees in this example. MGB vacuum modules vary considerably. Vacuum advance can start at anything from 3 to 10 in. Hg., maximum advance can be reached at anything from 8 to 15 in. Hg., and the maximum additional advance that can be applied ranges from 6 to 24 **crankshaft** degrees. The V8 distributor starts at 5, finishes at 17, and applies 16 **crankshaft** degrees.

The vacuum capsule changes the timing by pulling and pushing on a pin on the points plate, which twists it and changes the relative position of the points and the cam. When vacuum is applied to the capsule it pulls on its rod, which twists the points plate clockwise (on the 4-cylinder, anti-clockwise on the V8), which advances the points relative to the cam and so advances the timing. 45D4 distributors with sliding points have an additional feature whereby as the points plate twists a fixed pin acts in a slotted cam on the points, which causes the moving contact to move up and down relative to the fixed contact as the vacuum and hence the amount of vacuum advance changes. This means the point are continually making and breaking at different points on their surfaces, which reduces if not eliminates the pitting and spiking of old.

June 2016: It should be noted that this continual twisting back and fore as you move the accelerator pedal can eventually fracture two wires inside the distributor. One of these is the points wire that passes through the distributor body of course, and the other is a less obvious earth wire between the points plate and the distributor body. On 25D4 distributors the points wire is a short length of very flexible brown cloth-insulated wire from the spade terminal to the points, but on 45D4 distributors it is a longer grommeted wire that passes through a hole in the distributor body to a male spade terminal which connects to the harness, and internally goes to a tag that attaches to the points and on to the condenser. A new condenser is required if the wire fails. On both types the earth wire is the same type of very flexible brown cloth-covered wire as the 25D4 points wire. See

Transmission Controlled Vacuum Advance (TCSA): *April 2013*

North American spec cars from late 76 had a system of inhibiting vacuum advance until 4th gear was selected. Clausager says this was to prevent the engine surging when the clutch was operated, which was presumably an unwanted by-product of all the emissions equipment that had been added to the cars by then. This consisted of a vacuum switch or solenoid in the line between the inlet manifold and the distributor, which when unpowered disconnects manifold vacuum from the distributor. With the solenoid released the distributor side is opened to atmosphere to dissipate any vacuum already in the vacuum advance capsule. The solenoid was energised, to connect vacuum to the distributor, by a switch on the gearbox that only operated in 4th gear. Originally this was an additional microswitch that operated in 2nd and 4th, in series with the overdrive inhibitor switch that still operated in 3rd and 4th. Thus power was only supplied to the TCSA solenoid when the gearbox was in 4th gear. Whether the additional switch proved unreliable, or whether it was simply penny-pinching I don't know, but it wasn't long before the additional switch was deleted, and the overdrive inhibitor switch was modified to operate in 4th gear only, operating both the TCSA solenoid and the overdrive solenoid. By this time the manual switch for the overdrive was on the gear lever, so the circuit was ignition supply - gearbox switch - manual switch - overdrive solenoid so overdrive could still be switched on and off in 4th gear, while the TCSA solenoid was powered all the time in 4th gear.

V8 Vacuum Module:
I have had to replace this unit twice in eight years and they are very expensive - in the region of £35 a time. In both cases petrol had caused the rubberised diaphragm inside the unit to shrink and pull out of the seal, which allows outside air to be drawn up the vacuum pipe into the carb. This results in a weak mixture on one carb as well as no vacuum advance when cruising. Having said that I noticed no difference in running, performance or economy when they had failed and only detected it when checking the distributor at routine servicing.

I think this occurs because on the V8 HIF the vacuum port is on the bottom of the carb throat, therefore any liquid fuel in that area will run into the port and from there along the pipe to the module, which is downhill all the way. I notice early MGBs with the copper vacuum pipe have a module near the carb end of the pipe attached to a head bolt or similar. This is also positioned above the carb throat, and whether it is a fuel separator or not, it is going to have the same effect. But my roadster has the plain plastic pipe and as I say hasn't had the same

problem, almost certainly because the carb port in HSs is on top of the throat and so fuel cannot get into it anyway.

Someone mentioned getting a fuel or vapour separator as used on some later BL cars but when I went to the MG Rover dealership they were very unhelpful insisting I give them model details before they would look on the computer, so after the second replacement I decided to make something myself.

I reckoned all I needed was a small chamber, mounted higher than the carb port, and with the carb pipe going in the bottom and the distributor pipe coming out the top. So even when fuel pools in the port and the first section of pipe it should never get high enough in the chamber to reach the top pipe and run down to the distributor, carb suction and the relative heights being enough keep the distributor section of the pipe clear.

Amongst my treasure trove of bits I found a cap used to seal off the end off the open end of 1/2" copper water pipe. I cut out a disc of copper to seal the open end and soldered it on to make the chamber, soldered a short piece of steel brake pipe vertically into the bottom as the 'inlet' (carb) and another piece horizontally near the top for the 'outlet' (module). I did one vertically and one horizontally so I could use the same rubber connectors as used at the V8 carb and module i.e. one angled and one straight. Originally this was so I could get a pair of V8 items knowing they would fit but then I noticed an old 1.0L Metro engine I have kicking around in the garage uses the identical items. Unfortunately the angled one split shortly after fitting but at least I could quote the Metro at the MG Rover Parts place instead of getting an old-fashioned look when I quoted the V8. Got a shock when he quoted the price though, about a tenner, even the salesman was embarrassed.

I made a bracket that bolted under one of the accelerator cable bracket bolts, shaped such that I could clamp the cylindrical body of my chamber to it using a worm-clip, cutting the plastic vacuum pipe in a suitable place for the two rubber connectors. The position of the chamber is such that the whole of it and the angled connector is well above the bottom of the carb port, the top of the chamber being just about level with the top of the carb mounting flanges, so there should be no chance of fuel getting into the chamber, let alone high enough to get into the distributor pipe. Time will tell. Click on the pictures at the left for enlarged views of the general construction and placement.

Vacuum Advance - Carb vs Manifold

After many years of discussion over the differences - can a carb distributor be used on a manifold engine? (Yes and vice-versa) Is one vacuum advance and the other vacuum retard? (No, they are both vacuum advance) Are the vacuum advance curves completely different depending on connection? (Not when running, only at idle and just off it) - I decided to do some tests to show how little difference there really is between the two and that any distributor can be carb connected **or** manifold connected.

The first thing to reiterate is that it doesn't matter whether a distributor was fitted to an engine with carb vacuum or manifold vacuum, the advance mechanism in the distributor is identical - the more vacuum that is applied the more advance is applied and vice-versa.

The second is that the only difference between the two is at idle and just off it. Manifold vacuum is high at idle reducing to almost zero as the throttle is moved towards fully open. Carb vacuum is zero at idle as the butterfly plate covers the port and the port is effectively on the piston or low-vacuum side of the butterfly. As the throttle starts to open the port is uncovered and is effectively moved to the same side of the butterfly as the manifold port i.e. the high-vacuum side. Therefore the vacuum rises very rapidly, and when the throttle is only slightly open it becomes the same as manifold vacuum, thereafter it reduces gradually to almost zero as the throttle is moved towards fully open, exactly as manifold vacuum does.

I had recently obtained a TCSA vacuum solenoid from Gordie Bird (for some experiments with knock-sensing retard) which I modified slightly to provide a short tube on the atmosphere port in place of the filter. This allows the solenoid to acts as a 'change-over' switch passing vacuum from one of two sources depending on whether the solenoid is powered or not. My car has carb vacuum so that was one source. I have had a vacuum gauge for nearly 40 years that I used to use for tuning as well as economy driving, and had made an adapter to screw in place of one of the blanking plugs on the MGB manifold, so that was the other source. Thus a simple on/off switch taped to the bracing bar behind the dash allowed me to select the vacuum source. I made a 'T' junction and inserted this between the solenoid and the distributor to connect the vacuum gauge so I could see the signal the distributor was receiving. The following two pictures show the vacuum connections to carb and inlet manifold, and the solenoid and its connection from the vacuum sources and to the distributor and vacuum gauge:

In the cabin I attached the vacuum gauge with a bracket to one of the screws holding the centre console in place and rigged up a simple pointer that moved across the face of the gauge as the throttle was opened. The next two pictures show zero throttle with the pointer at the left, and full throttle with it at the right (engine off!):

The remaining pictures show the vacuum signal at various speeds and throttle openings, carb signal on the left and manifold on the right. The first pair are at a steady 20mph on the flat in 3rd gear. Even with the very small throttle opening carb vacuum is already at 10 in. Hg. with manifold at 19. Incidentally this manifold reading is **higher** than at idle as the engine is operating more efficiently:

The next pair are at about 25mph on the flat in 3rd gear now the throttle has opened a bit more carb vacuum has risen to about 13 but manifold has fallen to 17:

The final pair are at about 30mph, and carb and manifold vacuum are virtually identical at about 14 in. Hg.:

As you can see the throttle opening is still very small from the position of the pointer. At any higher throttle openings the vacuum falls away on both at the same rate. All these readings were taken at a steady speed on the flat. Under light acceleration vacuum will be significantly less than this, and under significant acceleration it will be much lower and the resultant additional advance will be zero. The important thing is that **both carb and manifold vacuum give the same results in most normal driving conditions.** The only reason for the change is that manifold vacuum results in a higher idle speed than carb vacuum. This allows the idle screws to be backed off slightly to achieve to same idle speed, which reduces fuel consumption and hence pollutants. The final thing to remember is that UK cars didn't get manifold vacuum until September 76, **but had the same engine and distributor from the start of rubber bumper production in 1974 to the end of production in 1980**. Which itself is surely proof that the two are interchangeable.

See also http://www.iwemalpg.com/Vacuum_gauge.htm which has information on using a vacuum gauge for fault diagnosis.

Vacuum Gauge *February 2013*

A vacuum gauge can have three roles:
A tuning aid
A diagnostic aid
An aid to economical driving

The first two only need the gauge to be connected as and when required, the third requires permanent connection and mounting in the cabin where you can see it safely.

For all three it needs to be connected where it can get as balanced a reading as possible from all four cylinders and both carbs. The MGB has a large-bore balance tube in the inlet manifold interconnecting all of these, so it could be mounted as centrally as possible on the manifold. Depending on era and market, there are a number of tapped holes in the manifold, some with blanking plugs, some (particularly North American spec) with emissions related stuff screwed into them. If you have a free, centrally mounted blanking plug then this is the best candidate for a fitting for the gauge. My gauge came to me with a threaded brass tube (2BA), so I simply tapped a hole for that in a central blanking plug, which means I can switch between the modified and standard plug at any time. However a slightly off-centre plug may result in a slightly different signal from cylinders 2 and 3 as compared to 1 and 4 which could cause confusion in diagnostic mode. You would get a more consistent signal by tapping into each carb to manifold spacer, and teeing the two together. If you chose the manifold route the MGB had various adapters that fitted into the manifold from time to time, like for the overdrive vacuum switch, gulp valve, PCV valve and anti-runon system, you will have to consult the parts catalogues for which one will best suit your manifold. Don't use the crankcase breather port on later SU and Zenith carbs suitable as that gives a relatively constant low level of vacuum regardless of throttle opening or revs, except when actually moving the throttle. Many carburettors including SUs have a vacuum port, usually for connecting vacuum advance, but they show zero vacuum at idle so again aren't suitable for diagnostics and are normally only on one carb. Some after-market carbs may have a port that shows vacuum all the time, which would be fine for a single carb, but they will need to be Teed together for multiple carbs. The Zenith has an EGR port, and you might be tempted to use that, but it is the same as the vacuum advance port on earlier carbs i.e. it shows no signal at idle.

A tuning aid: My REDeX gauge came to me with instructions for all three roles, and those for tuning were probably the most beneficial. There are sections on both carburettor and timing adjustment, but as I've always used it with SU carb-equipped carbs I've always found the standard instructions for setting those up using the Mk1 ear and lifting-pin have been better than anything else. All you can do is turn the jet for the highest gauge reading, which coincides with the highest rpm i.e. you can hear it anyway, but that is only the coarse setting for an SU, the fine setting needs to be done using the lifting-pin. It's for timing where the vacuum gauge has been most beneficial.

Even when these engines came off the production line, they differed in many aspects. All the components have tolerances, and depending on which side of 'ideal' each of those tolerances are can cause one engine to vary significantly from another. One of the things that varies from engine to engine for a given type is the onset of pinking, i.e. how much advance a particular engine can take at a given rpm, throttle opening and load. The manufacturers are aware of this of course, excessive pinking can cause engine damage, and so they choose a 'worst case' scenario for the setting of timing advance to avoid pinking, plus a safety factor. What this means is that some engines can benefit from more advance, giving them better performance and economy, without any risk at all to the engine. Others may benefit little or none if they are at the 'other' end of the scale. I've had engines that fall into both categories, a new 1973 Marina fell into the former, and my 1973 MGB roadster (bought in 1990) into the latter. I could run the Marina with 2 or 3 degrees of extra advance, making a noticeable difference to performance. As a new car I was having it serviced by the dealer to maintain the warranty, and it always came back running like a dog as they reset the timing back to book, of course. However with the roadster I found I could get virtually no more advance with the gauge over the book figures, so after that I always stuck to book. That was on leaded. When we changed to unleaded it pinked significantly at book values and had to be retarded a degree or two even with the higher 97, and later 98 and 99 octane grades. If I had to use 95 octane it had to be retarded several degrees, with very noticeable reductions in performance, and increase in temperature gauge readings. Running-on also got very much worse on unleaded, so much so that I had to come up with an enhanced form of anti-runon control, as the after-market valve that was available at the time used as recommended had no effect on it at all. This era of MGB engine seems particularly prone, I well remember a club run up Shelsley Walsh hill-climb where cars around this age were clattering away like billy-oh, earlier and later less so.

On to the practicalities. You adjust the gauge for a higher sensitivity than normal, so the needle is trembling at idle, then slowly advance the timing until you start to see occasional little downward flicks of the needle. Retard very carefully until they just stop, note the reading, then retard a further 3/4 in Hg. That should now be the ideal timing for your engine and fuel.

However! Our engines that can easily be 40 years old with worn components, sundry replacements to various standards, and dare I say 'bodges', that change the characteristics of the engine through the rev range compared to how they were when the engine was new. You may well set it correctly for idle, but further up the rev range the timing can easily be advancing either more or less now than when everything was new, which means the timing is not correct off-idle. If it is advancing more, or the engine has a greater propensity to pink for some reason, you will need to retard a little. And if it isn't advancing as much or has a lesser propensity to pink than originally, then you won't be getting the best out of it. For that reason the only practical way to get the best out of your engine as it is now - without spending a lot of time and money on a rolling road fiddling with springs and weights - is to use your ear. Start at book, or by using the vacuum gauge, by all means. But then on the road (in a safe location!) floor it between 30 and 50 in top gear and listen for pinking. Haynes says to adjust

until just the faintest trace of pinking is heard, but I suspect many won't want even that. Note the resulting static and dynamic figures for future reference. Another thing to bear in mind is terrain. If you adjust in Lincolnshire then go touring in Wales, the Lake District or the Scottish Highlands you may well find you have significant pinking. This brings the 25D4 distributor back into its own, being able to adjust the timing a couple of degrees each way using the vernier wheel. For that reason set the timing by ear with the vernier set appropriately, i.e. if on flat terrain then put it towards the advanced side so you have plenty of scope for retarding for hilly terrain. You could do the opposite if setting it for hilly terrain, but I doubt many would bother to advance it for touring in flatter areas.

A diagnostic aid: As far as diagnostics goes I've rarely had to use it for that purpose, the few times I've had problems I have mostly used other methods. So the best I can do is refer you to sites such as IWEMA Enterprise and Second Chance Garage, although in my experience the scenarios depicted in the second one are much clearer than they would be in real life. Again the sensitivity of the gauge has to be increased to give more needle tremor than would be normal if you had the gauge permanently installed in the cabin.

An aid to economical driving: The general aim to keep the needle as high as possible. Sensitivity is normally slightly reduced, to get near full needle movement, but damped i.e. no tremor or rattling. Not only is rattling irritating but it will rapidly wear the gears inside the gauge between the Bourdon vacuum tube and the needle. It might prompt you to use slightly less throttle for acceleration up to cruising speed, but more importantly once at cruising speed you will normally find that you can back off the throttle a smidgen to get a higher gauge reading, without any apparent loss in speed. This is counter-intuitive, but believe me it works, and after a time it becomes second-nature so that you do it anyway even if you don't have a gauge fitted. I credit techniques such as those with being able to get 40+mpg in the roadster on a good steady run, and 30+ in the V8, when period road tests claim the average mpg for the 4-cylinder car is 27mpg!

Instructions for the installation and use of my REDeX gauge.

http://www.mgb-stuff.org.uk/