Ignition Coil

All frequent questions as part of a lot of confusion on this subject. Coil manufacturers don't help - I have come across two coils marked '12v' but also saying it needed an external ballast resistor! This is confusing if not incorrect, and some suppliers do have completely incorrect information on their web pages. **You won't know what you have got until you measure both the wiring and the coil, and that goes for newly purchased coils.**

There is lot of conflicting and confusing information on the web regarding coil and ballast resistances. The original 12v system was changed to a different coil with an external ballast resistance in series with the introduction of V8s and rubber bumper cars. This system boosts the coil voltage - and hence the HT spark - during cranking and so gives a better chance of starting under adverse conditions such as weak battery or poor state of tune, but has no effect in normal running. More information here.

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. One example of a coil marked '12v' and 'must be used with an approved resistance' measured 2.2 ohms which is too high for a 6v coil, but also too low to run on an unballasted system as it will overheat. Hence the label saying it must be used with an approved resistor, but that can only be one measuring 0.3 ohms at most or it will degrade the spark. One MGOC advert states "Ballast Ignition Coil 12 Volt - GCL111 - DLB111 Ballast ignition coil, 12 volts, 3 ohm. Rubber bumper only." which is completely incorrect. 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. Rimmers GCL132HP quotes the same resistances as for a 6v sport coil. Reference to '9v' could simply be down to incorrect interpretation of coil voltage measured on a running engine. The ballast resistance should measure about 1.4 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.

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. From the factory this resistance is not an identifiable component but a length of resistance wire contained within the harness. The resistance wire itself is usually pink with a white tracer, but has a white or white/brown tail at the supply end, and on the coil end a white/light-green on a 4-cylinder or white/light-blue on a factory V8. 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 (unless you use a variable-dwell electronic ignition system in place of points which raises more questions). Using a 12v coil in a 6v system will result in reduced HT spark. You can't go by the colour of the wiring, there are some unfeeling butchers out there, you have to do a simple electrical test. Remove the wires from the coil on the points-side, usually black/white. Connect a voltmeter on its 12v scale to the other coil terminal and turn on the ignition. On all cars you should see battery voltage i.e. 12v. Now connect an earth to the points terminal...

- If the voltage stays at 12v or only drops a couple of tenths, there is no ballast resistance in circuit which is correct for a chrome bumper. There **should** be a 12v coil, but you will have to measure the primary resistance or do a current measurement as below to check you don't have a 6v coil.
- 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 and 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.
- Other voltages can indicate some other type of coil has been used, it is faulty, or the ballast resistance is faulty or incorrect. You will have to measure the individual resistances of the ballast and coil to see which exactly what you have.

However you could have a combination of an incorrect coil and incorrect ballast resistance which will give the correct voltage, which is why a current test should be done as well if you are having spark problems.

Testing a coil: It is possible to test a coil, and tell the difference between 12v, 6v and other coils, by measuring the primary and secondary resistances (all wires and HT cable removed) with an ohmmeter looking for these resistances:

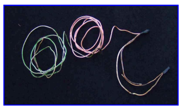
Coil	Primary Resistance (ohms)	Secondary Resistance (ohms)	Designations	Notes
12v	3	5.4k	GCL101, DLB101, GCL110	1
6v (15C6 UK)	1.5	6.5k	DLB102, GCL111	2
6v (16C6 NA)	1.4	8.9k	DLB112	3
Typical 12v Sport	2.4	8.3k	DLB105	4
6v Sport	1.5	8.6k	DLB110, GCL132HP	5
32C5	0.8	5.8k or 7.2k	DLB125 or DLB198	6

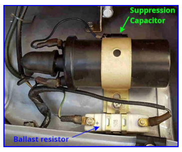
Notes:

1. Chrome bumper cars, resistance can measure from 3.1 to 3.5 ohms. DLB101 has the screw-in HT connector originally used on Mk1 positive earth cars, GCL101 and GCL110 the push-in used on Mk2 and later negative earth. Original positive earth coils with screw-in HT had SW and CB terminal markings and internally were wired differently to negative earth coils. These took account of the polarity difference and had '+' and '-' terminal markings. Note that new coils advertised as being for Mk1 cars have the terminals labelled '+' and '-' despite having screw-in HT connections (such as this one from Moss Europe), it's not known whether these wired internally for positive earth or negative earth.
2. Rubber bumper cars and all V8s, resistance can measure from 1.43 to 1.58 ohms, must be used with a ballast resistance (within the factory harness) of a similar value.
3. DLB112 was used with the 45DE4 electronic distributor.
4. 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 2.8 to 3 ohms primary and 8.3 to 10.45 kilo-ohms secondary.
5. The DLB110/GCL132HP 6v Sport coil must be used with a ballast resistance on a 12v system such as the MGB. The original (in harness) ballast of the rubber bumper MGBs is 1.3 to 1.4 ohms, and I have seen external 'component' ballast resistances ranging from 0.9 ohms to 1.6 ohms recommended for use with this coil. This range will give a significant difference in current hence performance and coil temperature - higher resistances reducing performance, lower increasing coil temperature. (Whether there is a usable and measurable performance gain from 'sport' coils is another matter ...).
6. **The 0.8 ohm primary DLB125 or DLB198 coils must only be used with a variable dwell electronic ignition module or it will grossly overheat. On the MGB these were used with the 45DM4 distributor and no ballast resistance**.

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.

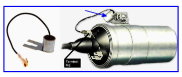
However it also quotes a running current of 1.4 amps at 2000 rpm, but this doesn't equate to the calculated figure when you take the higher running voltage and the relative points closed and open times into account, which should be (say) 14.5v, 60 degrees closed and 30 degrees open i.e. 67% closed, which 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 system should be significantly higher.


Click the thumbnail for information on the ballast resistance.



Whilst the MGB ballast resistance is a length of resistance wire contained in the harness and not an identifiable component other marques and models and some after-market coils for the MGB may use a discrete resistor in the shape of a rectangular block with two terminals mounted near the coil.

Is this a ballast resistor?


Quite a few cars will have a component that has a wire going to the coil +ve (or SW) terminal and a metal tag secured under a coil fixing bolt, but these are radio interference suppressors. They are capacitors that help to damp electrical noise spikes and can be found on the instrument voltage regulator, fuel pump, indicator flasher unit, alternator, electric screen washer pump i.e. anything with a motor or switch that can generate electrical noise. They are similar to the ignition condenser in a distributor in that both are capacitors, but whereas the condenser has values of about 0.2uF

and 600v a suppression capacitor will be about 2uF and 100v and the two are not interchangeable. Originally cylindrical, they can also be rectangular.

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

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. 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 used with wiring that includes a ballast resistance in the circuit allow the spark to be boosted during cranking, and as a side-benefit they give an improved spark at high rpms. 12v coils for older systems are still needed of course and at some point someone had the bright idea of putting a ballast resistance inside the can with a 6v coil so making it a 12v coil! This meant they only had to produce one winding unit instead of two reducing production as well as material costs, and you end up with a 12v coil that also has the improved spark at high rpms - albeit much higher than a factory MGB ever produced. So if anyone starts talking about internal ballast ignore it. A coil is either a 12v coil of about 2.5 to 3 ohms or a 6v coil of about 1.5 ohms, and the only way to be sure what you have is to measure it - including newly purchased coils as suppliers descriptions and manufacturers packaging and markings can be confusing if not downright incorrect.

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

Should I reverse the coil connections when changing the car's polarity? *May 2010* It's often recommended, but is it really necessary? And what are the benefits and drawbacks? Early, positive-earth cars had coils with terminals labelled 'SW' and 'CB' and Mk2 negative-earth cars have coils with terminals labelled '+' and '-'. For connections of these and other variations read on:

- **I have an original positive earth car and a coil with SW and CB terminals:** Connect the SW terminal to the ignition **SW**itch using the white wire and the CB terminal to the distributor **C**ontact **B**reaker aka points using the white/black wire.
- **I have a positive earth car and have to replace the coil with a modern one:** If the coil has a push-in HT connection connect the white wire from the ignition supply to the '-' terminal and the points wire to the '+' terminal. This will adversely affect the HT spark slightly but unless you can get a good SW/CB coil from somewhere you may have no choice. Note that new coils advertised as being for Mk1 cars have the terminals labelled '+' and '-' despite having screw-in HT connections (such as this one from Moss Europe), it's not known whether these wired internally for positive earth or negative earth. This method may show you, failing that try the connections first one way then the other, and if one way seems to work better then go with that.
- **I have a positive earth car that has been converted to negative earth:** Ideally fit a modern +/- coil, otherwise the wiring to an original SW/CB coil should be reversed i.e. the white wire from the ignition supply should go to the CB terminal and the points wire to the SW.
- **I have a positive earth car that has been converted to negative earth and need to fit a modern +/- coil:** This is a better option than reusing the original SW/CB coil - connect the white wire from the ignition supply to the '+' terminal and the white/black points wire to the '-' terminal.
- **I have an original chrome bumper negative earth car and need to fit an SW/CB coil:** Ideally don't, get the correct +/- coil for your car, but in an emergency connect the white wire from the ignition supply to the CB terminal and the white/black wires to the SW terminal.

- **I have a rubber bumper car and need to fit an SW/CB coil:** As above ideally don't, get the correct +/- coil for your car. In an emergency it can be done but using the existing wiring will halve the HT spark energy and you may have problems starting and running because of the ballasted ignition system on those cars. To avoid that, and if you can do so, connect a temporary wire from the white or white/brown terminals on the front of the fusebox, second fuse up, to the CB terminal on the coil and the white/black wires to the SW terminal.

Some cars had factory-fitted radio interference suppression capacitors fitted at the coil, these should be connected as described here. Some cars may have had after-market ignition conversions involving an external ballast resistance, typically as here, these are completely different to and independent from suppression capacitors.

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

How can you determine the polarity of a coil? You could measure from the HT terminal to each LT terminal, and the one with the lower resistance i.e. the junction between the two windings should go to the points. But that is looking for 3 ohms difference in over 5000 ohms, which would need a digital instrument with at least 4.5 digits to reveal. You could do an open-circuit bench-test and see which LT polarity jumps the largest gap (a cold gap, so HT polarity difference won't matter), but that will result in some very high voltages in the coil which probably isn't wise. A test with a controlled gap in the HT circuit is no good as the voltage will stop rising when the gap fires. You **may** be able to tell by looking at the two induced voltages on an oscilloscope. If that on the HT lead is negative with respect to earth (as it should be), and the LT terminal connected to the points is also negative with respect to the LT terminal connected to the ignition supply, then the implication is that the required auto-transformer effect is also present, but I have not tested this. I did wonder whether you could use the effect mentioned above whereby the auto-transformer action tends to reduce the current displayed on an analogue instrument, but because the induced voltage in the LT winding will always be opposite to the battery current, no matter what coil you have on what polarity car or which way round, the reduction will always be present. You can probably assume that an original coil from a positive earth car marked SW and CB is a positive earth coil, and that from a late car marked + and - is a negative earth, but that doesn't help one jot with replacement coils, where even if you can get one marked SW and CB there is no guarantee it's internal connections are for positive earth. Note that at least one edition of 'MGB Electrical Systems' is incorrect in that it states "On negative earth cars as long as the distributor is connected to the + terminal (of the coil) the test should be unnecessary". On a negative earth car the distributor (i.e. the earth supply to the coil) should be connected to the - terminal of the coil, and the 12v ignition supply (the positive supply to the coil) should be connected to the + terminal. A number of sources talk about using a graphite pencil tip held in a spark gap, and when the polarity is correct there will be a brighter spark or 'flare' from the pencil tip to earth.

However having tried that I found it very inconclusive, there is a much better way using an analogue meter between the HT lead and earth. You still need a spark gap e.g. a spare plug connected to the HT 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 with the upward and the downward flicks being so close together it may not be clear whether it is the opening of the points or their closing that is causing a downward flick.

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

What is an oil-filled coil? *November 2018:* Originally coils were 'dry', then at some point oil was added. Two possible reasons - the first being better heat transference from the winding to the coil case and thence away from the coil altogether, the seconds probably to do with preventing internal breakdown as will be seen below. In my experience an 'oil-filled' coil clearly makes a sloshing noise when shaken, so only partly filled and not completely filled as the description implies. I've seen a claim that Bosch coils are completely filled and don't slosh, but that would mean the oil would expand as it heats up and put pressure on the seal between the case and the end that carries the connections, which seems unlikely. *November 2022:* Some manufacturers have gone back to 'dry' coils using a resin compound. And that leads on to:

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

Hot coils: *January 2013:*

> There has been some discussion on this in various places for a while now, and it's a fascinating and complex subject given the apparent simplicity of the points/condenser/coil ignition system. Coils, like alternators and many other components, do run hot to the touch and are designed to be able to cope with it. The question is, how hot is normal, and how hot is too much? I'd say that if the average person can keep their hand on it, it's probably not too hot. If they can't, it probably is too hot. But that's very subjective, and the real arbiter should be whether there is a problem with the running of the car or not. If not, and it just seems hot when you touch it, then ignore it. If there IS a problem with running then there is definitely something wrong somewhere, but it might not be the coil. One thing for us in the UK to remember is that these cars run perfectly well in desert states in America at ambient temperatures of well over 100 degrees Fahrenheit. The coil is behind the radiator (if not bolted to the engine), and so is obviously expected to work correctly at the highest engine compartment temperature that Abingdon expected. If someone in the UK is having a problem, especially at the moment, then it's being caused by a definite fault.
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> Contrary to what one person writing elsewhere is insisting, the minimum resistance of a 12v coil is **not** 3.5 ohms. The Leyland Workshop Manual specifies 3.1 to 3.5 ohms (i.e. 3.5 ohms is the **maximum**), Sport coils can be as low as 2.4 ohms, and coils for electronic ignition systems can be much lower than that. The writer is getting hung-up on the fact that if you connect 12v to a 12v coil then with about 4 amps flowing through it developing 48 watts of heat it **will** overheat. But all that means is that you shouldn't leave the ignition switched on with the engine stopped. If you need to do that for diagnostic purposes on other components then disconnect one side of the coil, remembering to reconnect it afterwards.
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> As an electrical component it will will generate heat when it is powered and its temperature will rise. It has to be able to dissipate that heat somewhere or it would get hotter and hotter until the component was destroyed, and in the case of the ignition coil that heat is dissipated to the surrounding air i.e. in the engine compartment. But it can only start dissipating heat when it gets hotter than its surroundings, and so it will always be hotter than the ambient air in the engine compartment. Therefore it follows that on a winter's day with icy air blowing through the radiator that it will be much cooler to the touch than in high summer when the radiator is pumping out masses of heat.
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> I've checked both mine - V8 with a ballasted system and roadster with an un-ballasted - and after running for about 20 minutes in 8 to 10C ambient they were only round 40C, which is only warm to the touch. On one day with an ambient of about 15C the V8 coil was 52C, and on another with an ambient of 21C it was 58C. So with each increase in ambient there is a similar increase in coil temperature, as expected.
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> **July 2013:** In the midst of this heatwave I've been checking both cars again. The V8 at an ambient of 27C saw the lower part of the coil at 62C (the upper was a little cooler), so again a correlation between the increase in the ambient temperature and the increase in the coil temperature. Whilst 40C (10C ambient) is only warm, 62C is very much hotter to the touch. The engine compartment temperature varied between 40C bowling along the M6 round Birmingham at 9:30am, 45C coming back at 1:30pm, and in some stop-start traffic round Solihull with the fans on it got up to 58C. With the roadster at 26C ambient the upper part of the coil was at 67C (in this case the lower part was a little cooler). Higher than the V8 as before, but a slightly smaller difference than at lower ambients. The engine compartment in stop-start traffic round Solihull got up to 50C.
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> **July 2016:** Over the last two days of 30+C ambients I've been checking the V8 (the roadster is part-way through a clutch change). On both afternoons the engine compartment got up to 64C (measured closed with a probe through a grommet) and

stopped with the bonnet open the coil measured 68C. No problems hot starting - either immediately or after a few minutes, so what the problem was in 2014 (intermittent problems in May, June and July even though it wasn't as hot as it is at the moment) I don't know.

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

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

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

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

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

However, that's at switch-on. When running with points (electronic ignition systems are usually very different) the 25D4 distributor is only energising the coil for 67% of the time (derived from a dwell angle of 60 degrees in a 4-cylinder distributor i.e. 90 degrees per open/closed cycle). But now we have typically 14v as the system voltage so the heating effect is 42 watts (voltage squared divided by resistance times percentage energised divided by 100), but even that is not the full story. The coil is a transformer and has inductance and the effect of inductance is to cause the current to rise over a short period of time when voltage is connected, not instantaneously, so the heating effect is reduced still further. The Workshop Manual quotes a running current (i.e. the average of no current for some of the time, partial current for some of the time, and full current for some of the time) of only 1.4 amps at 2000 rpm which implies only 9 watts heating effect. However the readings in the Workshop manual will have been made many years ago, and hence on an analogue meter, and the reverse EMF generated as the points open tends to kick the needle back a bit and give an artificially low reading. Nevertheless if you connect an analogue meter on its current scale in series with the coil and run the engine, this **is** the current you should see. If the static current was correct but the running current is too high or too low, you need to check the points gap or dwell. If your points gap is too small you will get a high dwell, higher current reading and the coil running hotter. If too large you will get a low dwell, lower current reading and the coil will run cooler. Dwell is a dynamic (i.e. with the engine running) method of measuring points gap and avoids putting feeler gauges that might be oily against the points contact surfaces. With the correct gap you should get the correct dwell, and vice-versa, but there are some faults that means this isn't the case. Going back to current, on a running engine a digital meter may well show something completely different or no usable reading at all, depending on model and type. That's for a 25D4 distributor. With a 45D4 the points are only closed for 57% of the time, giving a slightly lower average current and hence lower heating effect.

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

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

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

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

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

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

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

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

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

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

Intermittent misfire/cutting-out:

Originally MGB coils had riveted spades and over time these can work loose and cause a misfire or cutting-out accompanied by the tach dropping, later coils have threaded studs and nuts and overcome this - at least when your nuts are tight! My 73 roadster had this in 2001 - varying in length but never completely dying and it has cropped up again on the MG Enthusiasts website. From a report of 'tach dropping' Nat found his 1972 (riveted) -ve spade terminal was loose and with an ohmmeter the resistance was at best 4.3 ohms (instead of nominally 3 ohms) but when the spade was wiggled it would rise to about 200 ohms and sometimes infinity. Replacement needed - be sure to measure the resistance between the spades before you fit it. Suppliers and even manufacturers do not always have the correct information and previous owners may have changed things. Get the wrong coil for your wiring and you can end up with weak sparking or an overheating coil.

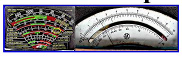
A similar thing can happen with original spade connectors being a bit loose on the spades, in that case pinching up the connectors a little with a pair of pliers is cheaper than a new coil ...

Diagnosing ignition LT problems with a voltmeter:

A tachometer (as opposed to a rev counter) is a useful diagnostic tool if your engine suddenly cuts out or starts misfiring while driving along - look at it before you do anything else including dipping the clutch in preparation to pulling over. If the tach has suddenly dropped to zero while the momentum of the car is still spinning the engine, or starts jumping up and down with the misfire (often accompanied by backfiring in the exhaust), then it's a good indication you have an ignition LT problem. The problem could be loss of ignition voltage to the coil, a failed coil, or loss of the switched earth through the points or electronic trigger but they will all have the same effect on the tach whereas a voltmeter will allow you tell which of those three scenarios you may have. Intermittent problems - that clear rapidly before you can do any testing - can be particularly difficult to track down and you can wire in a voltmeter positioned where you can see it in the cabin and look at that as soon as the problem occurs, having previously done the following tests and noted what the 'normal' conditions are for your car.

I'll start with chrome bumper cars for their relative simplicity as well as logically as they came first. For both chrome and rubber what follows relates to how they came out of the factory - including using points and condenser not how they might have been messed about with since including the fitting of after-market electronic ignition or different coils as the voltages can be very different. The two types of factory electronic ignition systems are not covered here, but you can still do as advised above and note what the normal conditions are for your car to compare against when you have a problem.

Certain voltages will be present on the LT terminals when the ignition is on and the engine stopped but that varies according to whether the points are open or closed and whether it is a chrome bumper or rubber bumper, and the voltages are different again when the engine is running. The following voltages were read on an analogue instrument, digital voltmeters can display differently depending on the internal design i.e. when the engine is running you may see these voltages, or something different, or the display may be jumping all over the place with no usable reading.

- **Chrome bumper:**
  
  These used a 12v ignition system i.e. a 12v coil measuring about 3 ohms between the spade terminals running at full system voltage i.e. 12v engine stopped (ignition on) and around 14v engine running. This means that the voltage on the coil +ve (SW terminal on positive earth cars) will always be system voltage. The voltage on the coil -ve (CB) (ignition on, engine stopped) will be 0v with the points closed and 12v/14v with the points open. When a running engine is switched off compression usually stops two of the pistons half way up the bores which means the points will be closed so the voltage will be close to 0v. If the engine has been turned manually then the points could be either open or closed.

  When cranking the load of the starter will reduce the voltage from a good battery to about 10v (lower with a weak battery or poor connections anywhere in the cranking circuit) and you will see this reduced voltage on the coil +ve. The points are opening and closing - the length of the 'closed' time is determined by the dwell setting and is longer than the 'open' time. The voltage on the coil -ve (CB) will be switching between the lowered system voltage (points open) and 0v (points closed) and an analogue voltmeter will display an average between the two which depends on the dwell value. The 25D4 distributor as used on all chrome bumper cars has a nominal 60 degree dwell which means they are closed for 60 degrees of the 90 degree ignition cycle of a 4-cylinder 4-stroke engine i.e. closed for 60/90ths or 66.7% of the time. Therefore they are open for 33.3% of the time and an analogue voltmeter on the coil -ve (CB) will show about 3.3v with a cranking voltage of about 10v.

  When a chrome bumper engine is running being a 12v system again you will see system voltage on the coil +ve (SW), which should now be around 12-14v depending on engine speed and electrical load. You may see the lower voltage for a dynamo if the idle speed is low, but should be towards the higher voltage for an alternator or when the dynamo is charging at a higher idle. The voltage on the coil -ve (CB) will be switching between that system voltage and 0v as before, an analogue meter will display the average of the two which for a 25D4 should be about 4.7v at a system voltage of 14v.

  Did I say chrome bumper is simple? What I actually said was *relatively* simple! 😁

- **Rubber bumper cars:**
  
  This section excludes later North American spec with factory electronic ignition. Other markets used a points distributor with a ballasted ignition system which comprises a ballast resistance of about 1.5 ohms primary resistance in series with a 6v coil of a similar value. Together they measure about 3 ohms so the same coil current flows as in the 12v chrome bumper system. With the engine stopped and the ignition on the voltage on the coil +ve (unlike the chrome bumper system) depends on whether the points are open or closed, as does as the voltage on the coil -ve. As before when a running engine is switched off the points will usually be closed and on the ballasted system you will see 12v divided pretty-well equally between the ballast and the coil i.e. about 6v on the coil +ve. However if the points happen to be open on a stopped engine then you will see full battery voltage on the coil +ve even though there is a ballast resistance in series with the coil, see how voltage varies between drawing current and not drawing current here.

  The voltage on the coil -ve is the same as for chrome bumper 12v system in that it also depends on whether the points are closed or open. If closed (as they will normally be having switched off a running engine) you will see close to 0v, but if they are open i.e. the engine has been turned manually you will see full system voltage here as well as on the coil +ve.

  Again the load of the starter will reduce the voltage from a good battery to about 10v when cranking. However the rubber bumper ballasted system has a 'boost' connection from the solenoid which puts this full cranking voltage on the coil +ve to increase the power of the spark which can make the difference between starting and not starting under adverse conditions. The points are opening and closing, the original distributor for a rubber bumper 4-cylinder car is a 45D4 which has a nominal dwell of 51 degrees and 51/90ths means the points are closed for 62% of the time and open for 38%. Therefore during cranking the coil -ve is switching between (say) 10v and 0v and an analogue meter will average the two at about 4v.

> On a running engine the boost connection is removed and the ballast resistance is in series with the coil again. The coil +ve voltage is switching between charging voltage of about 14v (points open) and 6v (points closed) and an analogue meter will again average the two based on the dwell and is about 9v (this is probably where the misconception that ballasted systems uses a 9v coil comes from). For the coil -ve it's at system voltage for 38% and 0v for 62% so at 14v the average is about 5.3v.

Note that cranking and running voltages (except for chrome bumper coil +ve) depend on the dwell setting of the points. As above the nominal dwell of a chrome bumper 25D4 is 60 degrees but allowable tolerance is +-3 degrees so percentages can vary between 64% and 70%, you may well find it beyond even those and the engine still run perfectly well. The rubber bumper 45D4 has a nominal dwell of 51 degrees +-5 degrees so percentages can vary between 51% and 62%, and again can be beyond those and still run perfectly well.

The V8 35D8 has a nominal dwell of 27 degrees i.e. half that of the four cylinder (eight lobes have to be fitted onto the shaft) but that points closed duration is still more than enough to fully recharge the coil at peak revs, 27 degrees equates to 60% closed and 40% open. However the tolerance is only +-1% which gives a small range of 58% to 62% hence the voltage figures for the V8 - which has a ballasted ignition system - will be similar to the 45D4.

On both 12v and ballasted systems if the engine is running but misfiring with periodic drops in the coil +ve (SW) voltage that indicates a loss of 12v supply to the coil. Periodic drops in the coil -ve (CB) could either be the same, or a coil intermittently going open-circuit so test the +ve first, or the points circuit intermittently shorting to earth. If the coil -ve periodically rises then that indicates the path through the points or trigger to earth is failing.

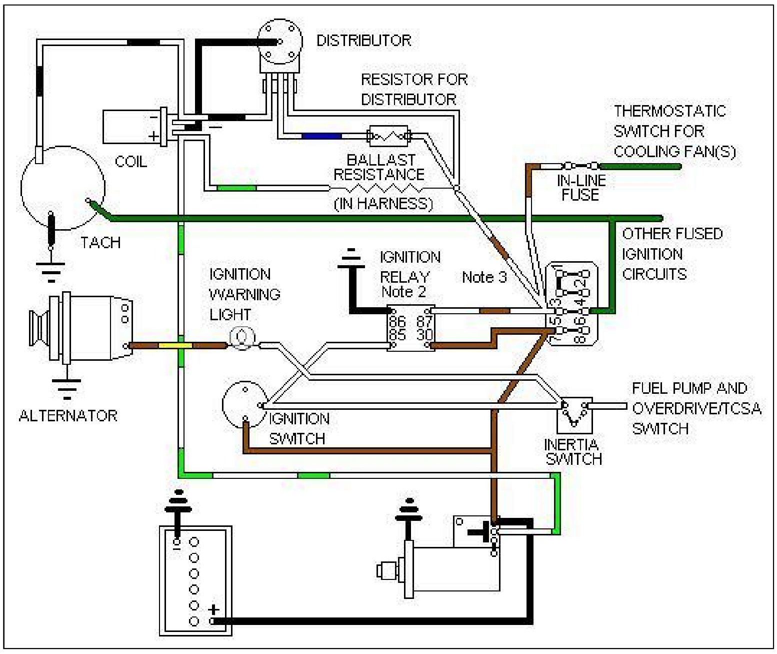
There are several variables in these calculations such as dwell has a tolerance of +- 3 degrees for the 25D4 and +- 5 degrees for the 45D4, coils have resistance tolerance of +-2%, ballast will be similar, and the nominal system voltage depends on engine speed and how much electrical load there is. But the resulting coil voltages should all be in the area of the figures given here. You can also expect to see some variation with changing revs and throttle opening as with a wider throttle there is a higher cylinder pressure which makes it harder for the spark to jump the plug gap, which means the HT voltage increases, and that is reflected back into the coil primary as a higher voltage.

But those variations can be ignored for the purposes of fault diagnosis, as what you are interested in is how the indication varies when a misfire or other problem becomes apparent, compared to when it's running correctly. If you do see a significant change then the implication is that the problem is in the ignition LT circuit although an open-circuit condenser won't give much of a change but will affect running. There is a very easy way of determining if the condenser is the problem and that is by temporarily connecting an additional, known good one between the coil CB or -ve and earth. If the condenser inside the distributor is the problem the problem will go away. If it isn't then the problem will continue, and having effectively two condensers in parallel with each other will have no noticeable effect on ignition performance.

Basically if the -ve(CB) voltage goes up to 12v when the engine cuts out you have lost the circuit to earth through the points or electronic trigger. But if it drops to zero then you have either lost the ignition supply through the coil (test the coil +ve or SW for 12v), or the points or trigger have shorted to earth. In this latter case disconnect the points or trigger wire from the coil -ve and see if you then have 12v on the coil -ve, and if you do the points or trigger are shorting to earth.

I have both conventional multi-meters and an automotive one with dwell and tach as well as voltage, resistance and current ranges - both analogue - and the latter meter has peculiarity that when I'm trying to measure voltage on the coil -ve it displays a much higher value than it should, higher even than the system voltage, because it is actually displaying the dwell value! So that is something to bear in mind.

Ignition - 45DE4 Distributor (integral amplifier, 75-on)

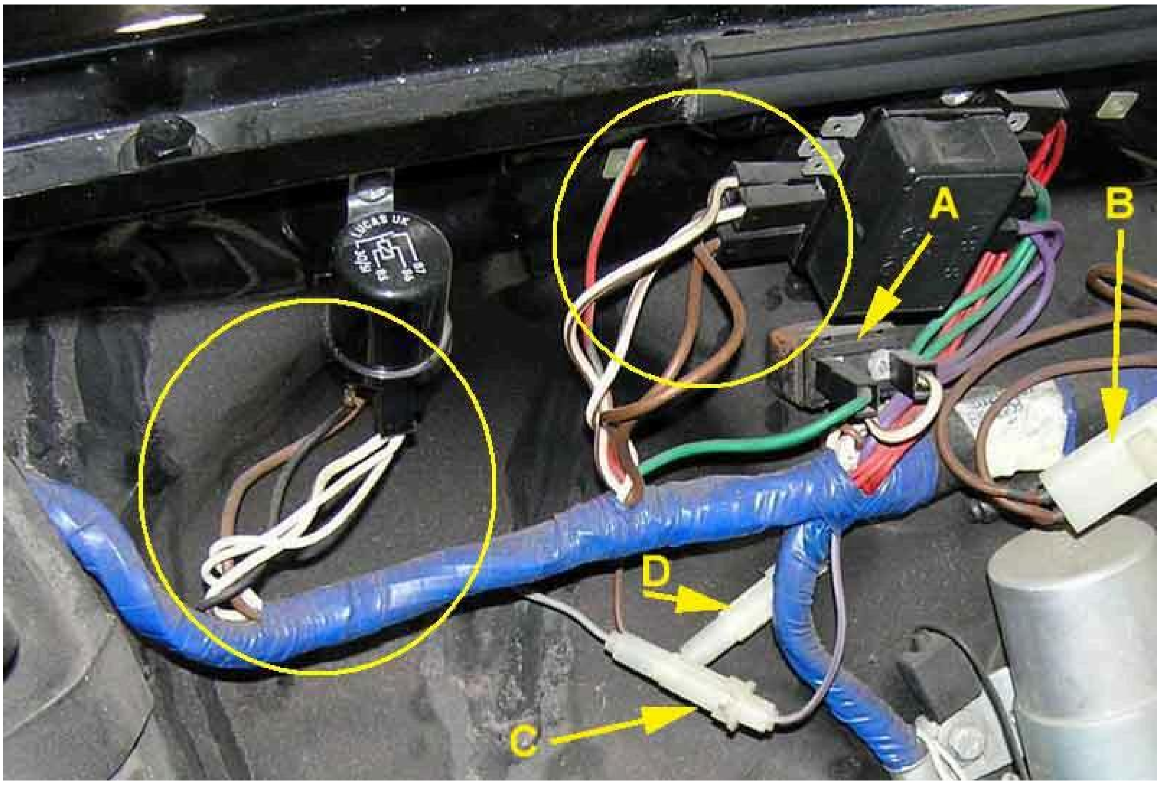


Note 1: Fitted to North American cars only, this troublesome 45DE system was often dealer-replaced with the much more reliable 45DM system.

Note 2: Ignition relay fitted from 1977 only, in 1976 the white from the ignition switch went direct to the fusebox and ignition components and there was no electric cooling fan.

Note 3: Information on the ballast resistance can be found here.

Note 4: 1977 models with the ignition relay can suffer from a problem whereby the engine may continue to run normally (not Dieseling) when the ignition is switched off see here. For 1978 on the problem was corrected by moving the white/brown feed for the ignition coil circuits from the fusebox to the white at the ignition relay, leaving two at the fusebox and three wires at the relay. This also shows 'A' the thermal cut-out for the cooling fans; 'B' the 'double-brown up from the alternator; 'C' the anti-runon valve in-line fuse; and 'D' the hazard flasher in-line fuse:

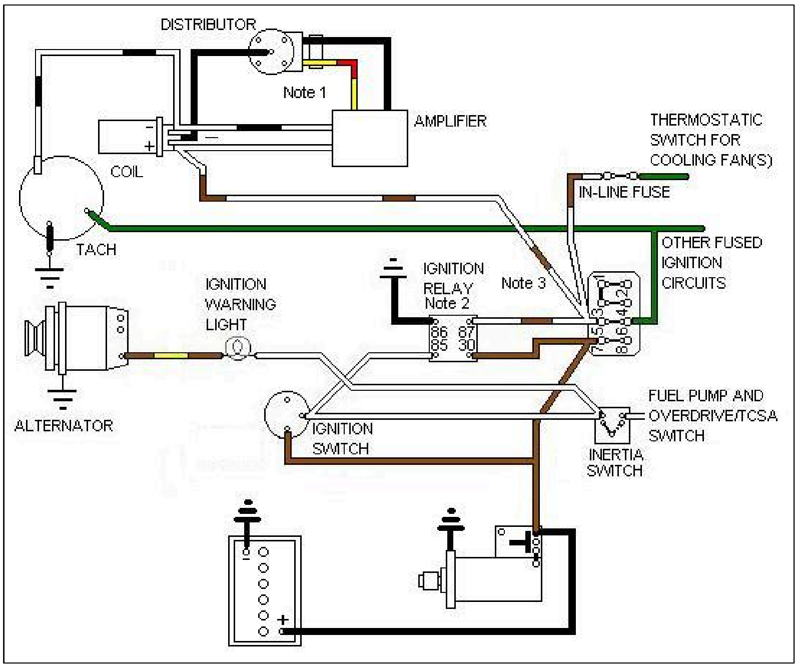


Note 5: The schematics show the original rectangular Lucas relays with W1, W2, C1 and C2 terminal numbering, but in practice cylindrical relays with ISO numbering were fitted. The relationship is as follows:

Wire colour	Original numbering	ISO numbering
White from ignition switch	W1	85
Black earth	W2	86
Brown 12v supply	C2	30
White/brown to ignition powered circuits	C1	87

The 'Resistor for distributor' in the above schematic is one of two power supplies for the electronics and is a 6.6 ohm metal-cased power resistor as shown below *picture: Monte Morris*

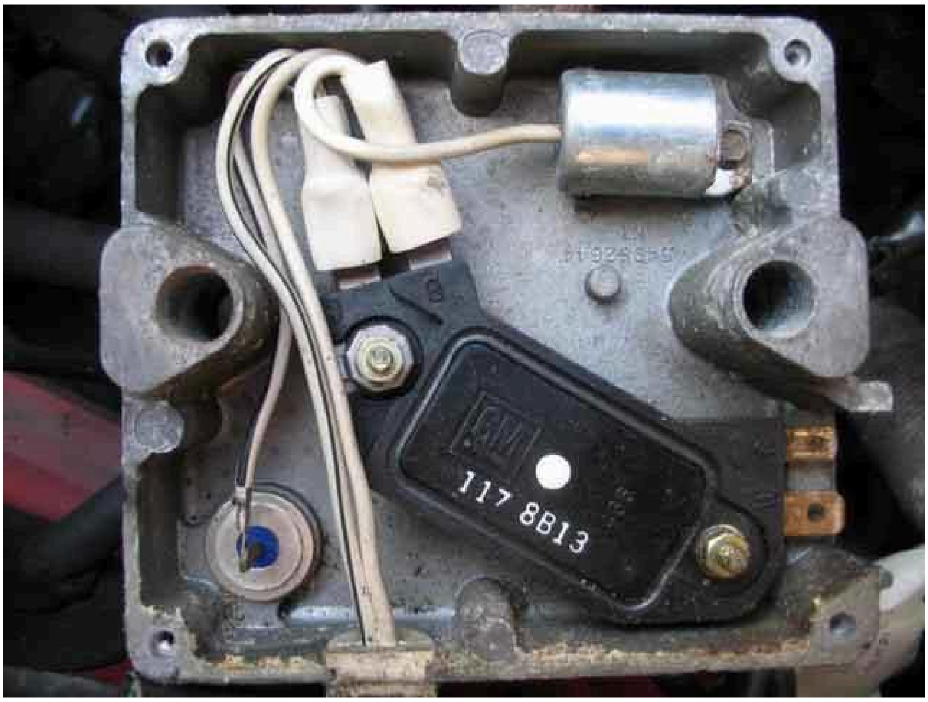
Ignition - 45DM4 Distributor (remote amplifier, 75-on)



Note 1: Fitted to North American cars only.

It did not use the ballasted ignition feed or solenoid bypass system, see this bulletin supplied by Allan Reeling showing how the troublesome 45DE system was replaced with the very reliable 45DM system.

Inside the external AB14 unit is the electronics module (GM in this case), plus a capacitor on the 12v supply to reduce electrical noise (a different function to the condenser inside a points distributor) and a zener diode on the coil wire. When the coil generates an HT spark it can also generate a pulse of several hundred volts in the primary. The electronics module must not exceed 400v so this zener diode 'clamped' the pulse to a maximum of 350v. Later versions of the electronic module did not need the capacitor or the zener diode: *(Anthony Piper)*



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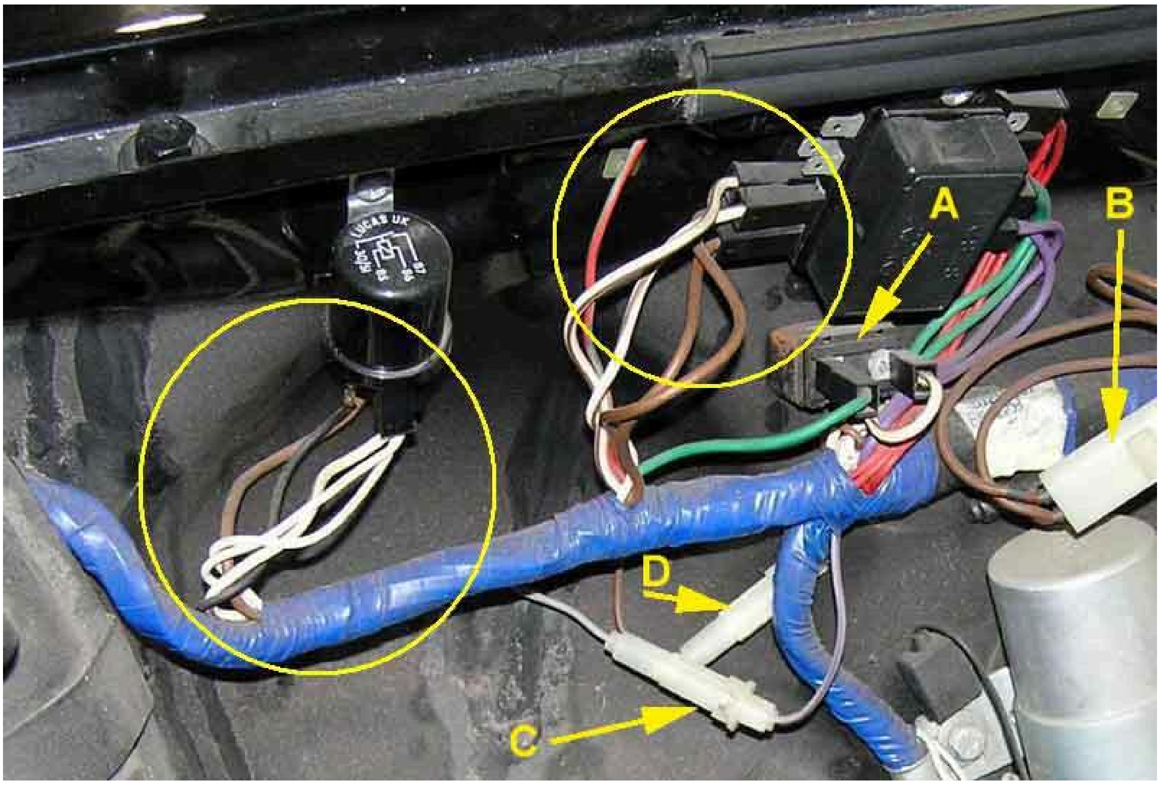

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White from ignition switch	W1	85
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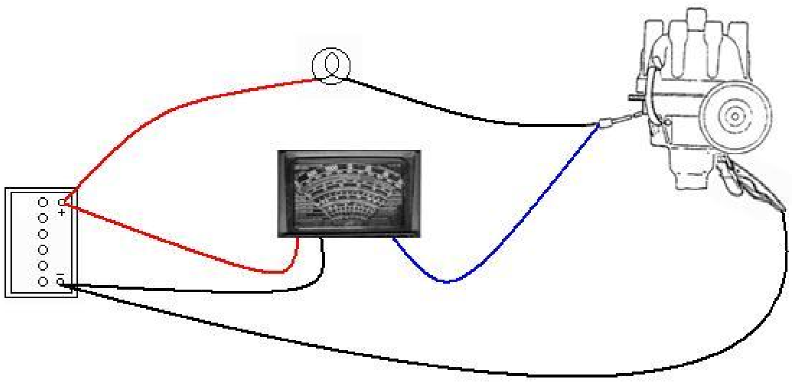
Bench Rig for Setting Dwell

Small Allen key lightly clamped to the distributor shaft for finger-tip rotation

Using an analogue ohmmeter (leads just connected to the points lead and the distributor body) and finger-twiddling to get a useable reading, which happens at a surprisingly low speed.

Circuit to use a dwell-meter. If you have changed the gap i.e. changed points you will need to check the timing once it is back in the car, even if you made marks on distributor and block, but using those marks will be close enough to start the engine and use dynamic timing. If you are fitting a spare dizzy because the original has failed on the road you will need to static time it first.



Gunson's TestTune dwell scales - percentage at the top, go/no-go sections for electronic ignition, points ignition, and petrol injectors, and a 4-cylinder degree angle scale at the bottom. Note the electronic ignition section is used for variable dwell systems where the dwell angle/percentage closed time varies hugely with engine revs from 8% to 60%, whereas points (all types) vary from 40% to 60%. Lots of other useful ranges:

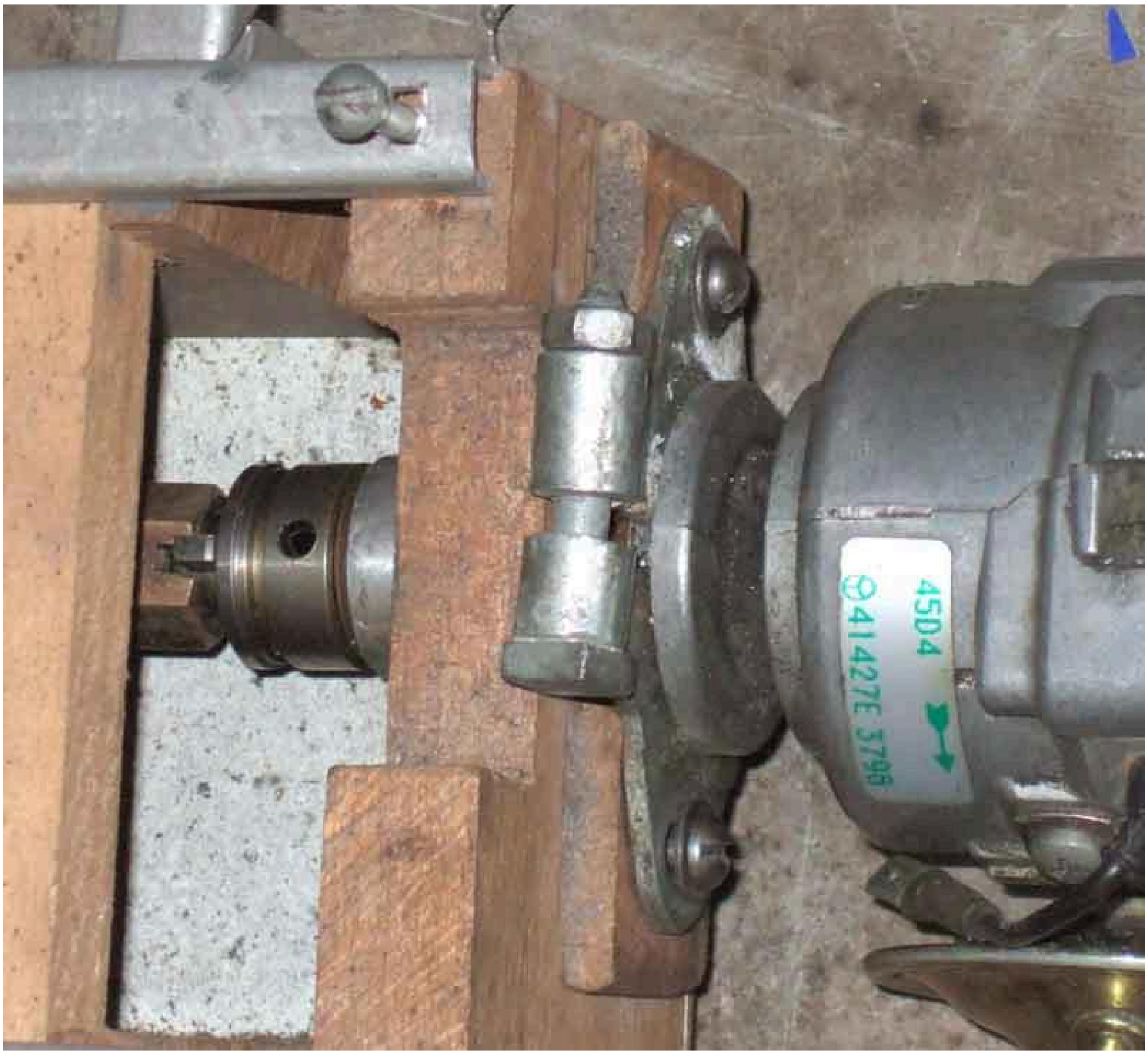
A test-rig to check centrifugal advance: Basic box to hold the drill

Clamps to hold the drill steady (coil and plugs were so I could drive a strobe light to measure curves)

Distributor drive dog (the blue thing is a right-angle gearbox to drive a degree wheel for measuring curves)

Detail of drive dog, simply a brass plumbing fitting with a slot cut, a bolt through with a nut on the back, ordinarily you would clamp the thread of the bolt in the drill chuck and drive the distributor directly.

Distributor clamp-plate screwed to the end of the box, shaft engaged with the drive dog. The tongue on the distributor is slightly offset to one side, so cut the slot wide enough so the two can be engaged either way round without wobbling as it is rotated.



Rig in use to measure dwell on a dwell-meter. The coil and plugs with a degree-wheel fitted to the top of the right-angle drive enable me to plot centrifugal advance curves as well.

Electronic Triggers

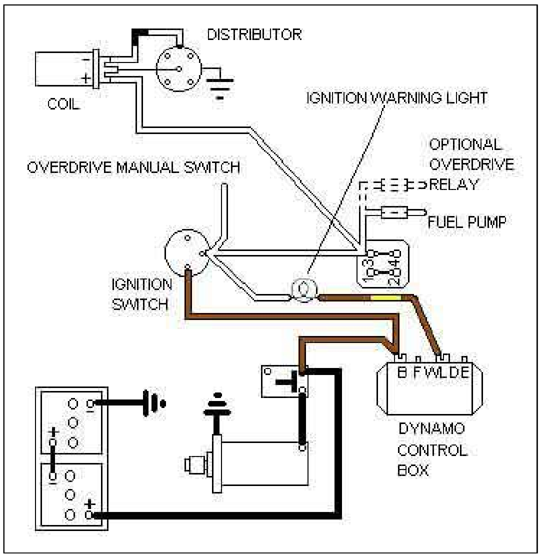
The no-name trigger contained within a distributor purchased from eBay.

Note the one-piece rotor and magnet ring, the magnets being in the wider ring at the base of the rotor (on the left, standard rotor on the right). This differs from other manufacturers who seem to supply just the magnetic ring with their triggers, a standard rotor going on the top. The complete thing was cheap at £50. Normally the triggers themselves are around £90 (Magnetronic and Aldon) although considerably cheaper from Pertronix at about £60, and with points distributors typically being about £80 new David didn't get a bad deal anyway even taking into account having to retro-fit points and a condenser.

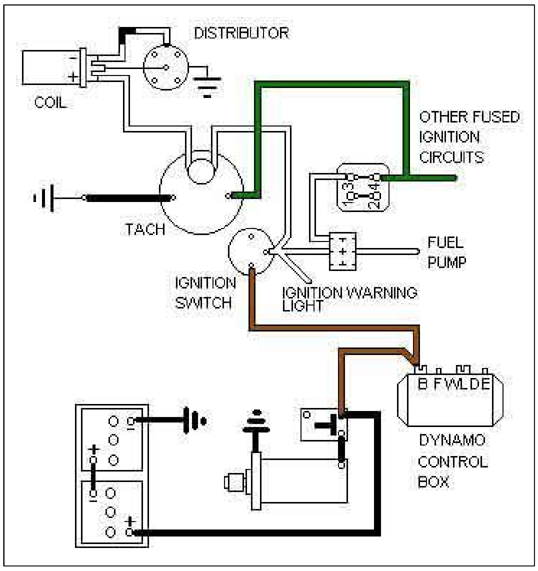
Subsequently Gary Falkiner pointed me to this ETC5835k from various Land Rover specialists sold as a conversion kit using the original distributor. This image (from Britpart) looks pretty-much identical. Although this initially seemed to work OK it became inconsistent, and was picking up iron filings on the magnetic collar, so Gary has gone back to points as well.

Optronic trigger wire with strands broken inside the insulation and causing an intermittent misfire: (*Ben Columb*)

Ignition - 12v coil, mechanical rev-counter (62-64)

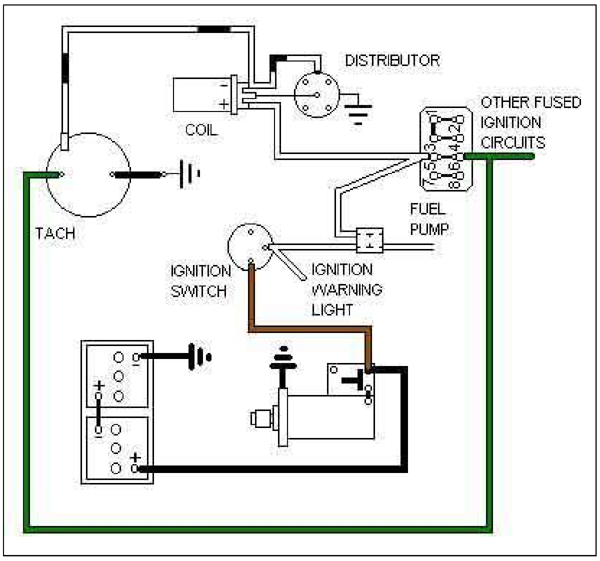


Ignition - 12v coil and inductive tach (64-72)

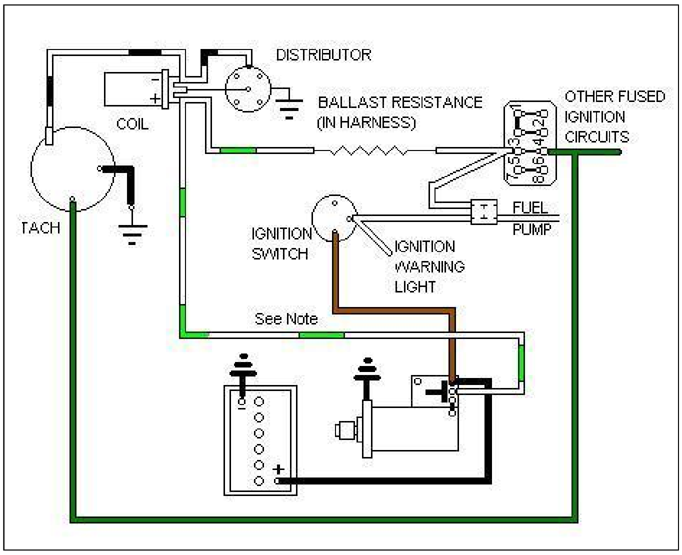


Note 1: Dynamo up to 1967, alternator after that.
Note 2: Tach powered from white up to 1967, from green after that.
Note 3: See here for the overdrive wiring which changed for the Mk2
Note 4: Two-fuse block up to 1969, four-fuse after that.

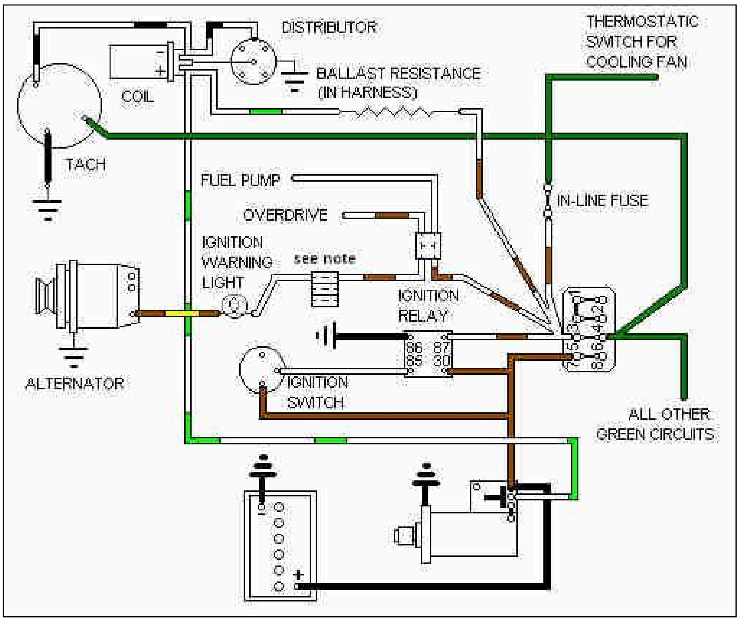
Ignition - 12v coil, voltage tach (73-74 1/2)



Ignition - 6v coil (UK 1974 1/2-1976 and all V8)



Ignition - Ignition Relay, UK (1977)



Note: This is one of three multi-way plugs behind the dash.

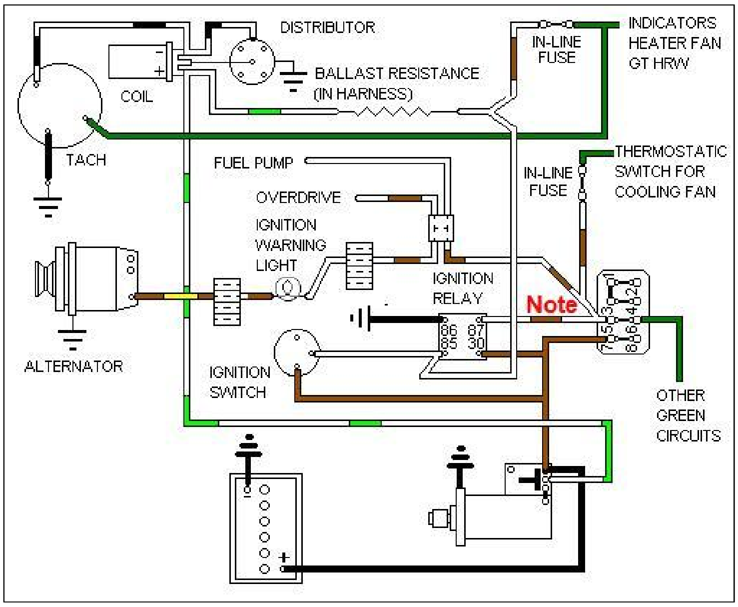
Added January 2010: 1977 models, with all switched ignition circuits powered by the ignition relay. Not shown in Advance Autowire on-line version or Haynes, their 'late UK market' diagram is for 1978 and later. It's not known exactly when that version came out but Geoff Turner's Oct/Nov 77 built 78 model has it so possibly part of the wiring changes for dual-circuit brakes on RHD cars in May 77 at chassis number 436465 (GT) and 437181 (roadster).

- There are two separate green circuits - the original circuit fed from the 2nd fuse up in the 4-way block for all the original green circuits, and another fed by an in-line fuse from the white/brown circuit on the relay output for the cooling fan. This fuse is located below the fusebox, probably with the hazard flasher fuse which has brown wires both sides.
- There are three separate white circuits - one from the ignition switch feeding the ignition relay, another in the rear harness feeding the fuel pump, and the third in the dashboard sub-harness feeding the ignition warning light. These last two are taken off the white/brown circuit from the relay output.
- The schematics show the original rectangular Lucas relays with W1, W2, C1 and C2 terminal numbering, but in practice cylindrical relays with ISO numbering were fitted. The relationship is as follows:

Wire colour	Original numbering	ISO numbering
White from ignition switch	W1	85
Black earth	W2	86
Brown 12v supply	C2	30
White/brown to ignition powered circuits	C1	87

Information on the ballast resistance can be found here.

Ignition - Ignition Relay, UK (78-on)



Updated October 2023: This version is on 78 and later cars, several circuits having been removed from the ignition relay and put back on the ignition switch, possibly because of problems with relays sticking on. However the fuel pump is still on the relay - not ideal if it sticks on! It's not known exactly when the change to this version occurred but Geoff Turner's Oct/Nov 77 built 78 model has this version, so possibly part of the wiring changes for dual-circuit brakes on RHD cars in May 77 at chassis number 436465 (GT) and 437181 (roadster).

There are three separate white circuits: One from the ignition switch feeding the ignition relay and ballast resistance for the coil (which then changes to white/brown for one of the inline ignition circuit fuses), another in the rear harness feeding the fuel pump (which changes from white/brown at a bullet connector in the main harness), and the third feeding the ignition warning light (changing from white/brown at a multi-way plug behind the dash).

There are two separate white/brown circuits: One teeing off the white from the ignition switch to the coil ballast for the indicators, heater fan switch, tach, and GT HRW. The other is from the relay contact feeding the fusebox, cooling fan in-line fuse, overdrive, fuel pump and ignition warning light.

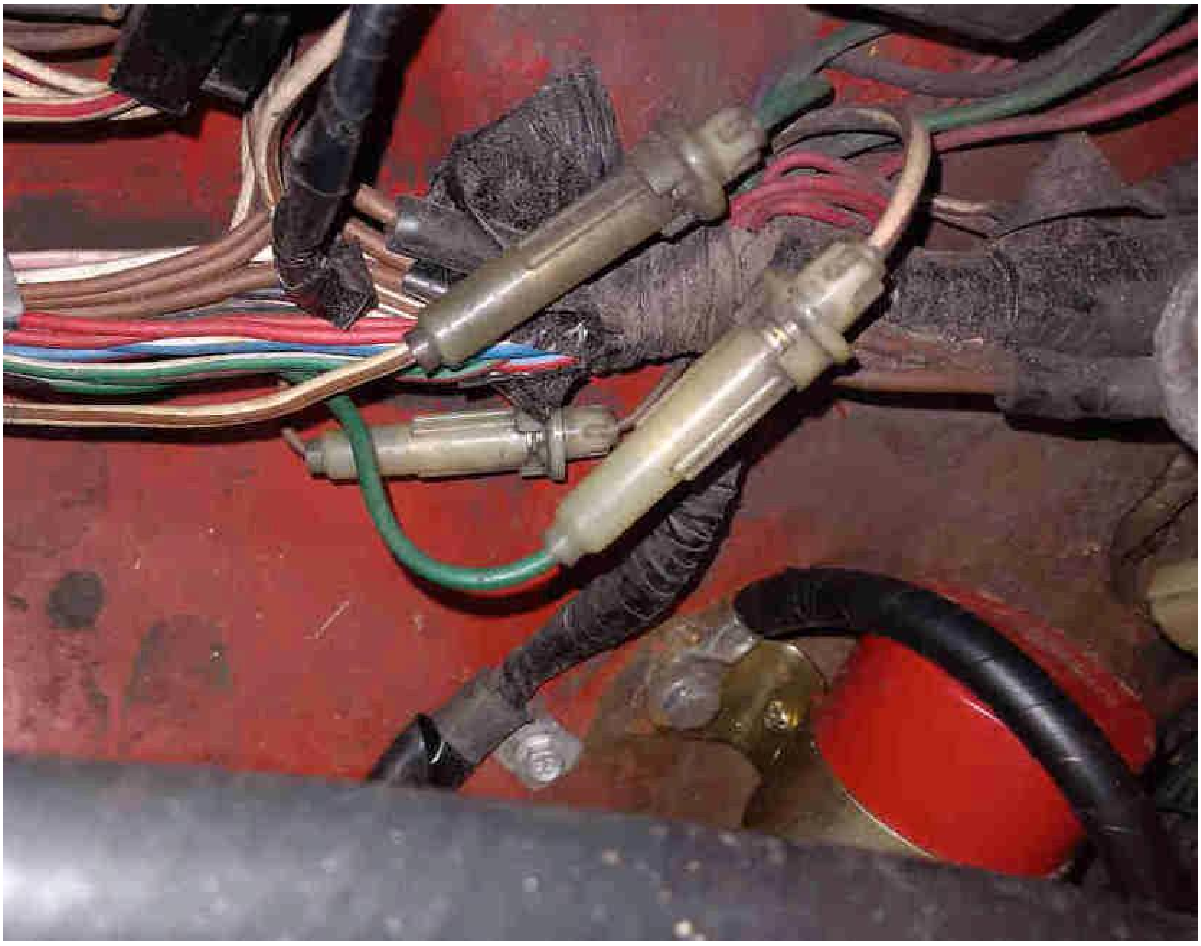
Note that the supply from the ignition relay is the single wire at the fusebox, and the wires to the fuel pump, overdrive etc. and to the cooling fan fuse share a single spade connector. This means that power has to go into the fusebox on one spade and come out on the other spade to feed the paired white/browns, so corrosion inside the fusebox can affect all those circuits as well as the green circuits fed by the fusebox.

There are three separately fused green circuits: The original circuit fed from the 2nd fuse up in the 4-way block, and two others each fed by their own in-line fuse under the fusebox - one feeding the cooling fan switch, and the other feeding indicators, heater switch, tach, and GT heated rear window switch. Both these in-line fuses have white/brown (unfused) one side and green (fused) the other.

Multiple uses of the same colour and several changes from white/brown to white and back again does not help in diagnosing ignition problems.

There is also the in-line fuse for the hazard flashers under the fusebox with brown wires both sides.

This clearly shows the two white/brown to green ignition circuit in-line fuses nearest the camera and the brown to brown hazard fuse further away. It also clearly shows that the way the wires have been routed and the orientation of the ignition circuit in-line fuses that it's possible to erroneously connect white/brown to white/brown and green to green, which was how a new harness came to me from the supplier and caused some head-scratching when I first powered it up!



The schematics show the original rectangular Lucas relays with W1, W2, C1 and C2 terminal numbering, but in practice cylindrical relays (and then cube-type SRB 520) with ISO numbering were fitted. The relationship is as follows:

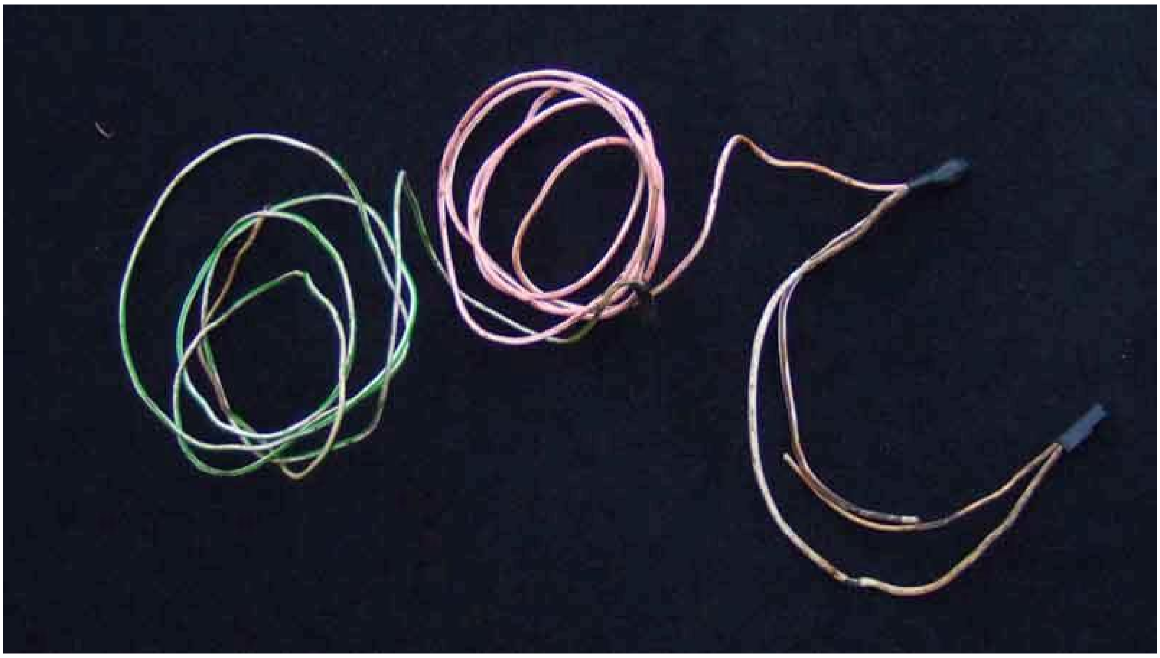
Wire colour	Original numbering	ISO numbering
White from ignition switch	W1	85
Black earth	W2	86
Brown 12v supply	C2	30
White/brown to ignition powered circuits	C1	87

Information on the ballast resistance can be found here.

Ballasted Ignition

Radio interference suppression capacitor

The physical arrangement of the ballast wiring, from a 1980 UK model:

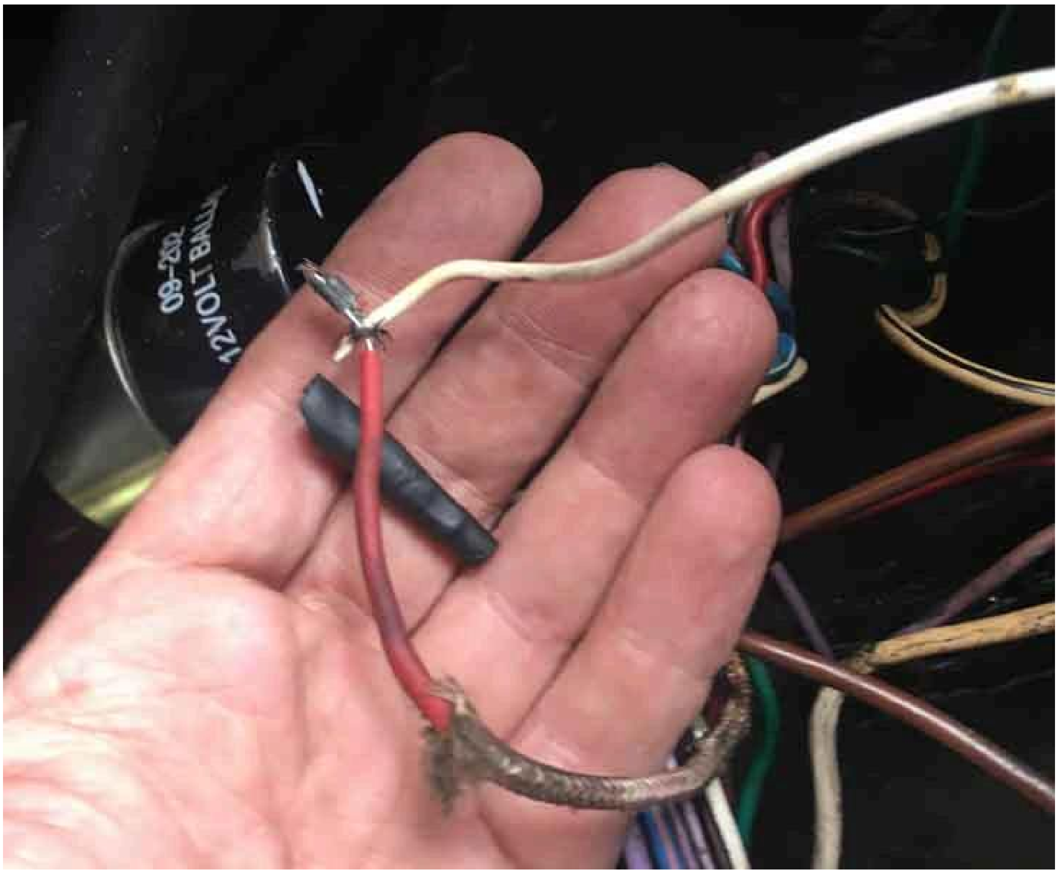


The pink/white resistance wire, measuring about 1.4 ohms, is in the centre.

There is a white/light-green tail on the left that goes to the coil positive and the starter solenoid bypass terminal.

On the right there are two tails - one is a white which comes from the ignition switch and the ignition relay operate terminal, the other is a white/brown that goes to the in-line fuse for the tach, indicators, heater fan and heated rear window on GTs.

This from a UK 1975 has much thicker resistance wire in its own braided sheath, the crimped (the resistance wire cannot be soldered) connection pictured had parted inside the wrapping which meant the engine would start but cut-out again as soon as the key was released: (*Colin Grimsley*)



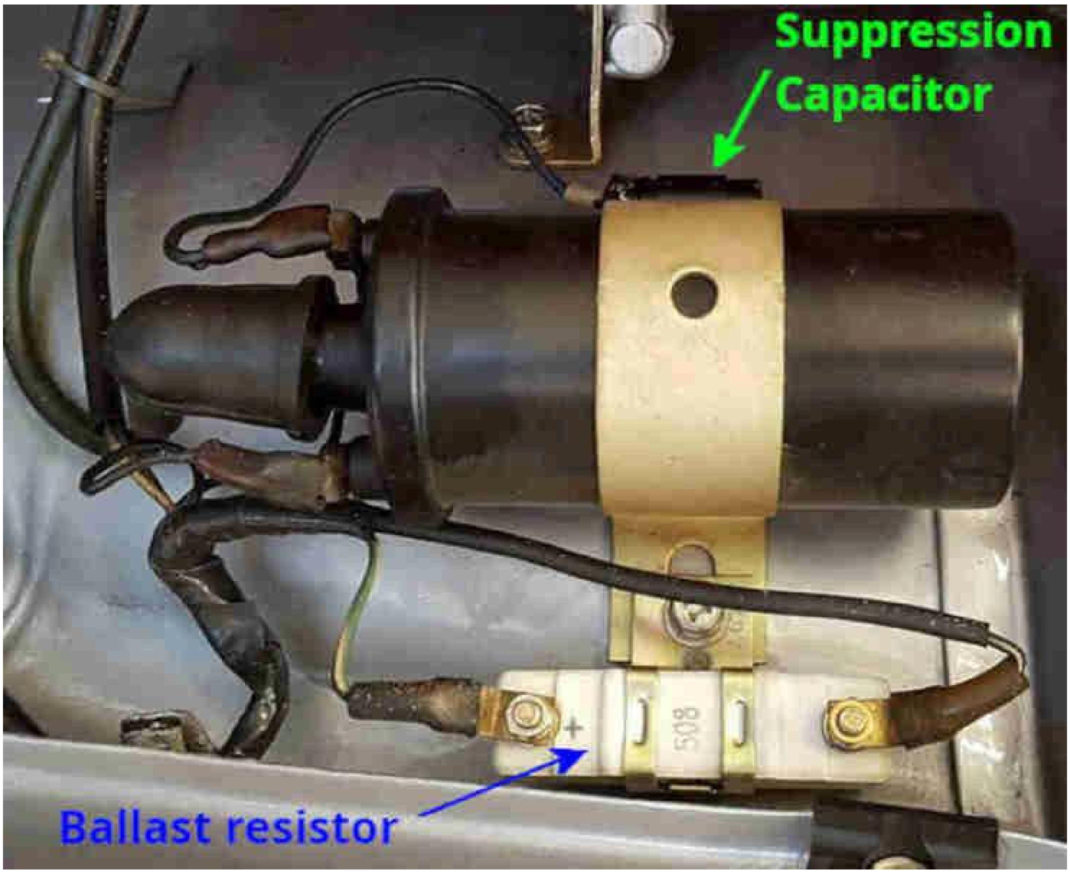
Note the coil is marked '12v ballast' which is how many are marked these days even though it is a 6v coil 'for use on a ballasted system', which is how they should be labelled.

This AC Delco coil has 12v embossed in the can:

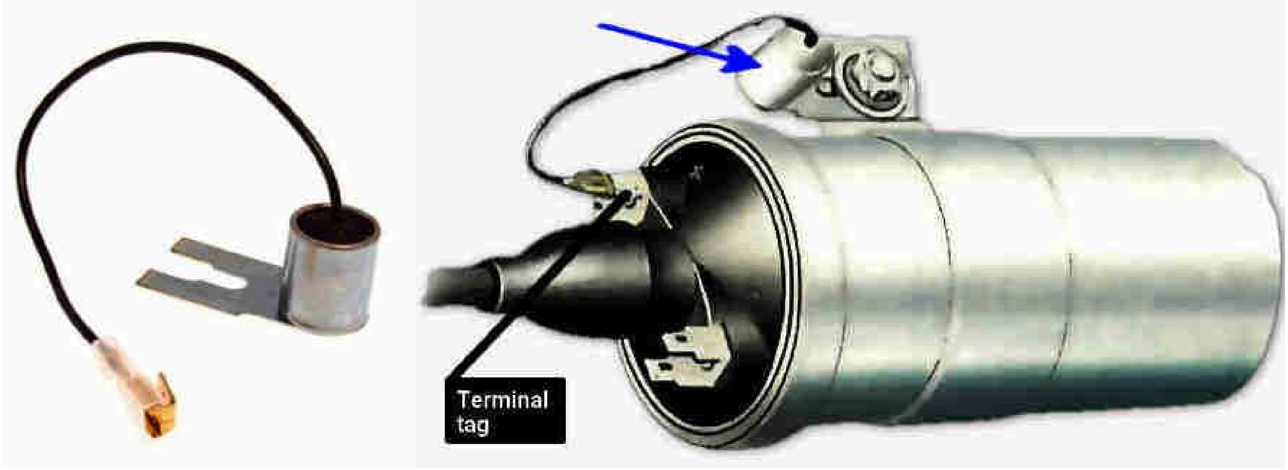
But also has a label saying it must be used with an 'approved' resistor:

The second example I have come across, this is from Peter Mitchell's 1978 UK car. The primary measures 2.2 ohms so it isn't a 12v, a 12v sport or a 6v! In this case the requirement for a resistor would be to prevent it overheating, but if it is any more than 0.3 ohms it would be degrading the HT spark energy, and with the factory ballast of 1.6 ohms it would be significantly degraded and may be why Peters car has been running poorly for a while. There is no mention of AC Delco coils being used in Clausager so it must be a replacement and is a good example of why replacement coils **must** be measured regardless of what the supplier, the packaging or the coil itself says.

Not used on MGBs from the factory but other marques and models, and some after-market coils for the MGB, may have a discrete ballast resistor mounted near the coil wired between the 12v supply and the coil +ve. This image from The Classic Z-Car Club shows a ballast resistor below the coil and a suppression capacitor above:



A radio interference suppression capacitor (not a ballast resistor), often found connected to the coil +ve (or SW) with the metal tag under a coil fixing bolt providing the earth connection. Can also be found on the instrument voltage regulator, fuel pump, indicator flasher unit, alternator, electric screen washer pump i.e. anything that can generate electrical noise, may also be rectangular:



This suppression capacitor is from Peter Mitchell's 1978 MGB and is 1uF at 150v. Typically these days they are described as being around 2.2uF at 100v, the values are not critical:

Note that suppression capacitors are always connected to the coil terminal that carries the 12v supply from the ignition switch or relay regardless of whether they are positive earth cars, positive earth cars converted to negative earth, or originally negative earth cars (Mk2 on) including both CB and RB. The same goes for all other places they are used i.e. always the on 12v supply terminal to the component.

HT Spark Testing

The original Gunson's Flashtest, adjustable to check the strength of the spark, you might pick one up on eBay cheaper than the Laser 5655:

A basic go/no-go but good value at around £8: *(Sealey VS526)*

Also no go, but checks all four plugs at once - at a price £22: *(Laser 2780)*

Adjustable to check spark strength - expensive at £30: *(Laser 5655)*

Another 'go/no-go' one but only needs to be touched onto the outside of the lead so easy to move from one lead to the next: *(Gunsons Spark Tester 77077)*


Gunson
SPARK INDICATOR
www.gunson.co.uk

HT Leads

[Types](#) [Positioning](#)

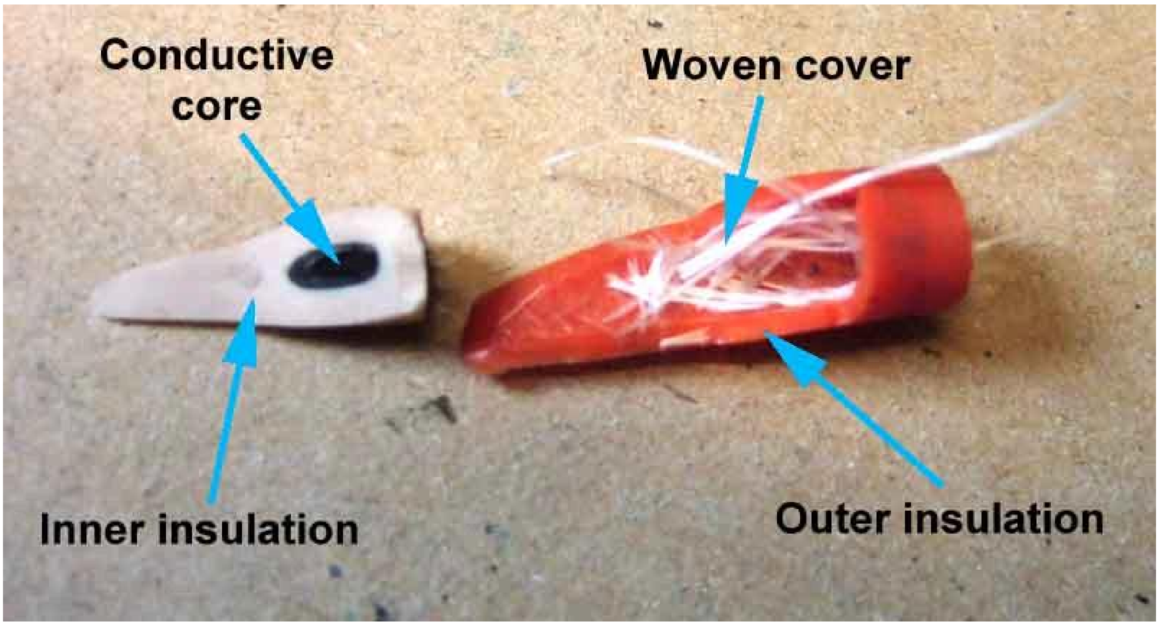
Types:

Yer basic silicone HT lead. I'd always though of 'HOTWIRES' as a gimmicky name when I saw it advertised, and was surprised to find the basic black leads I had bought from the MGOC were the same as these from Halfords.

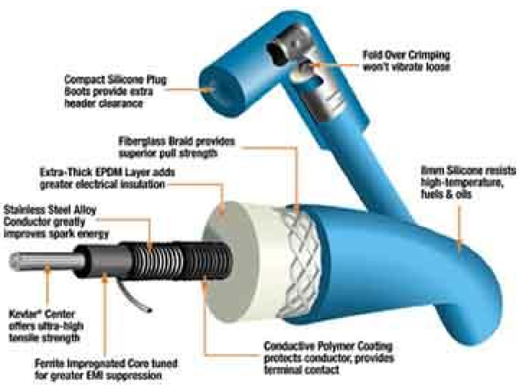
At first sight appears to have a single-strand resistive inner trapped under the crimped connector ...

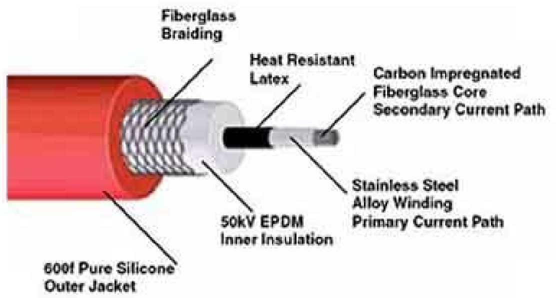
... but cutting diagonally through the cable shows it as many very fine strands which seem to have an outer coat bonding them into a single conductor. Each strand is conductive.

Construction



After that the sky is the limit as far as construction, claims and price are concerned. There are many that have a spiral wound steel conductor, which may have the central core as merely a strengthening device, or may be an additional resistive conductor such as in the basic silicone leads above. There is even one (at least) with 'capacitors' and braided earthing straps.





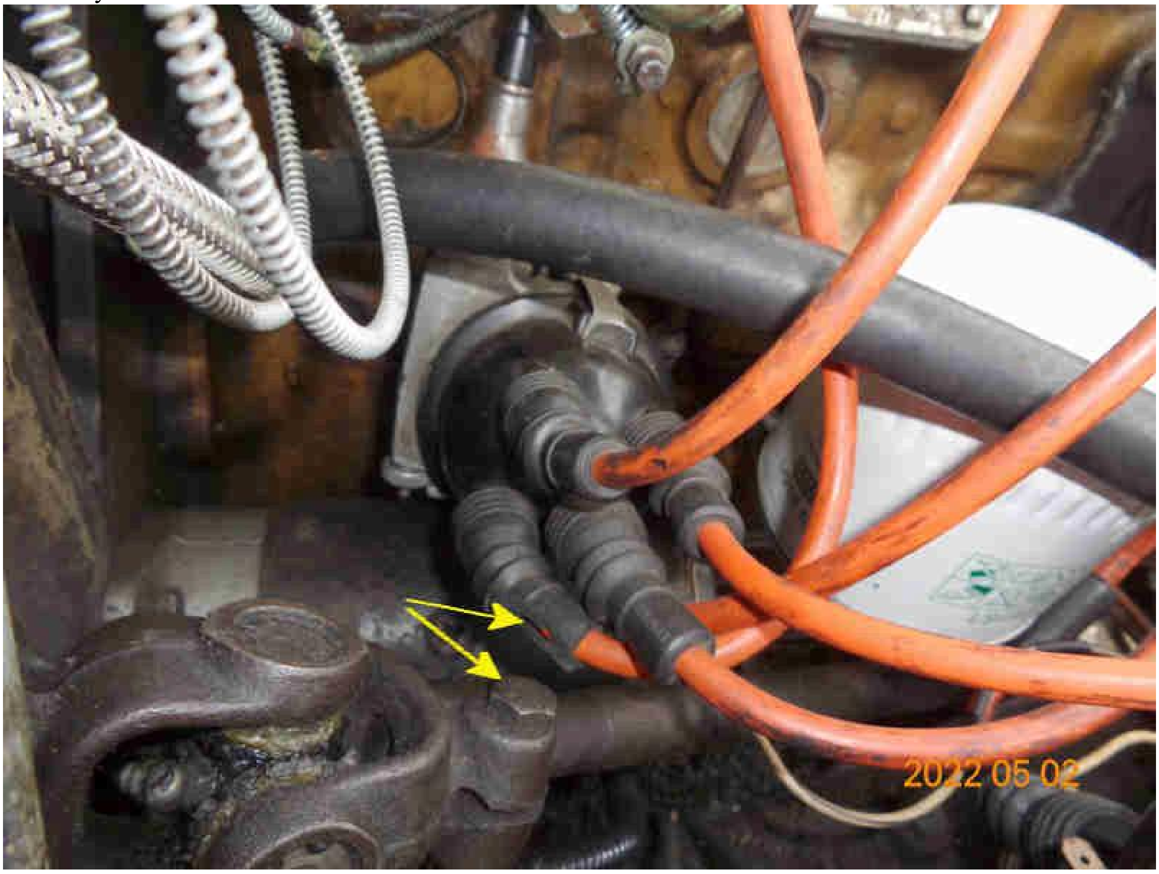
Magnecor have published an interesting document 'The Truth About Ignition Wire Conductors' that is very scathing about the claims made by many of these 'high-performance' aka highly priced leads. It includes the following statements:

- In effect, (when new) a coated "low-resistance" spiral conductor's true performance is identical to that of a high-resistance carbon conductor.
- ... a test performed by Circle Track Magazine (see May, 1996 issue) in the USA, show that NO "low-resistance" ignition wires for which a horsepower increase is claimed do in fact increase horsepower - the test also included comparisons with solid metal and carbon conductor ignition wires.
- Claims by Nology of their "HotWires" creating sparks that are "300 times more powerful," reaching temperatures of "100,000 to 150,000 degrees F" (more than enough to melt spark plug electrodes), spark durations of "4 billionths of a second" (spark duration is controlled by the ignition system itself) and currents of "1,000 amperes" magically evolving in "capacitors" allegedly "built-in" to the ignition wires are as ridiculous as the data and the depiction of sparks in photographs used in advertising material and the price asked for these wires!
- Unless you are prepared to accept poorly suppressed ignition wires that fail sooner than any other type of ignition wires and stretch your ignition system to the limit, and have an engine with no electronic management system and/or exhaust emission controls, it's best not to be influenced by the exaggerated claims, and some vested-interest journalists', resellers' and installers' perception an engine has more power after Nology wires are fitted. **Often, after replacing deteriorated wires, any new ignition wires make an engine run better.** (*My emphasis as that goes for anything on an MGB)*

Having said all that Magnecor produce their own range of wires from copper upwards, with prices for the MGB GT V8 ranging from £97 through £113 to £153!! As of September 2025 you can get OE GHT107 from Anglo for £15 (other sets for side-entry and RB), or a set from Clive Wheatley for £35 and that's the highest I would go ... if I really forced myself. Of course the same price differentials and sources apply to leads for the 4-cylinder, substituting any of the usual suspects for Clive as he doesn't supply parts for that engine.

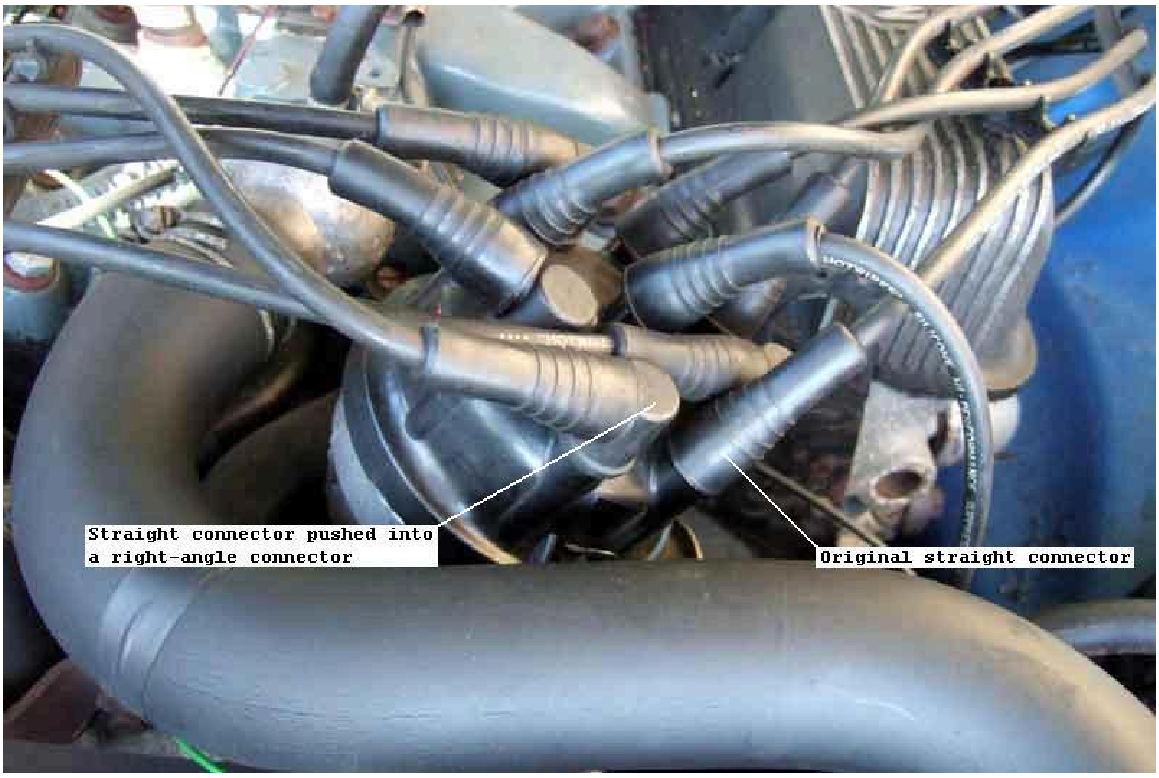
HT Lead Positioning

Showing how the 4-cylinder column UJ clamp bolt had gouged the rubber boot on the HT lead when it came straight of the cap to No.4 plug, probably not far short of causing a misfire. Wrapping it under the cap and the other leads holds it out of the way:

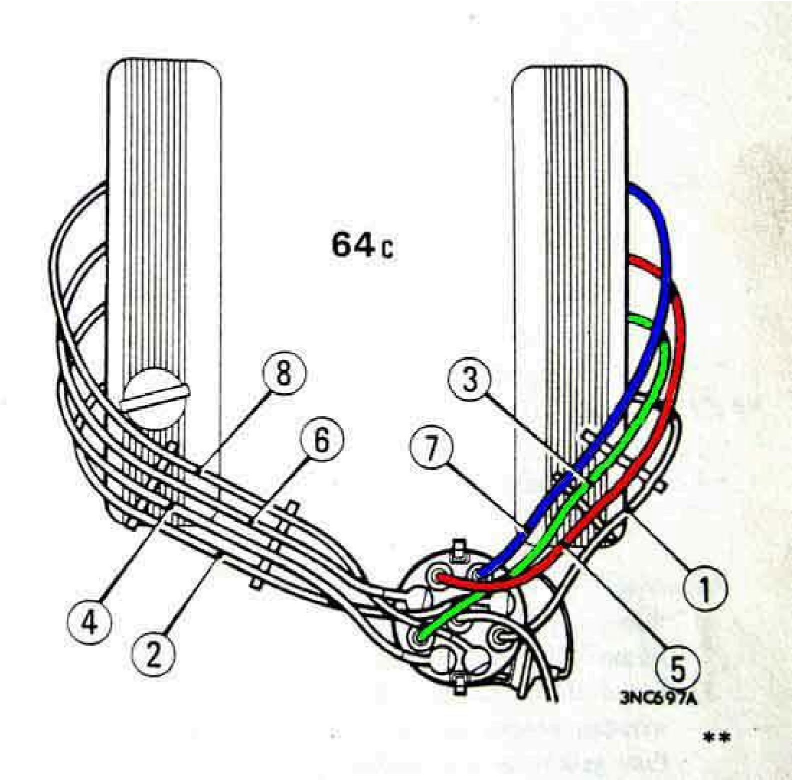


However there are lead sets with right-angled cap connectors (GHT106 for 25D4 and GHT184 for 45D4) that should solve the problem and are only £14 and £19 respective, I don't know how they differ.

Angled connectors fitted to the MGOC right-bank silicone leads for the V8:



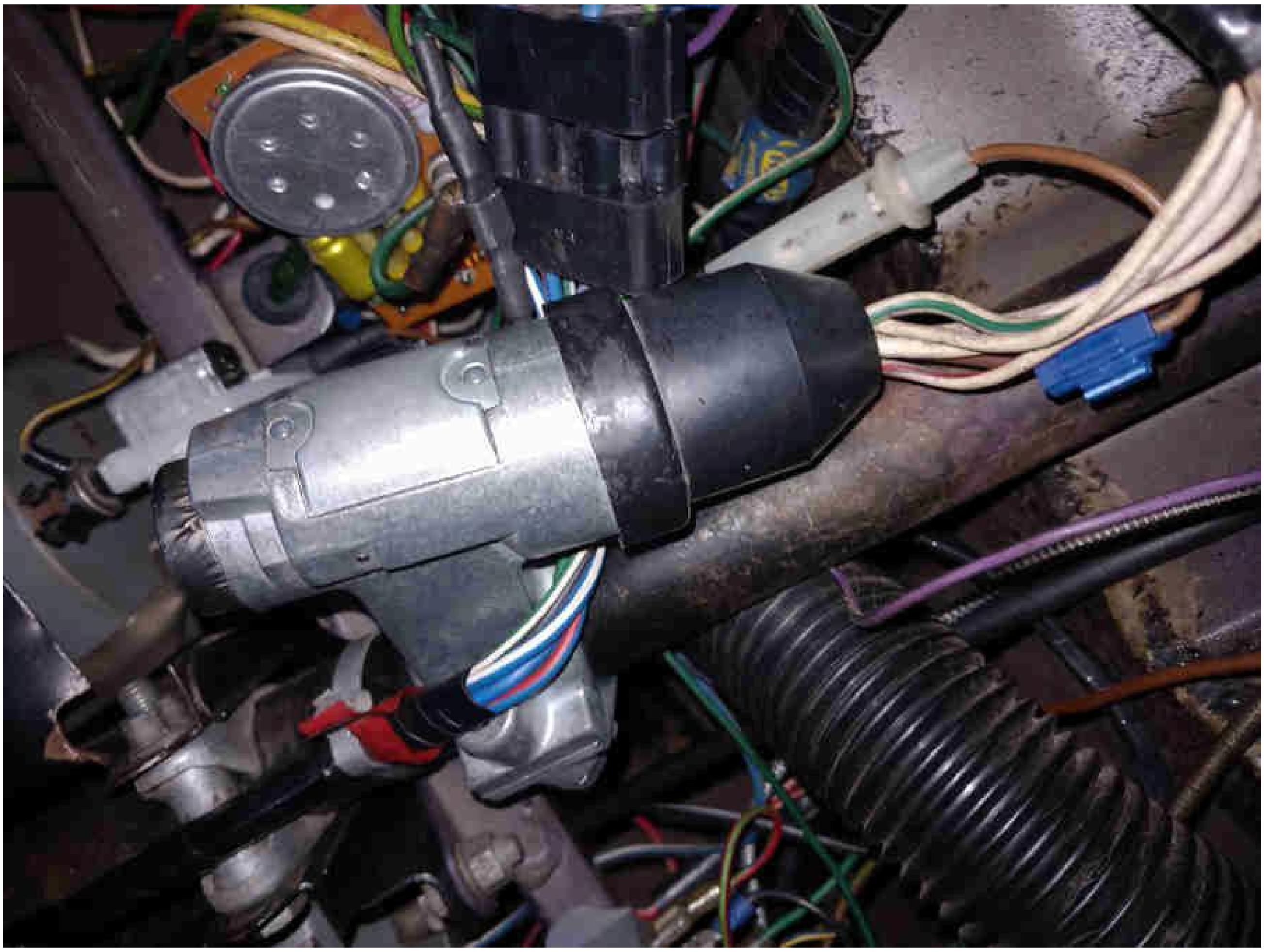
Separate leads 5 and 7 in the combs with lead 3 to prevent possibly parasitic ignition in cylinder 7 when 5 fires. Note the Leyland Workshop Manual Supplement states the direction of rotation incorrectly but the drawing of the firing order is correct: *(image from Leyland MGB GT V8 Workshop Manual Supplement)*



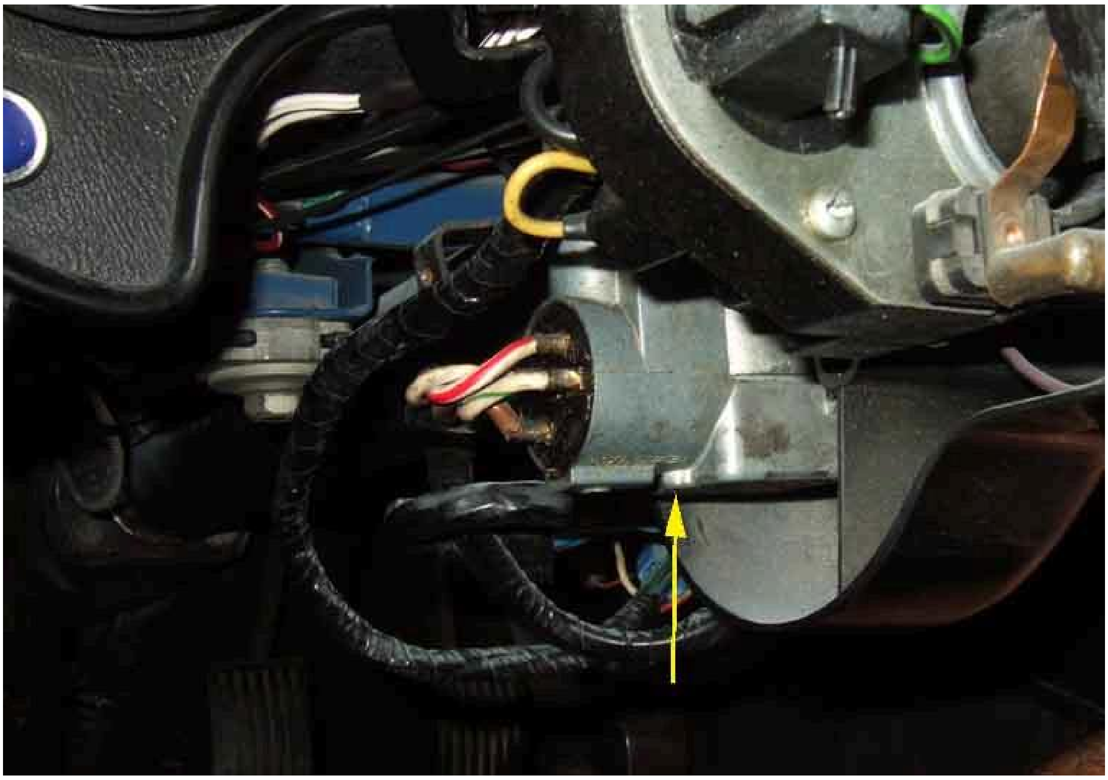
Ignition Switch Removal

1973 roadster (Bee) collapsible column with front-entry lock - round-head screw on the side of the lock, fairly easy to grasp hold of as it comes out and put in a safe place:

This era of switch has bare spades and a protective rubber boot covers the connections:

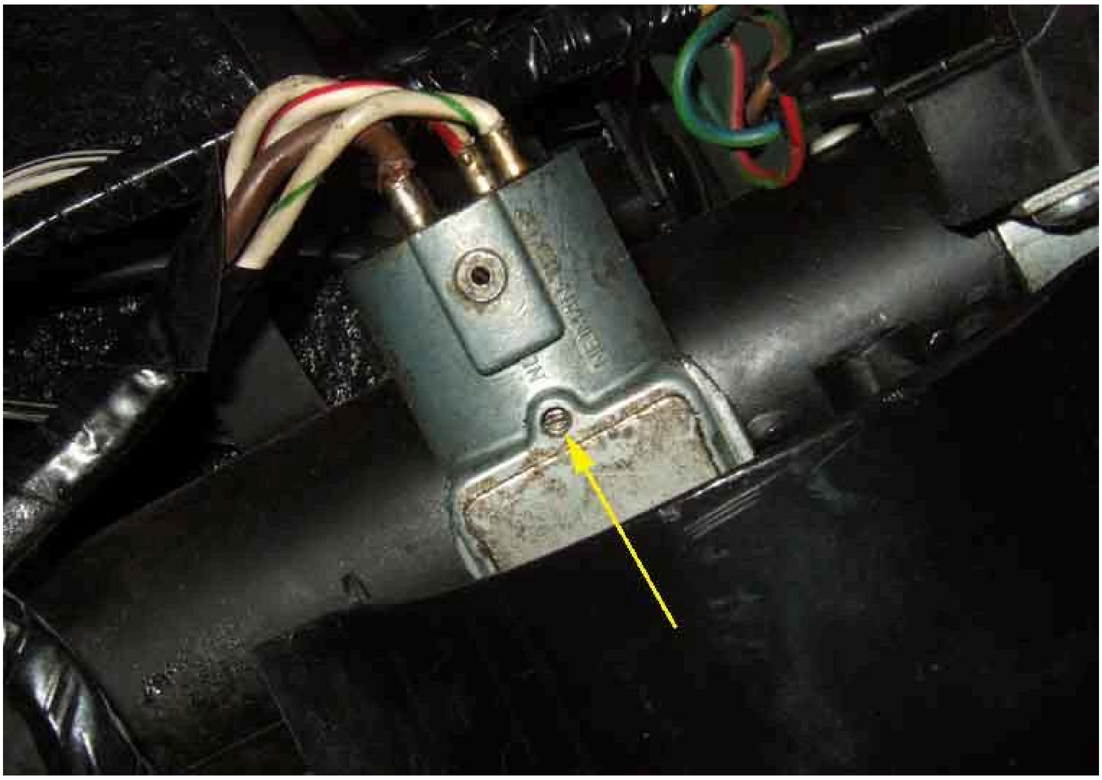


Later switches have a sub-harness on the switch with a large multi-plug for connection to the main harness and no cover. 1975 V8 (Vee) full energy-absorbing column with side entry lock (reputedly the final type as used on V8 and all RB cars) - on the bottom of the lock with the left-hand cowl removed:



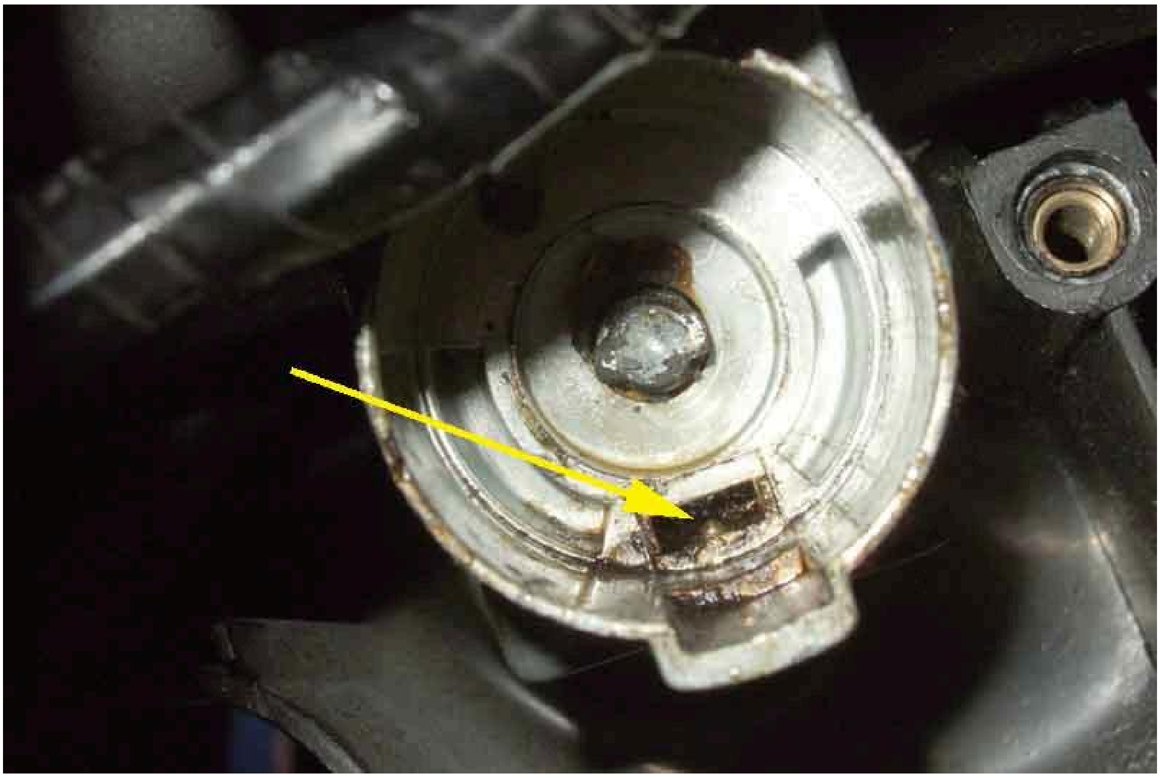
1

In this case a recessed grub-screw, still recessed when the switch is freed, be careful it doesn't fall out of its own accord when your attention is focussed on the switch as it is very small. It screws into the lock body and has a projection that fits into a recess in the switch body, so I kept the screwdriver in position while I pulled the switch out, then screwed it back in so as not to get lost:



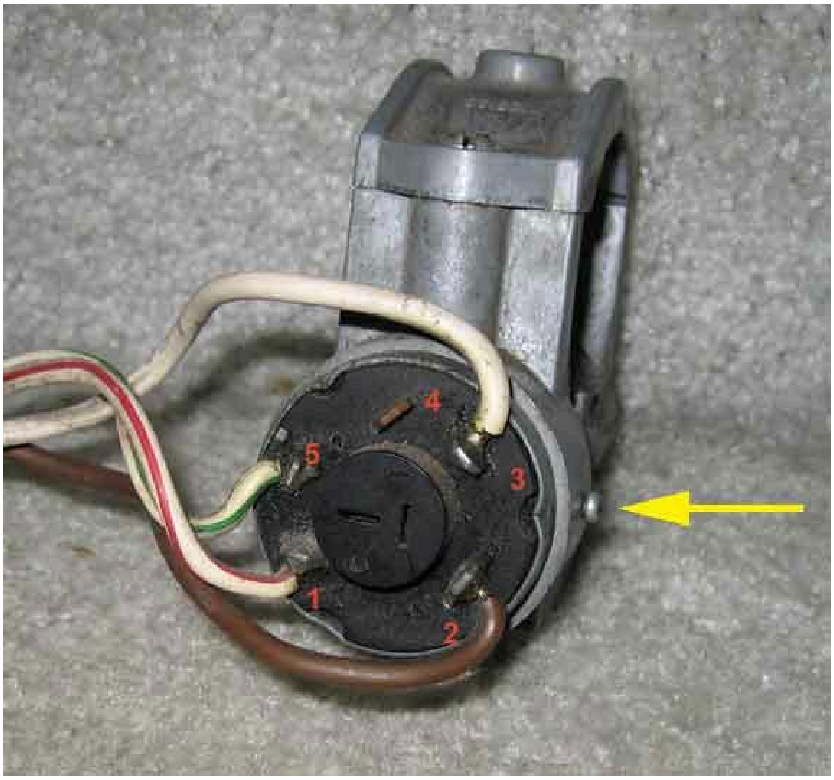
Note the switch is fully recessed into the lock, some switch bodies protrude from the lock body. Unless pushed all the way in it may not fully engage with the lock and fail to operate correctly. The hole closer to the switch entry is possibly an alternative screw position for other switches.

The screw locates into a hole in a tab on the switch:

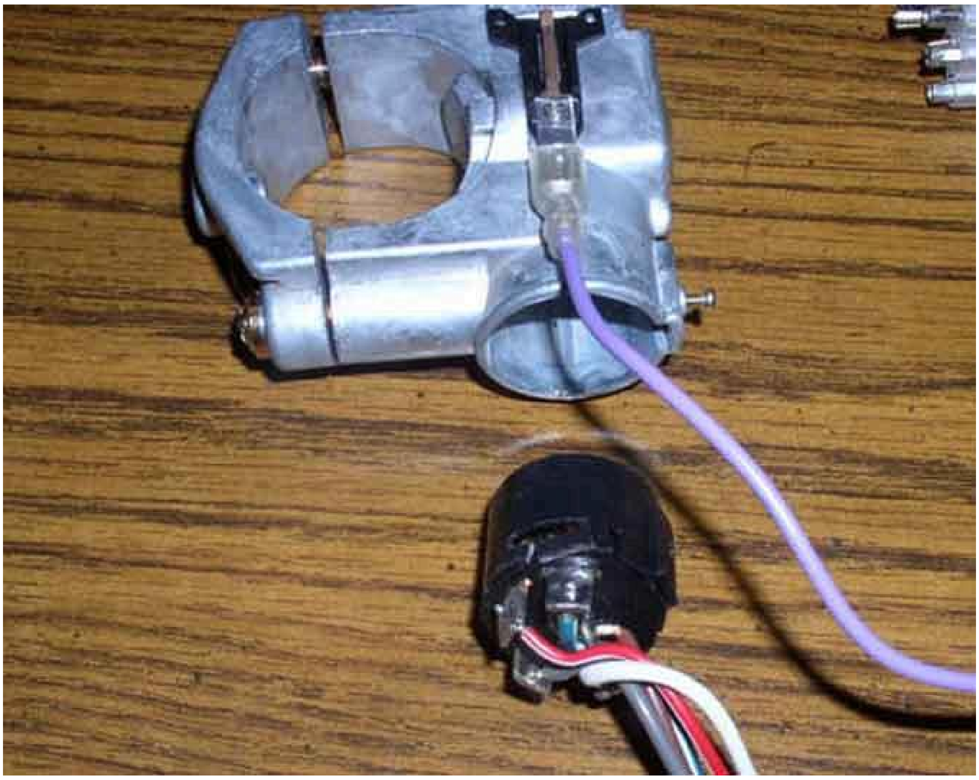


Late UK RB, with a countersunk head screw through the lock body closer to the lock. Both this and the 75 V8 lock above were made by Neiman: (*Crispin Allen*)

Early LHD side-entry lock - round-head screw facing the driver, although the edges of the socket seem to be peened over into recesses in the switch as well:

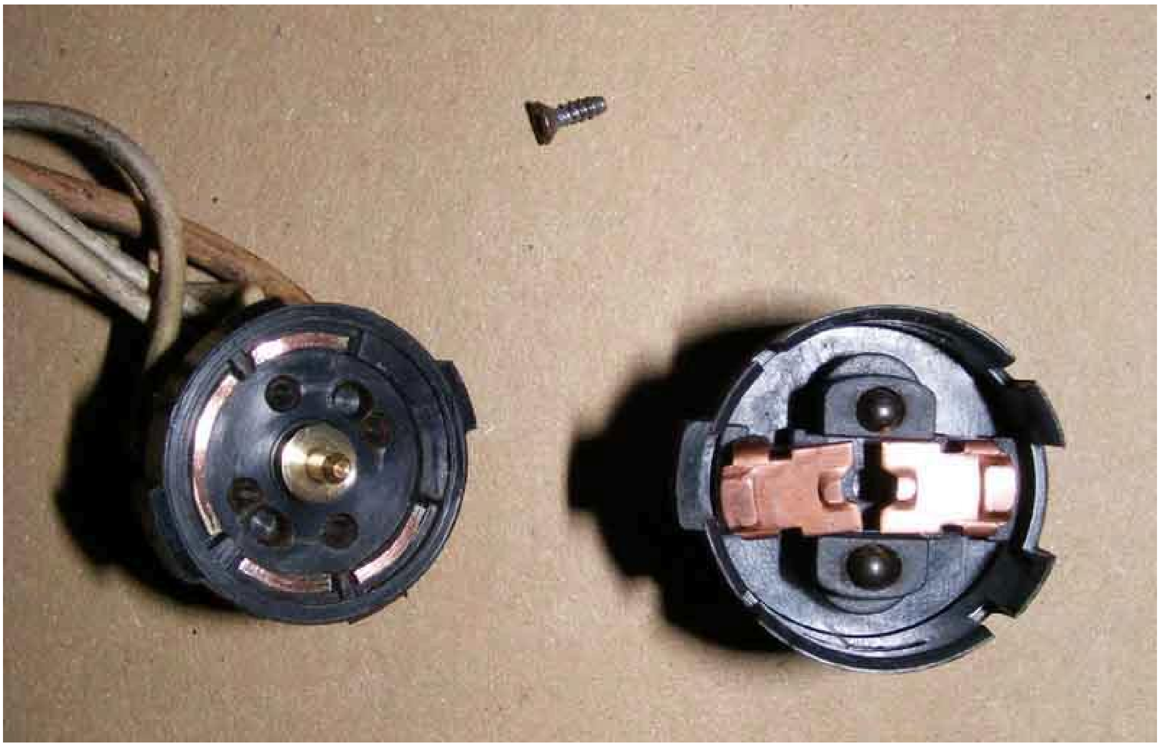


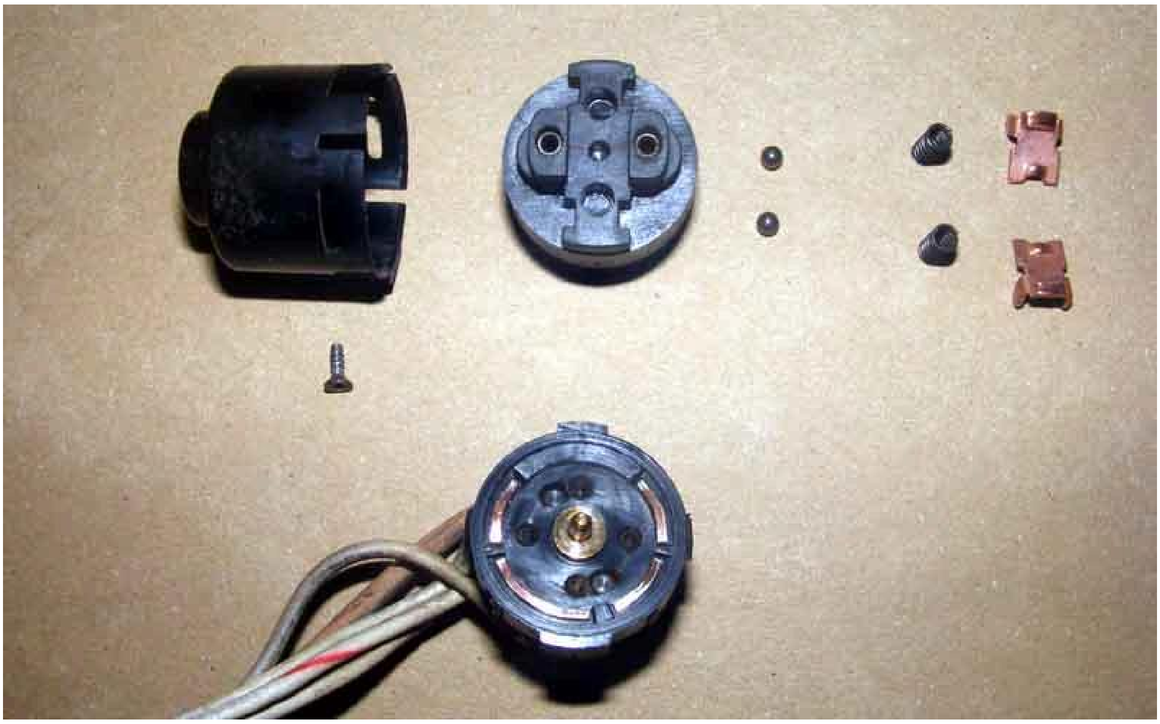
Later LHD side-entry lock, round-head screw under the lock, closer to the edge of the switch entry than Vee's lock as pictured above:



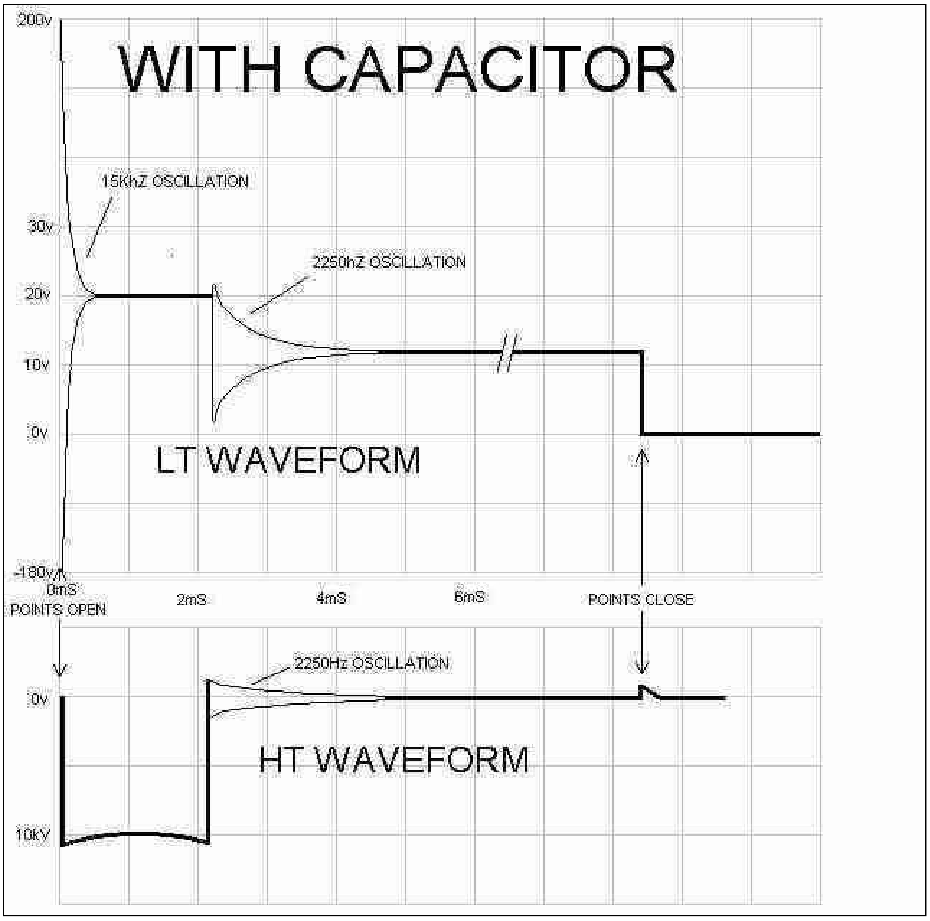
As there were a number of different lock manufacturers, it's possible the switches varied as well, which could mean marrying an original switch or lock to a replacement could be tricky. In Bee's case (top image) the original switch fitted the new lock without problem, but as can be seen above there were two different RB arrangements from the same manufacturer.

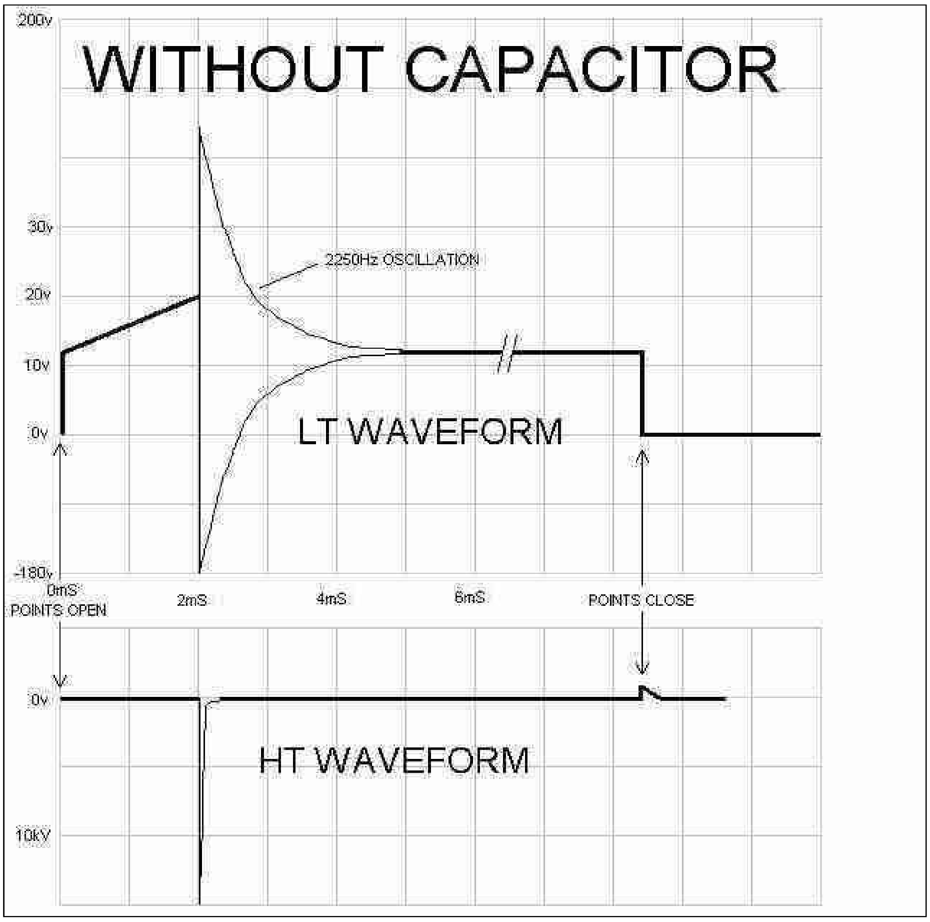
Late UK RB switch opened up for cleaning and lubricating (with Vaseline), which was all that was needed to fix a lock where the key could not be withdrawn: (*Crispin Allen*)



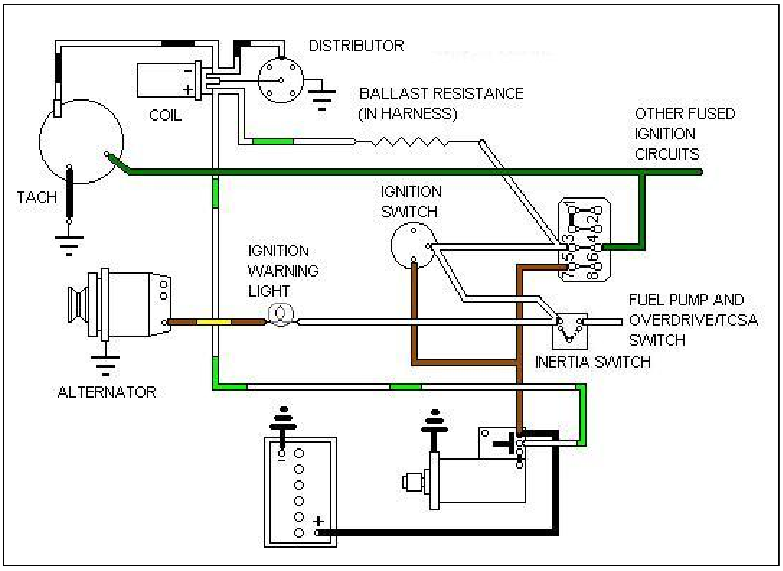


Ignition Voltage Waveforms





Ignition - 6v coil and points - North America (1974 1/2-1975)

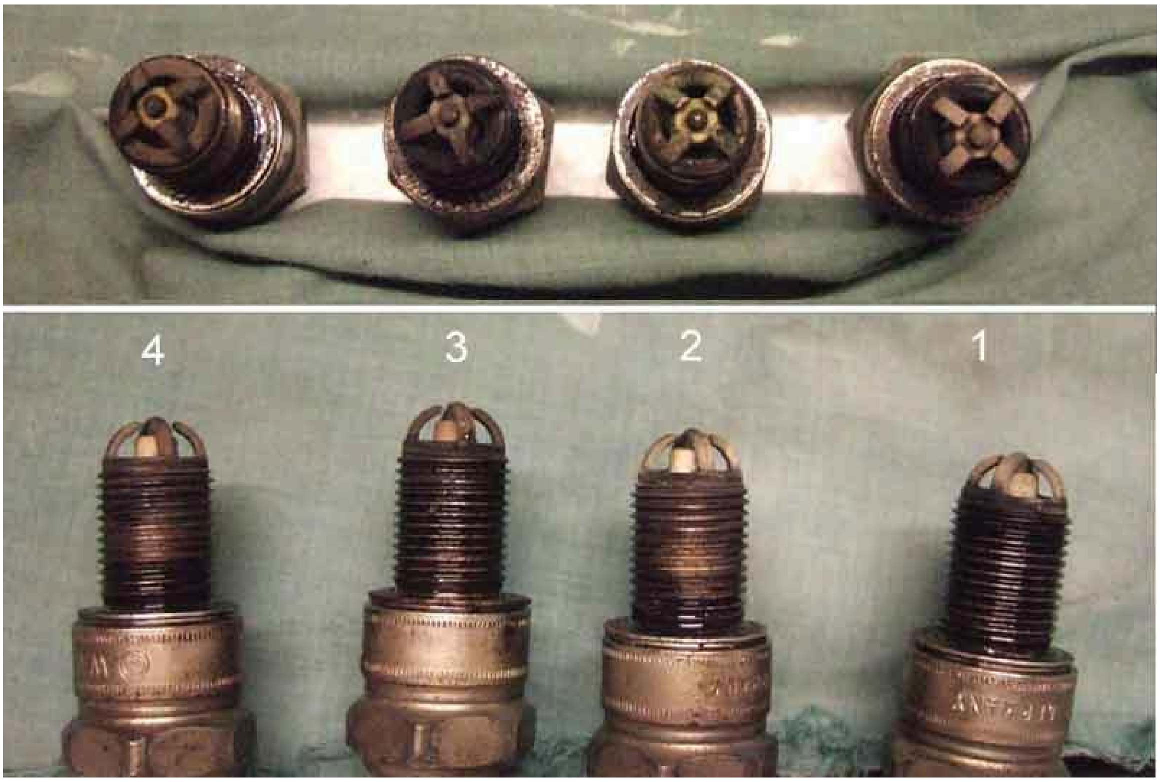


Note: The schematic for 1975 models does **not** show the second light-green/white wire from the coil +ve to the solenoid, but they do for 76 and later. It's not known whether this is an error in the schematic or an omission in the harness and solenoid, I can't think of any reason why it should be intended to be like that.

Information on the ballast resistance can be found here.

Sparkplug colour

These Bosch 4-point had been in since 1999, this was taken in 2014 after a 400-miler following a head gasket change, plugs only replaced in 2017 after some 40k. Back pair (on the left) a smidgen darker than the front pair, rear carb weakened a tad:



August 2023 - NGK fitted in 2017, about 8k since, the last time I would have messed with the carbs would have been after going lead free at that time. Again the front pair (on the right) very slightly weaker but less than before, I'll put half a flat on the front carb this time:

Timing Lights

Basic light using an orange neon discharge tube connected in series with the HT lead. It works, but needs to be used in low ambient light conditions with the timing marks clearly marked with white paint.

More sophisticated 12v style with a very bright white xenon discharge tube, easily viewed in daylight. Has 12v and earth connections for the electronics, and a clip-on pickup than can easily be moved from lead to lead while the engine is running. Versions available with an adjustable dial which is very useful for checking advance at various rpms, others with a digital tach/dwell/volts display. I dislike too many functions in one device, for a start it makes them much more expensive, but if any one of them fails either you have to scrap the tool and buy another, or buy an additional tool for the failed function, which you could have done in the first place.

Turn the knob until the flashing shows the timing marks at TDC, then the pointer on the knob indicates the amount of advance - simples.

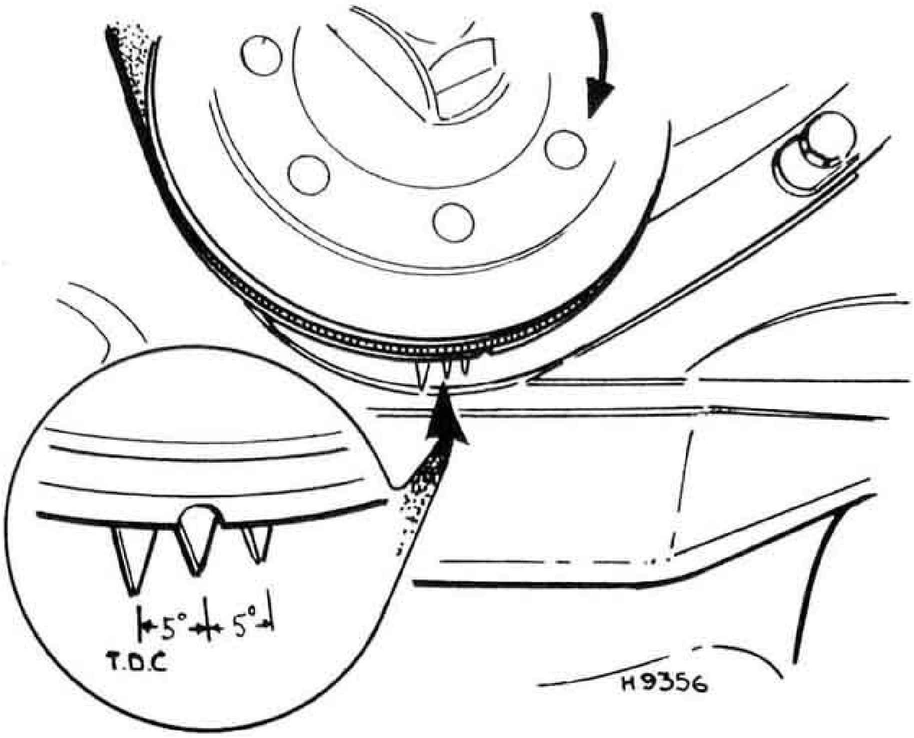
Timing Marks

4-cylinder V8

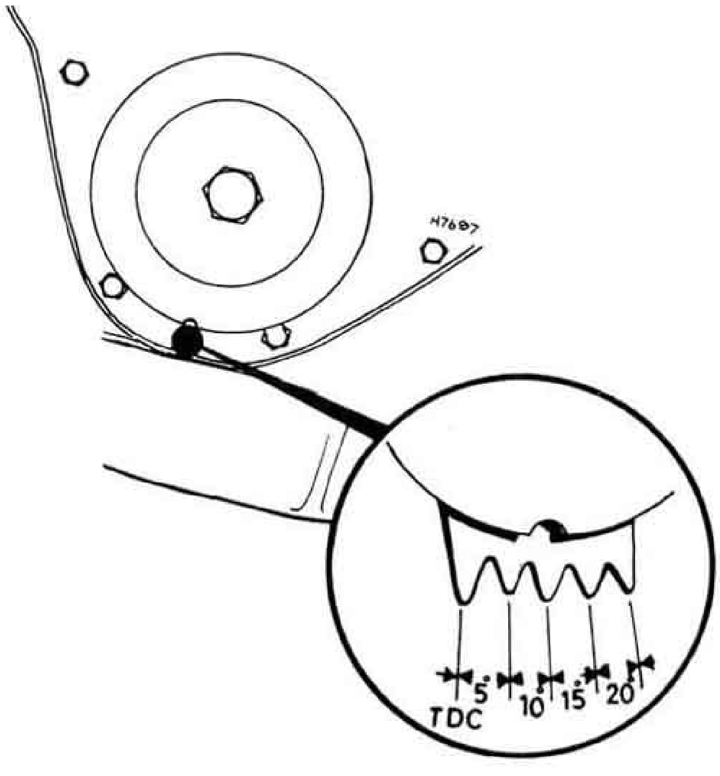
4-cylinder:

Crank pulley bolt lock washer

The earliest arrangement - pointers below, but only at TDC, and 5 and 10 degrees before (Haynes).



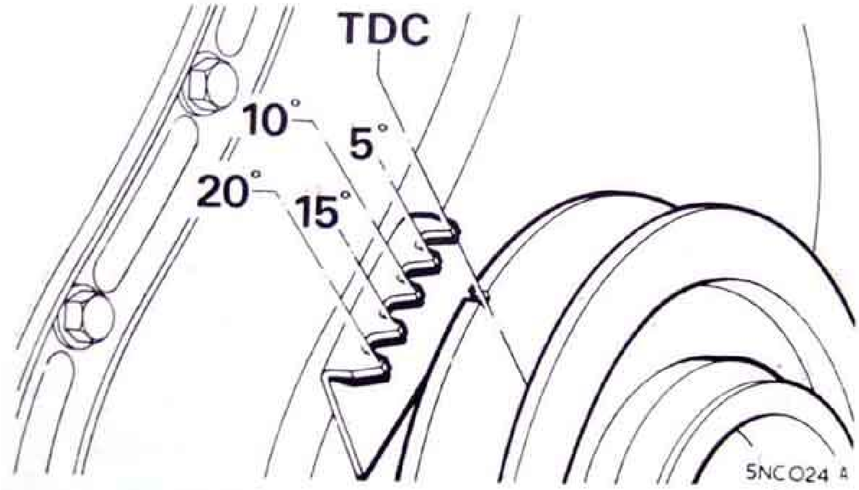
Haynes calls this 'later arrangement' but it still has the pointers below, but additionally at 15 and 20 degrees BTDC (Haynes). This is the only arrangement that my workshop manual shows.



This on a 1970 18GH from Bill Etter has five, of varying height, but with the first one seeming to be the longest instead of the last. From the Parts Catalogue 18GJ would be the same, although by this time non-North American 18GG and GK engines had the timing marks on top:

Peter Basher writing on the MGOC MGB Technical forum shows this version on his 1970 which appears to have four pointers. Going by Bill Etter's it could be that the first pointer (closest to the cover bolt) has been snapped off, possibly because being large it was confusing as to which was TDC! Engine number not known but from October 68 non-North American engines should have had the pointers on top:

The later arrangement - probably on all 18V engines - above and angled towards the alternator: (*Leyland Workshop Manual*)



Even then there were two different positions - most CB on the left and late CB (18V779/780) and RB on the right because they had a larger crank pulley so the pointers were moved further out (from the Parts Catalogue, Clausager indicates this change didn't occur until the RB engines 18V846/847/836/837):


And there's more. Difficult to show on a CB (left) because of the closeness of the radiator but the pointers on that are about 5mm further out from the circumference of the pulley, whereas on the RB (right, John Pinna) they barely clear it:


Practical considerations: *September 2023*

Since the advent of unleaded I've always set the roadster timing by ear i.e. listening for pinking. Haynes suggests to set the timing so pinking can only just be heard when accelerating at full throttle from 30 to 50 in top gear, but I have found I can get pinking at part-throttle acceleration and flooring it stops it, so maybe Haynes is a bit aggressive. Eventually I decided to back off until I couldn't hear any at any combination of throttle opening, revs and load and ran like that for some time. Each year I check and note the timing and dwell to see if they have drifted at all. Dwell is always very consistent, and so is timing, but comparing the latter with the book figure I found I had been recording 12 to 15 degrees at 1000rpm, and most recently 20 at 2000. From the WSM my engine should have a static of 10 degrees and a strobe of 13 degrees at 600rpm. Combining the static figure and those from the centrifugal curve it should be 20 at 1000 and 28 at 2000, so mine seems well down. Using the very convenient Vernier adjustment on the side of the 25D4 I advanced about one degree and over a 288 mile run had no pinking, so wondered how much further I could go. But before that, not having looked at static timing for very many years I decide to do a static check ... and was very surprised:

Given that each pointer to the next represents 5 degrees this is very nearly at TDC! Wondering about slop in the mechanism I took the cap off. I found the rotor was fully at it's rest position, with the springs (replaced in my time) returning it almost all the way back when rotated by hand. Out of interest I checked the static timing with it fully advanced against the springs which gave 20 degrees:

However thinking about it later on if the strobe was supposed to be 20 at 1000 and I was getting 12 then it's hardly surprising that the static had reduced by a similar amount from 10 degrees to close to TDC.

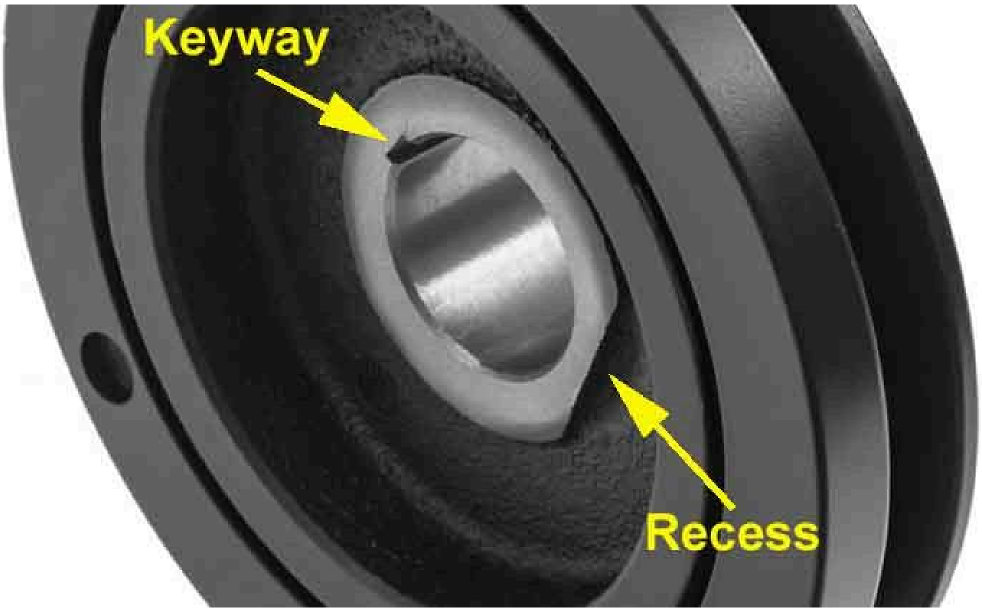
Having a 25D4 with Vernier adjuster I advanced that 10 clicks at a time until I got to 16 degrees at 1k and 28 degrees at 2k, then checking the static again it was about 9 degrees and I'm guessing around 30 when fully advanced manually by twisting the rotor:


A bit of a run and loading up the engine showed no pinking, needs more running and perhaps more heat to be sure.

Crank pulley bolt lock washer:

Two types are shown for the part number given for all engines in the Parts Catalogue - 1G1319. Some suppliers show 12A398 as being a later number for the same part, but Googling either number shows the same mix of types. These shown by Moss (left) and Motaclan/Leacy (right):


Crankshaft pulley with keyway and recess: (*Moss Europe*)



The flat type seems to key to the crank then the other side is bent up to key to a bolt flat. The dished type is bent down to lock into the recess on one side and bent up to key to a bolt flat on the other, and the flat type can be locked in the same way if there is no key. If there is a crank key and it extends past the face of the pulley then the dished type would need a keyway to be filed out. However if the key extends past the lock washer then it may prevent the bolt tightening the pulley onto the crank. It seems more likely that the key **would not** extend past the face of the pulley, meaning either type can be used but both would have to be bent down into the recess and up to a bolt flat.

V8:

Pulley markings up to 10 degrees, at 2 degree intervals, for both BTDC and ATDC

The single pointer is adjustable, which on the face of it is simply to cater for different pulley sizes ... but!

You can clearly see that when looking directly down on the pulley markings, there is a difference of about five degrees between fully out and fully in, which would have a significant effect on timing. My pointer was set fully in i.e. close to the pulley, but I'll have to check what that represents as far as true TDC goes.

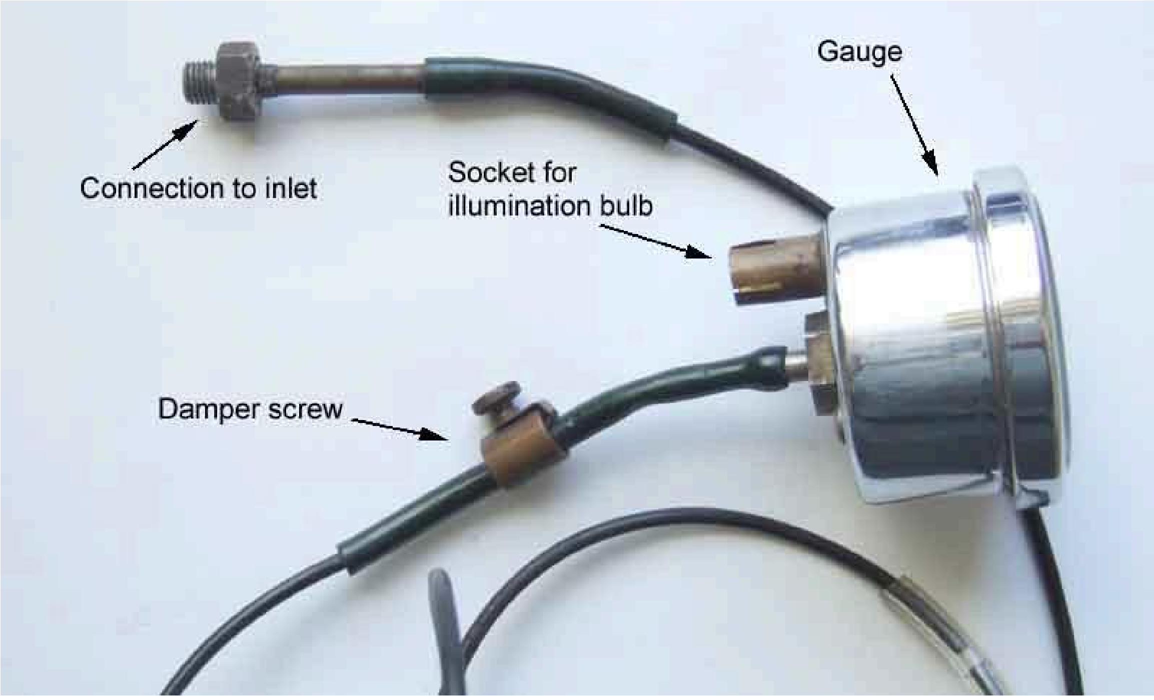
Although I bought a modified timing pointer from Rimmers I can't find any way of mounting it to the new front cover, so have to fabricate my own. With the old engine, front cover and water pump at home, I decide to best place to mount one is on two of the lower water pump bolts - one that goes right through the front cover and the other just into it. With the original pointer (which I had lost, but found again when it came back with various bits from the engine man this week) I was able to make a card template, and from that cut one out of sheet metal. With the pulley (which I now have back as well) in the front cover I turn that so the original pointer is over the TDC mark then remove that and fit the new one, for final tweaking of bolt holes and pointer angle to be in the same position. As the water pump and crank are in the same positions relative to each other on both old and new covers, the new pointer does the job.

Checking timing marks and adjusting the V8 pointer: Knock the ceramic insulator out of an old plug and insert a length of dowel. I was considering fixing the dowel in position, but opted to leave it sliding (but not loose) and marking it instead.

Vacuum Gauge

My REDeX gauge, bought in the late 60s

The component parts



Instructions for installation and use

CAR CARE ROBOT

ALSO AVAILABLE WITH METRIC DIAL
STANDARD 13/1/2 ILLUMINATED 13/1/5

Boxed complete with

Part No.	*Description*
4/3/2	**Synthetic Tubing**
4/2/5	**Damper Collar**
4/13/1	**Instrument Panel**
4/2/2	**2in. long 2BA Manifold Adaptor**
	Full Instructions

Part Numbers

STANDARD	13/1/1
ILLUMINATED	13/1/4

THE REDEX CAR CARE ROBOT

The REDEX Car Care Robot is a miniature edition of the REDEX Engine Tester which is used in most garages to test and tune engines. The Robot is packed complete with all components necessary for quick and easy fitting to any private or commercial vehicle having a four-stroke spark ignition engine with single carburettor. Kits are available for twin carburettors and for rear engine cars where longer tubing is necessary.

Construction

The REDEX Car Care Robot is made with a pressure sensitive element of the "C" type bourdon tube, manufactured from high quality, seamless drawn, phosphor bronze. This is connected through a link to the movement which is of the rack and pinion type. A tension spring is fitted to take up any back lash that may occur. The indicating pointer is fitted to the pinion spindle.

The Illuminated REDEX Car Care Robot is of the same construction with the exception that a hole has been drilled in the rear of the casing to let the bulb enter. A plastic pointer is fitted and is illuminated from inside the gauge. The bulb holder is held in position by one of the screws securing the movement to the gauge case.

Fitting

The Robot should be fitted where it can easily be seen whilst driving. With the aid of the bracket supplied, the instrument can be fitted to the top or the bottom of the dashboard with self-tapping screws and the Robot inserted. Alternatively, a flush fitting can be obtained on the dashboard by cutting a 2" diameter hole, inserting the instrument and securing it from behind.

The damper collar (Fig. 1) should be placed on the 6" length of (green) P.V.C. tube and one end of this tube fitted to the back of the Robot. The (black) Nylon tube should then be inserted into the end of the P.V.C. tube and the free end of the Nylon tube pushed through rubber grommets in the engine bulkheads until it has reached the manifold. It should then be joined to the permanent adaptor by means of the 2" length of P.V.C. tube.

The 2BA permanent adaptor (Fig. 2) should be fitted between the carburettor butterfly and the engine. It can be fitted into the inlet manifold as near as possible to the carburettor or in the carburettor flange (see illustations), using a No. 24 drill and a 2BA tap. Both the drill and the tap should be well greased to catch any loose swarf. Where an engine is fitted with a water-heated manifold, care must be taken to avoid this. The Robot may operate from existing take-off points on the inlet manifold but under no circumstances must the Robot be connected to the vacuum take-off to the distributor.

When an engine has more than one carburettor, it will be necessary to fit a 2BA adaptor for each. These can then be connected to the instrument by means of short lengths of tubing and a multi-way adaptor.

The Illuminated Robot wiring circuit can be made from any instrument light connection to the terminal at the rear of the Robot, which is insulated by a sleeve. The circuit is completed by earthing the Robot case.

REDEX Limited, 365 Chiswick High Road, London, W.4

Fitting — *Continued*

The damper collar should slide over the tube (Fig. 1) to a position near the Robot. WARNING: When the instrument is first fitted and before starting the engine, the damper collar screw should be tightened fully to make the instrument inoperative. As soon as the engine reaches normal working temperature, release damper collar screw, then gradually tighten again until needle is free from piston pulsations and steady, at the same time responsive to the slightest movement of the acceleration pedal.

Fig. 1.

Undue Noise or Sluggish Needle Movement

If a sucking noise or a sluggish needle movement occurs, this is an indication of petrol in the tube. The remedy for this is to disconnect the tube at the gauge head, run the engine to draw out petrol, stop engine and replace tube. Now remove green P.V.C. tube from engine manifold adaptor and insert a $\frac{1}{32}$" split pin into the outer end of the engine manifold adaptor, or into the Robot outlet of the 3-way adaptor.

In certain cases severe pulsations may cause needle vibration in the Robot Head; the insertion of a $\frac{1}{32}$" split pin in the manner described above will also overcome this difficulty.

Once the setting has been made in this way, the instrument should require no further attention.

Fig. 2.

Principle of Operation

The Robot gives a scientific check on engine efficiency, since every aspect of carburation, ignition and engine condition influences the depression at the air intake as do also the impulses caused by valves, pistons and sparking plugs. Wear on these parts and their defects are revealed by characteristic movements of the Robot needle (see diagrams on page 4,) without dismantling any engine part. Disturbance in the balance of the engine or falling off of power output is indicated whether due to mechanical or electrical causes; to carbon, gumming or deficient lubrication; to a change in petrol quality, or to incorrect adjustments.

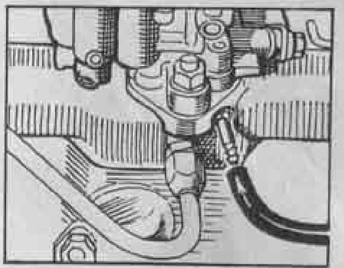


Fig. 3.

In addition to its use as an engine "X-ray", fitted to the dashboard, the Robot may be used for testing and tuning the engine. Disconnect the Robot and reconnect so that it is in a position visible whilst working on the engine.

Run the engine until a normal working temperature is reached, then carry out the following preliminary experiments, observing the movements of the Robot needle:—

(i) **Carburettor.** Alter mixture from extremely rich to extremely weak, noting how the needle "floats" or "weaves". (See page 4).

(ii) **Sparking Plugs.** Short each plug with a screwdriver, noting that the needle falls back slightly. (See page 4).

(iii) **Ignition Timing.** Rotate the distributor body to the extreme positions of over-advance and over-retard. Over-advance causes "kicking" of the needle, while over-retard gives a low but steady reading. (See page 4).

(iv) Read the Robot dial and make a rapid fault analysis according to the diagrams on page 4.

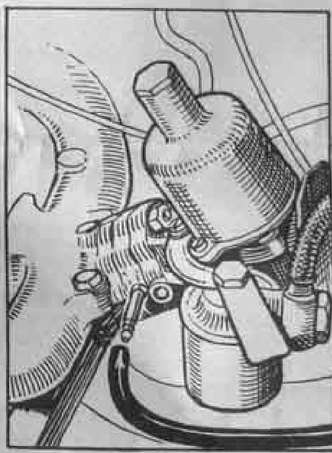


Fig. 4.

Normal Readings

The normal readings that could be expected from a 4, 6 or 8 cylinder correctly tuned and REDEXed engine are 19 to 22. In the case of a twin cylinder engine the reading could be considerably lower. Every 1,000 feet of altitude above sea level reduces the readings by 1 (i.e. 1" Hg.). The object is always to obtain the highest possible steady needle reading.

METHOD OF USE

Fuel Economy

The Robot helps to make economic driving a regular habit. The rate of fuel consumption is indicated by the position of the needle. For economy, drive at a steady speed and keep the needle reading as high as possible. Wide fluctuations show that you are over-accelerating and wasting petrol. Sustained low readings show that foot pressure is too heavy. Ease off the accelerator pedal and you will lose but little speed while the higher reading shows substantially less throttle opening and reduced consumption. Watch the Robot and you will drive more comfortably with less strain on yourself and the engine and arrive just as quickly at your destination.

Sparking Plugs

Set throttle to a fast tickover and short each plug in turn to earth with a screwdriver. The recorded drop of the needle indicates the efficiency of that particular cylinder.

A correctly tuned and balanced engine should show an even drop on all cylinders. If the needle drop is uneven this would indicate faulty plugs or cylinders.

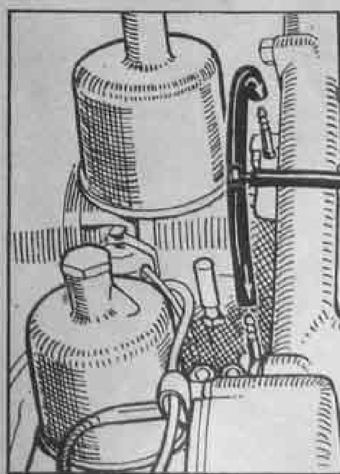


Fig. 5.

METHOD OF USE — *Continued*

Ignition Timing

1. Before setting the ignition timing ensure that the ignition vacuum advance control is connected and then adjust the carburettor so that the highest steady reading is obtained.
2. Increase engine speed by adjusting the throttle stop until the ignition warning light goes out.
3. Re-adjust damper collar of the gauge to allow sensitive movement of the needle.
4. Slightly enrichen carburettor mixture until the gauge reading fractionally falls. (This will obviate needle kicks caused by weak mixture, which could be misinterpreted as kicks due to over-advanced ignition).
5. Set the distributor micrometer adjusting screws (if fitted) to a central position, then loosen the distributor body clamp bolt. At this is stage it is recommended that the operator should familiarise himself with the effect on needle movement when the distributor is rotated in either direction.

Note. Rotation of the distributor body in the opposite direction to that of the rotor arm advances ignition.

6. Retard ignition until needle falls, then slowly rotate distributor, advancing ignition until needle kicks.
7. When needle kick is seen, carefully retard the ignition just sufficiently to maintain an absolutley steady needle (highest possible steady reading). From this point retard the ignition by a further ½" Hg. and tighten distributor clamp.
8. Reset the carburettor to a normal tickover and reset slow running mixture control.
9. This is the correct ignition setting which takes account of every engine condition, mechanical or otherwise also the grade of fuel in use.

Carburettor Setting

The carburettor should be cleaned and the jet and float level checked. Clogged jets must not be cleaned by mechanical means, any blockage should be removed by blowing out with an air jet.

All carburettor adjustments should be made at normal tickover. To obtain correct mixture, adjust mixture control until the reading is as high and as steady as possible.

On S.U. carburettors disconnect the choke wire or rod before adjusting the jet position. Do not attempt to tune an S.U. carburettor with hydraulic damper unless the chamber contains the correct amount of oil. On non-hydraulic types apply REDEX to the piston spindle. For best performance with this type of carburettor richen mixture until reading just starts to fall from highest steady position.

Multiple carburettors are synchronised in the following manner:—

(a) Remove air filters and slacken connecting linkage between carburettors.

(b) To ensure that all carburettors are balanced, listen to each in turn at tickover speeds (this is done by means of a short length of tubing placed into each air intake). Adjust throttle stops so that all carburettors are pulling evenly and re-tighten linkage.

(c) Connect all carburettors by means of "T" connectors. Before starting engine close all mixture controls completely, then open again an equal amount on each carburettor until engine runs satisfactorily. From this point adjust each mixture control alternatively the same amount until the highest steady reading is obtained.

Before refitting air filters ensure they are thoroughly cleaned, or if replaceable element type, renew elements.

Other Causes of "Floating" Needle Movement

(i) Excessive or insufficient fuel pump pressure. (ii) Blocked fuel line from petrol tank to fuel pump.
(iii) Worn butterfly spindle (also indicated by the engine failing to idle slowly).

Causes of Needle Tremor

If damper collar adjustment is correct and needle tremor persists after adjusting sparking plugs, ignition timing and carburettor setting, the contact points should be checked with a feeler gauge and reconditioned or renewed if burnt or badly pitted. A liberal dose of REDEX should be applied to the distributor weights and springs.

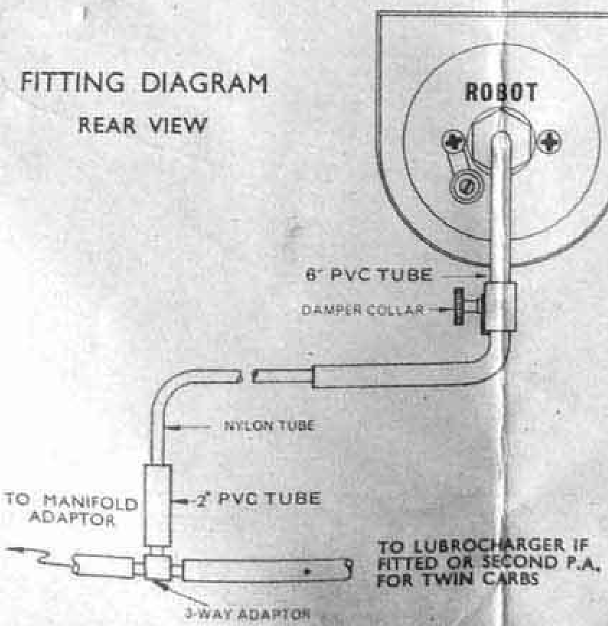
Choked Exhaust Systems

If the exhaust system is badly choked, the Robot needle will gradually recede to a low reading as back pressure is built up.

A quick check for exhaust efficiency can be made with the Robot connected to the inlet manifold adaptor. When the throttle is opened and closed quickly the needle should drop sharply, then rise rapidly to above the normal idling reading. This change should be rapid and any tendency for the needle to remain low or return sluggishly to normal indicates the presence of back pressure.

FITTING DIAGRAM

REAR VIEW



Compression Check

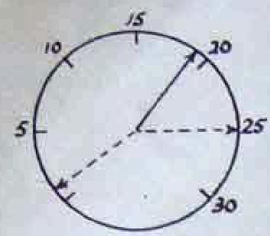
Connect the Robot to the manifold adaptor and, with the throttle completely closed and engine switched off, operate the starter. If the compressions are balanced the needle will rise to a steady reading of approximately 15. If reading is steady but low this could indicate an air leak. If the reading is an uneven pulsation this indicates unbalanced compressions; a check should therefore be made using the REDEX Compression Gauge.

Perfect Balance

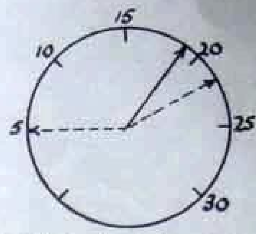
Correcting one condition in an engine may affect another. For example, the use of REDEX raises the efficiency of an engine to a new high level and the engine must be retuned to correspond. Advancement of ignition timing may call for readjustment of the carburettor mixture and both of these would again require adjustment if any alteration is made to carburettor jet size, plugs, points, air filter or any other component or condition of the engine. Therefore, a rapid check-over of carburettor and ignition timing should be made with the Robot to make certain of perfect, all-round balance before passing the engine as satisfactory.

GENERAL CHECK ON ENGINE CONDITION

OPEN AND CLOSE THROTTLE QUICKLY



Needle falls sharply and returns quickly to about 25 then steadies to normal. Indicates good engine.

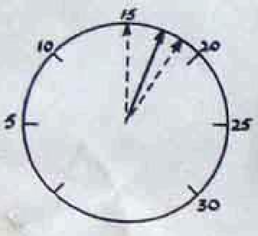


Needle falls slowly to about 5 then drifts back to normal. Engine in poor condition generally. Very slow return of needle indicates choked exhaust.

ENGINE FAULT DIAGNOSIS

LOW VACUUM 16-17

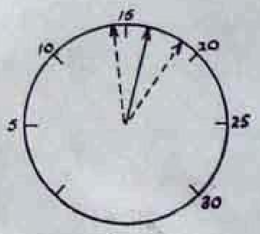
Floating or Weaving Needle.



Mixture too weak. Air leak at carburettor or manifold gaskets.

LOW VACUUM 15-18

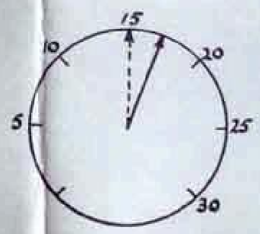
Regular Float.



Mixture too rich. Dirty air cleaner. Float level too high. Needle valve not seating. Punctured Float.

LOW VACUUM

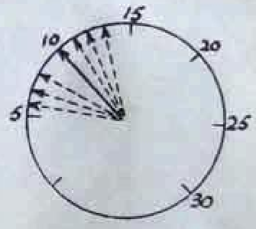
Regular beat.



Burnt Valve. No clearance on one or more valve tappets. Check with REDEX Compression Gauge whilst turning engine over slowly by hand.

LOW VACUUM

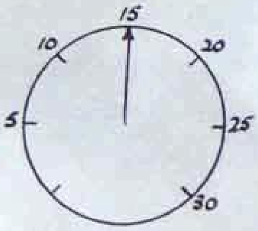
Very unsteady needle.



Hot spot plate or heat riser burnt through. Starter vacuum test will assist diagnosis.

LOW VACUUM

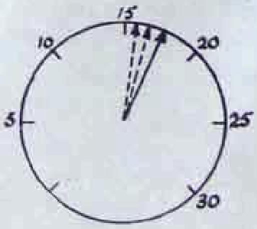
Steady Needle.



Ignition retarded. Late valve timing. Perforated hot spot.

SLIGHTLY LOW VACUUM

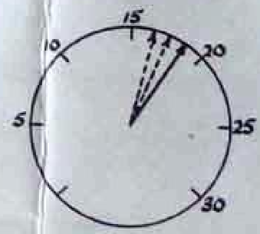
Needle tremor.



Tappets out of adjustment.

NORMAL VACUUM

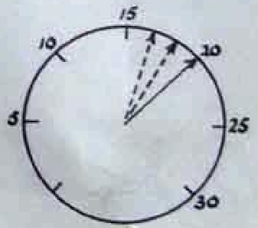
Irregular slight kick.



Plug points too close. Plugs fouled. Contact points pitted, burnt, or out of adjustment. Auto-advance springs loose.

NORMAL VACUUM

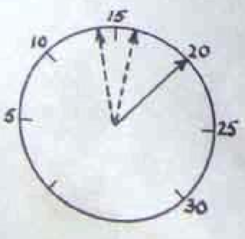
Irregular drop.



Gummy valve stems. Faulty plug.

NORMAL VACUUM

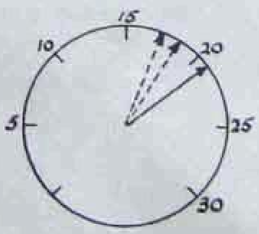
Irregular kick.



Sticking inlet valve.

HIGH VACUUM

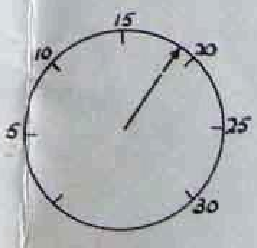
Irregular kick.



Over-advanced. Loose timing chain. Faulty condenser.

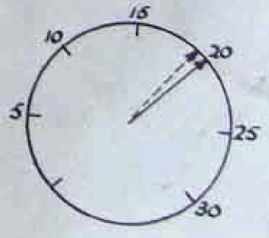
STEADY NEEDLE

18—21



Normal Vacuum prior to REDEX. Rising 10% or more after REDEX.

CHECKING PLUGS



Short each plug in turn. The needle drop should be even for all cylinders. Uneven drop indicates faulty plugs or cylinders.

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