# Understanding the Ignition System:

**Introduction:**
Even the best ignition and carburation systems will have little effect upon an engine that is in poor condition. Before checking/servicing the ignition and carburation systems I always carry out valve adjustment and a compression test. Only then would I proceed onto ignition and carburation checks.

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**The ignition system:**
To make your engine run really well, the ignition system needs to be able to deliver a good spark to the combustion chamber at exactly the right time. Although the ignition of the fuel air mixture is often described as a bang, it is more helpful to think of it as a burning process which is not quite instantaneous. To achieve the best and most complete combustion, or burn, the spark plug should fire just before the piston reaches TDC (Top Dead Centre) resulting in the optimum power being produced at or just after TDC It is for this reason that ignition timing is described in terms of advance or degrees before TDC. At low rpm the piston speed is relatively slow and there is more time for complete combustion to occur, for example an initial static ignition setting for an MGB 'B' Series Engine type 18GG (as fitted to 'Cracker' my TC) is 10 degrees before TDC. With the engine running the advance will increase (dynamic timing) and at tick-over (600 rpm) the bob-weights in the distributor will advance the timing to approximately 14 degrees (an additional 4 degrees) before TDC.

As the revs rise above idle (tick-over) and the piston speed increases further there is less time for the burning process to occur, therefore to produce the best cylinder pressure the spark must initiate the burn much earlier. This is achieved by the 'bob-weights' in the base of the distributor that fly out under centrifugal force and advance the cam and rotor arm and hence the spark. At approximately 1350 rpm the bob-weights come against a stop which limits the distributor advance in the region of 18 to 20 degrees; this is over and above the static advance of 10 degrees for my 18GG engine. It is important to note that the settings for ignition timing will vary for different engines in a model range and also for special stages of tune. Always check your handbook or workshop manual for the exact figures.

**Notes.**
*If the ignition is too far advanced the burn will be completed before the piston has reached TDC, this can cause a top end rattle known as pinking. If the ignition occurs too late it is known as retarded and the engine will not develop full power, lack economy, run hotter and can cause the engine to continue 'running-on' when the ignition is switched off. Other things can cause running-on, which is bad for the engine. An engine that runs-on can often be stopped more quickly by holding the engine on a fast idle for a few seconds then switching the engine off from the fast idle position whilst at the same time closing the throttle. Some engines are so prone to running-on that the carburettor(s) are fitted with an electrical solenoid to cut off the fuel.*

*When I buy an old car I nearly always renew the distributor cap, leads, points, condenser and sparking plugs. If the engine was running reasonably well I keep the distributor cap and leads as spares in the car tool box, I also carry a new rotor arm, CB points, condenser and a set of new spark plugs.*

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**Electronic ignition systems:**
Many people swear by electronic ignition systems so what are the advantages? The main advantage is fit-and-forget, in other words no more Contact Breaker (CB) Points to change and adjust every few thousand miles so the ignition timing remains constant. Another advantage is that many systems allow the ignition curve to be adjusted; i.e. you can change the timing of the spark to varying degrees before Top Dead Centre depending on rpm and engine load, this can improve engine performance if correctly set up on a rolling road etc.

So what are the disadvantages? Generally they work perfectly well until they stop, how soon they stop tends to vary between a few minutes and several years, or on some rare occasions maybe never. When they stop it means you have broken down and repairs will be needed before you can move again. The chances of you doing these repairs yourself on the side of the road are negligible.

Some suppliers of certain types of electronic ignition systems provide a set of CB Points etc. that in an emergency can be used to replace the electronic ignition 'Trigger' device to enable you to get home; to me that says it all, 'the manufacturers are expecting a failure'. Personally I would never fit an aftermarket electronic ignition system to anything, "if my car breaks down I want to be given the opportunity to fix it at the side of the road!"

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**Description of the ignition parts:**
The various parts that make up the ignition system are.

1. **Distributor: -** An engine 'Distributor' incorporates a switch (CB Points) that makes and breaks the ignition circuit thousands of times a minute over many thousands of miles of usage, it also has the ability (depending on engine speed and throttle opening) to vary the timing of the spark for better performance. There are many different Lucas distributors available and some of them are a direct fit to an MGB engine, but the different specifications of the mechanical advance bob-weights and the vacuum advance and retard settings could be totally unsuitable for a particular engine.
2. **Contact breaker points: -** The CB points are a simple electrical switch (contained within the distributor on most cars) which switches the electricity supply to the ignition coil off and on every time the points open and close.
3. **Condenser: -** A condenser is a small electrical component that can reduce arcing of switch contacts and also help eliminate radio interference. The condenser is normally cylindrical and fitted inside the distributor, but it can be fitted on the outside of the distributor. It is fitted in the Negative (-), circuit and absorbs/reduces the spark that occurs between the contact breaker points when they are opened by the cam in the distributor.
4. **Ignition coil: -** An ignition coil consists of two separate coils of wire around a central core; all of which are contained in a housing. The housing has 3 terminals consisting of a Positive (+), Negative (-), and a central HT (High Tension) terminal that provides power to the spark plug. In most cars etc. this high tension lead from the coil goes into the centre of the distributor cap from where it is distributed to the individual plug leads via the rotor arm. On a modern high performance engines (e.g. a sports motorcycle) it is quite common to have a separate coil for each cylinder. Whenever the ignition is switched on power is supplied from the battery to the Positive (+), terminal on the coil and electricity flows through the low resistance primary circuit and to the negative connection on the coil. The Negative (-), terminal is attached to the CB (Contact Breaker) points in the distributor. As the distributor camshaft rotates the cam opens and closes the points (switches off and on the circuit/current flowing through the coil). When the points are opened the current in the primary coil collapses and a high voltage pulse (in the region of 50,000 volts or more), is induced into the secondary (high tension circuit), where it is delivered to the sparking plug.
5. **Rotor arm: -** The high tension pulse from the ignition coil is passed via a lead (often referred to as the 'King' lead) to the centre of the distributor cap where it makes contact with the rotor arm. The pulse then travels along the rotor arm and up into the relevant lead of the distributor cap and from there to the sparking plug.
6. **Sparking plug:** - The sparking plug is simply a device that consists of two terminals (electrodes) which are held slightly apart in the combustion chamber. When the up-coming piston squashes the fuel air mixture sufficiently a spark is timed to jump across the spark plug electrodes. This causes the air/fuel mixture to ignite and the resulting controlled explosion forces the piston down.

**Note.**
*In my opinion renewal of the condenser, cb points, rotor arm, spark plugs, distributor cap and leads on an unknown car is a must-do-job.* Additionally if it is a car I intend to keep long term I often fit another coil alongside the original one.

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**Firing order:**
Make sure that you replace the ignition leads in the correct firing order of 1, 3, 4, 2. When working out the order of the leads note that the rotor arm rotates in an anti-clockwise direction.

**Note.**
*I always identify the number one plug lead with a coloured cable tie.*

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**Inspection of ignition components:**

**Distributor cap:**
Carefully examine the distributor cap for hairline cracks, if any damage is found the cap must be replaced. Although barely visible, hairline cracks will cause misfiring and poor starting. Any dampness (either inside or out) will cause irregular running, in my experience a distributor cap that is damp inside can cause some unusual problems; I can remember one incident when the car (a Morris Minor) ran perfectly well at tick-over and up to around half revs, it then started to misfire and wouldn't rev any higher, the problem was moisture inside the distributor cap. Clean and dry the cap (and rotor arm) thoroughly. In many instances a temporary solution can be obtained by spraying the distributor cap and leads with a water displacing fluid (such as WD40) but treat this as an emergency solution and clean the cap and leads correctly as soon as possible.

Check the condition of the contacts and the central brush in the distributor cap, again clean or replace the cap as necessary.

**Rotor arm:**
Inspect the rotor arm for cracks and burning at the tip, clean or replace as necessary.

**Ignition leads**
Always ensure that the leads are not cracked or damaged, you can check their operation (and the operation of the distributor) by using a set of spark testers fitted over each sparking plug. These will enable you to see if each plug is sparking correctly and to compare the intensity of the spark at each plug. (Sparkrite sell a set of eight for as little as £20). Copper ignition leads rarely give trouble but can cause radio interference.

**Sparking Plugs:**
To work correctly the sparking plugs must be of the correct 'reach' and 'heat range', they must also be clean on the outside and across the terminals on the inside. It is not a good idea to buy cheap spark plugs. I use NGK BP6ES standard plugs in my 18GG engine.

**Contact breaker points:**
To work effectively the distributor must be fitted with a set of contact breaker points that are in good condition and correctly gapped. Remove the distributor cap and examine the surfaces of the contact breaker points. If the points are severely pitted, indented with tiny craters or have surface splinters they should be replaced.

The point's gap can be checked by measurement using feeler gauges or electrically by using a 'Dwell Meter'. The use of a dwell meter negates the need to remove the distributor cap, although its removal will be required if adjustment is needed.

**Note.**
*I have never known a set of correctly adjusted points in good condition give an incorrect dwell angle.*

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**Adjusting the points with a dwell meter:**
A Dwell Meter is another monitoring device that can improve the performance of the points in the distributor. These are easy to obtain and relatively inexpensive, the meter measures the angle of dwell of the contact breaker points (the number of degrees the points are closed). Using a dwell meter enables you to carry out a quick check to ensure that the points remain correctly adjusted; they also allow you to adjust the gap between the points for the utmost efficiency. Workshop manuals will give the dwell angle in the tuning data section. Proceed as follows.

1. Remove the distributor cap and rotor arm.
2. Connect the dwell meter.
3. Slightly loosen the set screw in the centre of the points so that some movement of the assembly is possible.
4. Get an assistant to turn the engine over..
5. While the engine is turning insert the flat blade of a screw driver into the slot at the end of the points and use the dimples in the base plate of the distributor as a fulcrum to open or close the contact breaker gap.
6. Adjust the points until the dwell meter is showing the correct reading, the dwell angle for an 18GG MGB engine for example is 60 degrees plus or minus 3 degrees.
7. Nip up the securing screw and re-check, make further adjustments if necessary.
8. Replace the rotor arm and distributor cap.

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**Adjusting the points with a feeler gauge:**
Proceed as follows.

1. Remove the distributor cap and rotor arm.
2. Put the car in gear and with the handbrake off rock the car until the points are fully open.
3. Put the handbrake on and take the engine out of gear.
4. Slightly loosen the set screw in the centre of the points so that some movement of the assembly is possible.
5. Insert the flat blade of a screw driver into the slot at the end of the points and use the dimples in the base plate of the distributor as a fulcrum to open or close the contact breaker gap.
6. Adjust the gap until it is between 0.014” to 0.016” (.35 to .40mm) for most MGB engines.
7. Nip up the securing screw and re-check, make further adjustments if necessary.
8. Replace the rotor arm and distributor cap.

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**Contact breaker points replacement:**
The points are fitted onto the base plate of the distributor with a centre screw and their replacement is quite straightforward, but take careful note of how the points are fitted and the position and route of the wiring. When the new set is in position make sure the distributor cam is holding them in the fully open position and adjust the gap as described above. If you have the facilities (phone etc.) then take a photo before you start. Not all Lucas distributors take the same style cb points.

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**Vacuum advance:**
The vacuum advance mechanism adjusts ignition timing at part throttle to improve economy and performance. When the engine is running at low throttle openings less fuel air mixture is drawn into the cylinders which results in a lower compression pressure. To help the ‘burning’ the low vacuum advances the ignition timing.

**Note.**

*With the car at tick-over speed there is a large vacuum but it does not effect the vacuum advance and retard mechanism as the vacuum transfer port (that is adjacent to the throttle butterfly) only comes into operation as the throttle is opened. Under light load the vacuum has an effect on the vacuum bellows which being connected to the distributor base-plate advances the ignition. Under heavy loads (throttle open and higher compression pressure) the vacuum is reduced and the spring returns the bellows (and attached distributor base-plate) to the inoperative position.*

You can check if the vacuum unit is operating correctly by disconnecting the pipe which connects it to the carburettor or inlet manifold and sucking hard on the end; you will hear a click as the base plate moves. The movement is only very slight and is best detected by listening for the noise it makes. If sucking hard produces no response then the vacuum pipe or diaphragm is probably faulty and replacement will be necessary.

**Note.**
*On most engines the dynamic timing is carried out with the vacuum pipe disconnected, but not always, so check the manual.*

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**How to set the timing:**
Check in the handbook or workshop manual for the correct timing figure for your engine; use the engine number prefix to identify the figures relevant to your engine series. The figures given will refer to static timing and also to stroboscopic/dynamic timing.

**Static timing:**
This method employs the timing marks positioned on the timing cover and the crankshaft pulley. The adjustment is made while the engine is stationary (static). It is necessary to align the marks while number 1 cylinder is approaching top dead centre on its compression stroke. Number 1 cylinder is the cylinder closest to the radiator. An effective way to help you align the timing marks is to begin by removing all the sparking plugs; this will enable you to turn the engine over by pulling on the fan belt or by pushing the car in gear. Using either method you will be able to turn the engine and position the marks exactly. To be sure that you have number 1 cylinder at top dead centre put your thumb over number 1 spark plug hole as you turn the engine over and you will be able to feel the air being expelled as the piston rises in the cylinder. With the plugs removed you can just see the top of the piston through the spark plug hole as it nears top dead centre. Now align the appropriate marks on the timing cover and crankshaft pulley. Check your handbook or manual for the static timing settings, the MGB 18GG engine has a static advance setting of 10 degrees before TDC. Look at the row of pointers on the timing cover, the longest pointer indicates TDC and the others are spaced at 5 degree intervals before TDC. Align the mark on the crankshaft pulley with the pointer for 10 degrees before TDC; then connect a 12 volt test lamp between the low tension terminal on the side of the distributor and a good earth on the engine.

With the ignition on a test lamp connected to the distributor will light up as the points begin to open. It can be made from two crocodile clips and two lengths of wire connected to a bulb holder fitted with a 12 volt bulb (you can make one up from an old side light unit etc.)

Now switch on the ignition, always remember to switch it off again as soon as the timing check has been made, because leaving the ignition on for long periods without the engine running can damage the coil. When the ignition is switched on, the lamp will light up as the contact breaker points open and will go out when they close. You have set the marks at ten degrees before top dead centre and this should be the moment when the points just begin to open, therefore if the test lamp is already on, the points are open. Should your engine be fitted with a distributor that has a vernier adjusting nut, you can use this to fine adjust the timing. With the test light on, turn the nut towards R (Retard) until the light goes out, then back towards A (Advance) until it just lights. If your distributor does not have a vernier adjuster you will need to slacken of the pinch bolt that clamps the distributor in position and make a very small adjustment by turning the distributor body slightly anti-clockwise until the light goes out, then slowly clockwise until the test lamp

lights up, you will need to find the exact position at which the points begin to open and the lamp just begins to light. Once you have located this spot, nip up the pinch bolt to clamp the distributor into position.

**Stroboscopic timing:**
This method of dynamic timing involves using a hand held timing light connected up to the spark plug lead for number one cylinder. First highlight the timing marks with a tiny dab of white paint or Tippex on the appropriate pointer and on the notch in the crankshaft pulley. The vacuum advance is then disconnected and its connection in the inlet manifold blocked off.** The engine is then run at 600 rpm (low idling speed) while the pulsing strobe light is pointed at the timing marks. The flashing strobe effect makes both the timing marks appear to stand still and provided the engine speed can be accurately measured either by the rev counter or a device on the strobe itself, then the timing can be correctly adjusted. Adjustment is made by slackening the pinch bolt on the clamp that holds the distributor and rotating it by a very small amount. This is usually a matter of fractional twisting in either direction until the timing marks line up; the setting is 14 degrees before TDC for an 18GG engine.

**Note.**
*** Don't forget to reconnect the vacuum pipe when you have finished timing the engine.*

Strobe lights are readily available and not too expensive; the latest examples have a built-in system of measuring the engine revs and an easy to fit clip-on attachment for the ignition lead. These strobe lights require their own power supply which can pose a problem for cars with batteries located behind the seats; therefore you will need to connect the red crocodile clip of the strobe light power lead to one of the live terminals of the fuse box etc. and the black crocodile clip to a good earth in the engine bay. If you have a spare battery you can stand it at the side of the car and connect the leads to that.

By speeding up the engine you can check the timing at various rpm (revs per minute) as the distributor bob-weights are slung out by centrifugal force and turn the rotor arm in an anti clockwise direction which advances the ignition timing.

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**Oil filler cap:**
This seems a funny item to mention in an article covering the ignition system! I learnt many years ago (1982, on a 3-series BMW) that a missing oil filler cap, or one that doesn't seal correctly, can cause some unusual problems, that could lead you to think you have ignition or carburettor related problems, especially on post 1980's cars with more complicated breather systems.

**Summary:**
It is vital for the smooth running, long life, economy and performance of your engine to get the ignition timing correct. If you are not confident that you can carry out the timing yourself and you suspect that your engine is not running as well as it should, it is well worth taking your car to a tuning specialist to ensure that it is set up exactly to the manufacturer's specification. If your car has been modified then inform the specialist tuner of all the details because changes to the camshaft, cylinder head or other engine modifications will alter the timing requirements of your engine.

Finally don't forget to tune the carburettors as well, not forgetting that many mechanics believe that 80% of suspected carburettor faults are ignition related.

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**Short story:**
In 2014 we stopped at Brookside Camping and Caravan Park in Scunthorpe for a few days and walking our dog that evening I spotted a 'Morgan Plus 8' in a garage and Richard the site owner looking under the bonnet.

Being a car enthusiast I stopped for a chat. It turned out that Richard had spent a couple of years restoring the car and it was now just about finished and ready for a new coat of paint. During our discussion - which went something like this, it transpired that the car had an occasional misfire and despite lots of knowledgeable friends looking at it (including members of the local Morgan Owners Club) and spending lots of money, he couldn't cure it.

I said start it up and let me have a listen. The engine ran reasonably well but every few seconds it missed a beat. Richard said any ideas. I said I know exactly what's wrong with it, have you got a torch, he said yes, so I said go and shut the garage door then turn the lights off and come back here. When he got back I said turn the torch off and look at the distributor cap. Sure enough every time it missed a beat you could see sparks jumping around the centre of the distributor cap.

The next afternoon he came over to our pitch and said that he had gone out and bought a new distributor cap and leads and it had totally cured it. He said I can't believe it, I've spent weeks trying to fix it, have renewed loads of bits on the advice of so-called experts and a bloke with a dog walks past and tells me to buy a new distributor cap and it cures it.

I would like to conclude this story by saying that Richard was so pleased that he refunded our camp site fee's, but he didn't so I won't.