Ignition System

Last updated 25-Nov-2011

For a description of how to fault the ignition system go to Won't Start.

Centrifugal Advance


Centrifugal advance is obtained by turning the upper part of the distributor shaft, carrying the points cam, **anti-clockwise** relative to the position of the crankshaft to open the points sooner and hence advance the timing. The lower part of the shaft has a pair 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 springs 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, and then the strong spring 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 *Added October 2009:*

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 enery into the spark instead. A diode would be much more effective at quenching the spark at the points, but would do nothing to improve 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 meter now, then you will know for the future!

Distributor Adjustments

4-cylinder
V8 *New September 2008*

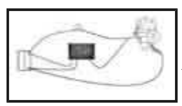
4-Cylinder: The points are so difficult to get at with the oil pipe and steering column in the way on RHD cars (it's bad enough just getting the cap off) that I always remove the distributor to check or change them. I also remove it by undoing the two screws that hold the clamp-plate to the block (pulling 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.

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. The longer dwell of the 25D4 is down to the less efficient coils in use when that distributor was first designed. 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.

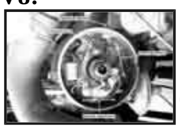
Note that the pulley consists of a metal-rubber-metal sandwich and there have been some reports of the two metal parts getting out of line with each other and being useless for setting timing. If in doubt remove No. 1 plug and turn the engine till the piston is at its highest, this will either be TDC 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. The felt pad on the points is greased, not oiled, 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 (facing forwards) is No.1. Odd cylinders are on the left bank, even on the right.

The distributor clamp is a much more positive design than on the 4-cylinder, being a fork that presses down 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 they are apart, on the V8 it is **highly likely** that you will lose the correct position if the distributor is removed. To regain the correct position:

- Turn the crankshaft so that tim ng 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.

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.

NEW 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 proceded to give intermittent misfiring shortly before total failure.

Distributor Drive Gear

4-Cylinder
V8

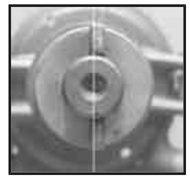
4-Cylinder: Whilst, as long as each plug gets its spark at the correct time, any position on the cap can be used for No.1, the 'correct' position is between 2 and 3 o'clock when looking down on the top of the cap whilst standing beside the right-hand wing. The rotor should be pointing at this lead when 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 any one of six or eight (I forget how many teeth the gear has) positions, only one of which is correct (see Engine for how this can happen). 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.

Note that whilst the distributor drive dog will only engage **fully** with the drive gear in just one position if the distributor is dismantled and the two halves of the shaft separated it is possible to reassemble them 180 degrees out, which will mean the rotor is pointing down and left instead of up and right, and short of dismantling the reassembling the distributor again, or moving the drive gear (possibly the easier option), and all the leads will have to be moved round two positions before the engine will start.



Note also that whilst the drive dog and drive gear will only fully engage in one position it is possible to get them partially engaging 180 degrees out. But the distributor body won't be fully engaged with the clamp plate when the clamp plate is fully bolted down to the block, and even if the leads are altered to suit this position, and the engine starts, the relationship between drive dog and drive gear will almost certainly shift when the engine is run causing massive misfiring at best or stopping altogether.

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!

Distributor 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 'distributor 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 plug lead, 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.

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.

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 a description) or the 45DM4 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 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 loom 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 even has the same dwell as points (non-adjustable) although the 45DM4 unit seems to use more sophisticated electronics that give a constant 'on' (coil reflux) period and a variable 'off' period i.e. variable dwell according to revs (Constant Energy), rather than the variable 'on' and 'off' periods but fixed dwell angle of points. This variable dwell can reduce the heat in the coil at lower revs as well as avoid the reduction in HT energy that high-revving engines (not the MGB!) can experience at high engine speeds. The 45DM4 system was used by a large number of manufacturers, albeit with differing mechanical arrangements, and the MGB system has been said in the past to be a Delco D1906. At the time of writing the modules are still available from WaiGlobal (was Transpo Electronics) as the 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". But if you are determined to replace it, 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. Other systems using Capacitive Discharge, Inductive Discharge and the like usually result in a much higher energy spark, although whether this results 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 current-triggered type. 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 unballasted coils, 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. In various places it says non-ballasted coils must be fitted as well, 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. 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.

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 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 for HT reasons, 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 it 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 (see the section above). 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 missfire 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 the phasing was 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.

Added November 2009: 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 45DM or some after-market triggers. This article 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 0.75 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!

Ignition Coil

April 2011: 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**), and Sport coils can be as low as 2.4 ohms. 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 then disconnect one side of the coil, remembering to reconnect it afterwards. When the engine is running the points are opening and closing, which is interrupting that current, hence reducing the current and heating effect by the duty cycle of the points (nominally 67% on 33% off for the 25D4, 57% on 43% off for the 45D4). However the Workshop Manual quotes a measured running current at 2000 rpm of only 1.4 amps and hence 20 watts for the 25D4, which is significantly lower than the calculated running current (say 3.1 ohm coil, 25D4 distributor, 14v supply giving a current of 3 amps and hence 42 watts). Another effect reducing current is that the resistances are quoted when cold. When at running temperature they will be higher and hence the currents and heating effect will be lower.

The upshot is that if you measure your coil when cold and in winter (when the original article was published) you would almost certainly come to the conclusion that your coil was under resistance if you use 3.5 ohms as a **minimum**. I say again 3.1 ohms is the minimum quoted for standard coils in the Leyland Workshop Manual, Sport coils can be lower but shouldn't be below 2.4 ohms.

Should I have a 12v coil or a 6v coil?
How do I **tell** which I have?
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?

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 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 loom. The resistance wire itself is usually pink, 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 other 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.

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	n/a	DLB102, GCL111
6v (32C5, NA)	0.75	n/a	DLB102, GCL111
Typical 12v Sport	2.4	8.3k	DLB105
6v Sport	1.5	?	DLB110

Note 1: DLB101 has the screw-in HT connector, GCL101 and GCL110 the push-in.

Note 2: 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 kohms secondary, i.e. not as 'sporty' as the one I have.
Note 3: 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 and hence performance and heat from lowest to highest, the higher values reducing the performance gain from the coil. (Whether there is a usable and measurable performance gain from such coils is another matter ...)

It should be noted that these resistances are nominal, they have a tolerance e.g. the 12v can measure from 3.1 to 3.5 ohms and the UK (for example) 6v 1.43 to 1.58. It should also be noted that 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. 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.

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.

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. 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 loom 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 oscilliscope. 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 this document was written ignition systems may have need every volt they could get, there should be more than enough energy in an MGB ignition system to be able to ignore all these variations. However it 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 25k miles, and still show no signs of electrode erosion. Double the price of 'conventional' plugs, but since they have done 2.5 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 system 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.

Ignition Switch

Ignition Switch Connections
NEW Ignition Keys

Ignition Theory

Click here for 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 gasses 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 carburetor. 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

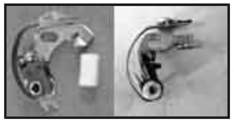
  by over-advanced ignition or weak springs in the distributor advance mechanism. With the distributor cap off you should be able to manually twist the rotor arm and spindle in an anti-clockwise direction, against spring pressure, and it should return fully when released slowly. If it does not return at all, or does not return all the way, one or both of the springs may have become detached or stretched (unfortunately it seems that standard springs are not available "off the shelf", the distributor has to be replaced or sent away for reconditioning). 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 (e.g. UK) or inlet manifold (e.g. North America) 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.

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 required as we want the largest spark possible inside the cylinder.

Points Types *Added January 2008*

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, and must be **greased**, 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.

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 always go by dwell rather than gap, and make fine adjustments to get the dwell right. It is far easier to do this off-car, especially on RHD cars with the steering column in the way. You just need a bulb in series with the points and a 12v battery, you don't need a coil. You also need some means of turning the distributor shaft but this can be as simple as a crank-handle i.e. a bit of wood clamped to the drive dog, it doesn't need to be spun at great speed to get an accurate dwell reading.

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

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 breadown 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, is non-conductive. He has two styles available - this one with the extended body and the rivet much further away from clip or shaft and no spring clip (which may only be suitable for TRs), or these red ones modelled on the originals with no rivet, for 25D4s and 45D4s (even though at the time of writing the page still says 'available shortly'). 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.

Schematics

12v Coil and Mechanical Rev-counter (1962-1964)
12v Coil and Inductive Tach (1964-1972)
12v Coil and Voltage Tach (1972-1974 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)
North America CEI Electronic Ignition (45DM4 with remote amplifier)

Spark Plugs *Amended and updated October 2011*

Spark plugs for MGBs
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.

NEW **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 carful with the alignment of the plug socket, but still managed to break off two more. When I examinded 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.

In February 1999 I bought a set of Bosch Super 4 4-electrode plugs for the roadster, since when they have done about 25k miles, and still show no signs of electrode erosion. Double the price of 'conventional' plugs, but since they have done 2.5 times the recommended life so far (May 2010) and still look as good as new, good value. Having said that I inadvertantly left single-electrode plugs in the V8 for about 25k, and although running seemed fine hot starting recently 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 with the centre and side electrodes eroded very badly have been in beggars belief.

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.

There is a particular issue with the V8 in that the plug body is deeply recessed into the head, with very small clearance around it. 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.

Plug gap was 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 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 puts more and more 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. No standard, road-going MGB should need any more than standard coil, leads, 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.

NEW **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 transferance. 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 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.

NEW **Spark plug condition:** Or 'read your spark plugs'. Lots of examples of specific engine problems (and change interval exceeded - ooops) here from Bosch.

NEW *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, 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-sieze 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. 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 - 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?

Helecoiling 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 onto the plug body. 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!

NEW *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 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 occured. 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 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 I have worn the chrome 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
NEW 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. 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 analog 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.

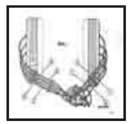
Then, take one probe and stick it into the spark plug end of the wire. You can probably insert it between the metal terminal and the boot to hold it in place. Then, you touch the probe to the terminal inside the distributor cap. This tests both the cap and the wire. Make a note of the resistance reading, 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 18 years and 85k 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 an pick-up which clips onto the HT lead (observing the direction of spark travel from coil to plug in the lead) 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.

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.

Vacuum Advance *Added January 2008*

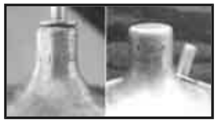
General Description
V8 Vacuum Module

General description:

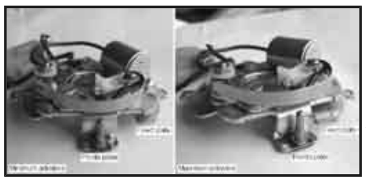
As described above the vacuum module is part of the system that changes the spark timing according to various conditions pertaining at the time. Specifically, it adds more advance under cruising conditions and a light throttle, and less under acceleration i.e. a heavier throttle. There is a difference 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 is piped either to the rear (4-cylinder) or left-hand (V8) carb on early models, or the inlet manifold on North American models from August 1971, but other models (e.g. UK) not until September 1976. 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 as vacuum is applied. 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 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 in dependants (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 commonly available 4-star leaded (99+), and even Super unleaded is only 97 or 98 octane plate. 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. Having a 45D it was out with the spanners, a 25D would have made it much easier.



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, 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.

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 a 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.

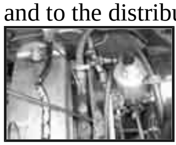
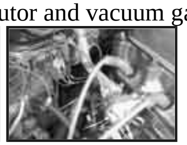
Vacuum Advance - Carb vs Manifold

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.