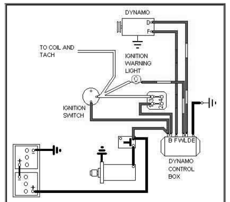
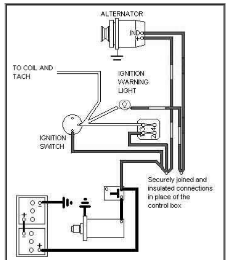
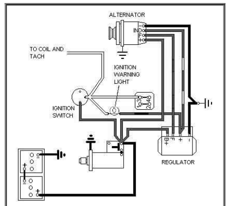
Alternator Batteries and Charges Indicators & Hazards

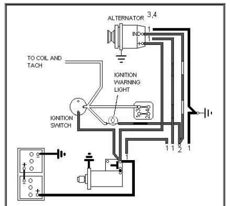
Alternators and Dynamos

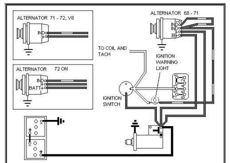
Schematics

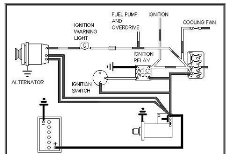

Dynamo

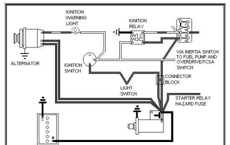

Dynamo converted to Alternator

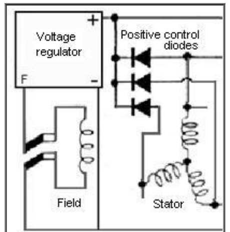

Alternator with external regulator (16AC, 1968)


Alternator with external regulator (16AC) converted to Alternator with internal regulator (16/17/18ACR)


Alternator with internal regulator (16/17/18ACR) without Ignition Relay (69-76 inc V8)


Alternator with internal regulator (16/17/18ACR) UK with Ignition Relay (77-on)


Alternator with internal regulator (16/17/18ACR) North American with Ignition Relay (77-on)



Alternator Internals

Types

Alternatives/Replacements *April 2021*

January 2021: **A dynamo does not output AC as Ant Anstead said in the Wheeler Dealers episode on the TR4**. Both dynamo and alternator output DC at their terminals, they just use different methods internally to do so. A dynamo generates DC internally and outputs that directly, an alternator generates AC internally but rectifies it to DC before outputting it.

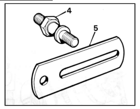
What Ant Anstead held up is the 'control box' which regulates the voltage and current the dynamo outputs to charge the battery and run the cars electrics, using relays and resistors. The first alternators used on the MGB - the 16AC used on early Mk2s - also had external regulation, albeit electronic instead of relays and resistors, but after that that 16ACR, 17ACR and 18ACR had internal regulation and all modern alternators (except possibly very specialised applications) will be the same.

A dynamo and separate control box were used on Mk1 MGBs. The first MGB alternators (MkII models in 1967) were the 16AC (remote regulator) and 16ACR (integral regulator) which are rated at 34 amps. It was changed to the 17ACR in February 1973 and finally the 18ACR in about June 1976. There is conflicting information about the output rating of these latter two, some sources say the 17ACR is 36 amps and the 18ACR 45 amps, others say the 17ACR is 43 amps and the 18ACR 45 amps. 43 or 45 amps ought to be sufficient for factory loads, the V8 has a Delco 46 amp alternator and that is sufficient to keep the **battery** voltage above 12.5v even with headlights, twin cooling fans and the heated rear window running, and at idling speeds. The problem is that people fit voltmeters wired to the green circuit, which can be a couple of volts lower than the solenoid i.e. battery voltage, then get paranoid. It's battery voltage which is important, and any volt-drop between there and the green circuit is down to ageing connections, and the best alternator in the world isn't going to cure them, although it may cover them up.


I had briefly wondered why an AC/Delco was chosen for the V8 when it has almost the same output capacity as the later Lucas items. It was only during a discussion with someone about alternators for a V8 conversion that it became clear - the Lucas alts are too long to fit in the factory position as the rocker cover is in the way! It wasn't a problem for Costello as he swung the alternator out from the engine, but the factory fitted the MGB V8 filter high up on the inner wing which precluded that. Hence a shorter alt that would fit directly in front of the rocker cover. Only just though, as the harness plug has to be wiggled off at an angle.

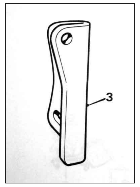
Mounting

Front:


With the top front mounting bolted to an ear on the water pump, there is an adjuster link on the lower front mounting. Prior to the 77 model year both dynamo and alternator used a flat link 12H67 or 2A497 and a pillar 2A128 on the engine front cover. For 1977 on a different link was used - 12G2627, which the Parts Catalogue (and a couple of supplier drawings) seems to show is cranked, without the pillar. However Googling 12G2627 shows a flat link, albeit curved with a curved slot, so the pillar is still needed. On older alts the lower adjuster ear is threaded, so the bolts clamps up the link directly, then a locking nut is fitted for security. However a replacement alt purchased by John Wallace is **not** threaded, so really double-nuts should be used, or at the very least a stiff-nut.

Both front and adjuster link mounting points may need spacer washers to correctly align the alt pulley with the water-pump pulley.

Rear:


Both dynamo and alternator use their own versions of an angle bracket to attach a single mounting point on the rear end-plate to two bosses on the block. Early blocks only had two for the dynamo, whereas later blocks have one pair for a dynamo and another pair further forwards for an alternator. After-market adapters are available to mount an alternator to an early block which only has the rear-most pair of bosses. Alternators should have a sliding (interference fit) bush in the rear ear which automatically takes up the correct position as the front and rear bolts are tightened. The bracket is also adjustable to the block, and that should be set such that the bush is somewhere between its two extremities. If right at one end then as the bolts are fully tightened the ears could be under a bending stress risking fracture.

Connections


There are several different connection arrangements for Lucas alternators over the years ranging from 4-pin of the 16AC with remote regulator (best avoided for a conversion), then a 5-pin using two connectors on the early internally regulated 16ACR and finally a 3-pin single connector for other 16/17/18ACR variants. 5-pin/two plug systems have two Indicator spades in one of the connectors which are linked together by a loop of brown/yellow wire in the plug, possibly to protect the alternator if the engine is run with the IND/B+ plug removed. 3-pin have two variants - one with two large spades side-by-side and a single standard-sized spade to one side, and another with a single large spade in the middle and a standard-sized spade either side of it, one possibly with chamfered corners. Where there are two large spades both are outputs (+), with the standard-sized spade being for the indicator wire (IND). With the other type the single large spade is the output (+), the standard spade is for the indicator wire (IND), and the one with the chamfered corners is for the voltage sensing wire (B+ or BATT+).

The B+ (or BATT+) voltage sensing terminal is wired back to the solenoid with a standard gauge brown wire. This is used to sense the voltage at the solenoid rather than the alternator for voltage regulation purposes, and would ensure that under high current conditions any volt-drop occurring in the main output wires (thick brown and black) between alternator and solenoid/body is ignored and the voltage at the solenoid (and hence the battery) is maintained at the correct level, this system is called 'battery sensing'. This was the case in the 5-pin 2-plug 16ACR from 69 to 71.

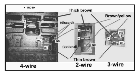
Initially the 3-pin single-plug alternators used machine sensing (i.e. the correct voltage is maintained at the alternator terminals, but could be lower at the solenoid and hence battery under high current conditions) with just a single thick brown and a standard gauge brown/yellow in the alternator plug with the third position in the harness plug empty. This is a '2-wire' alternator, seen on a 1972 model.

Possibly because of problems with low battery voltage for 1973 the Workshop Manual diagram shows the alternators have reverted to battery sensing again having 3-wire alternator wiring. Clausager states that a new version of the 16ACR with modified regulator and surge protection was provided in March 72, and is how Bee a 73-model built September 72 is wired with an additional standard-gauge brown in the alternator plug wired back to the solenoid as before, and seems to have remained the case up to and including the 77 model year at least.

Clausager states the 17ACR was fitted from February 73 so higher output, possibly associated with the GT HRW having being made standard equipment. This is a 3-wire alternator, but can be used with a 2-wire harness by connecting the third spade to the output spade in the alternator plug. A '2-wire' alternator i.e. one with two large output spades can be connected to a 3-wire harness as-is i.e. each brown wire to either of the large output spades, although the harness plug may need to be changed to fit the alternator.

The final variation was the 18ACR. Clausager says the exact change point is unavailable, but thinks it was from June 76, borne out by the Parts Catalogue which shows the 18ACR being used before September 76. The schematics get confusing here, with UK 1979 from the WSM and 'later' models for both UK and North America indicating it had reverted to machine-sensing with two thick brown wires from the two large output spades to the solenoid. This would give increased current carrying capacity and lower volt-drop now cars had electric cooling fans, offsetting the loss in voltage caused by the regulator sense terminal moving from the solenoid back to the alternator again, and despite the three wires is effectively a '2-wire' system. However JCR Supplies at one time showed this diode pack which is the 3-wire battery-sensing type, and I have seen the harness plug on a 78 which does match that with thick and standard brown wires rather than two thick. However they said it was for an 18ACR, which other sources indicate should be machine sensing. They also showed one with the two large spades i.e. the Euro plug, correctly described as machine sensing, but saying it is for 15/16/17ACR.

October 2014:



Click the thumbnail for details on converting between 4-wire, 3-wire and 2-wire alternators.

And to beat it to death, put a bullet in its brain, and hang, draw and quarter it, there are additional changes to the above in the Parts Catalogue:

- The original 16ACR as detailed above - part No. 37H 4194
- A different 16ACR in Jan 71 - 37H 6983
- The modified 16ACR as detailed above in March 72 - 37H 7503
- The 17ACR as detailed above in Feb 73 - 37H 7959
- A different 17ACR (no date) - 37H 8208
- An 18ACR (no date, but prior to September 76 and used to the end of production) - AAU1013

'Two browns' (what a terrible thought) wiring will cope equally well with both battery sensing and machine sensing alternators, but battery sensing alternators must have the 2nd brown wire, or at least a link in the harness plug between the + and B+, to operate correctly. In addition to the brown/yellow Indicator wire a friends 72 only has one brown (large), my 73 has one large and one smaller brown, and another friends 74 is the same, so those at least conform to the above. For completeness my 75 V8 (AC-Delco) uses the same plug, both large spades are output terminals, however only one is wired (as per the factory schematic) with a heavy gauge brown, the other is unused (and has allowed me to use it as a direct output to the cooling fan relay).

So some care needs to be taken to determine just which type of wiring, plug and alternator you have when making changes, even swapping alternators which take the same plug. If by looking at the two large spades on the alternator you can see they are clearly connected together, then you have a machine-sensing alternator and can use either or both large spades for the output. But if the two are clearly insulated from one another, then you have a battery sensing alternator. On these you must have a large gauge brown wire on the output spade at the very least, and a smaller gauge at least on the sense terminal. If in doubt as to which you have, it may be possible to determine by voltage measurement. Turn all the electrical loads on you possibly can, alternator plugged in, engine running at a fast idle, then connect a voltmeter between the two large spades. If you can measure any voltage between the two (may only be in the order of tenths of a volt) then you probably have a battery sensing alternator. If there is zero volts between the two large spades, then you probably have a machine sensing alternator. Or simply provide large gauge brown wires to both large spades to cover both eventualities, and get the benefit of a lower volt-drop under high-current conditions if you have a machine sensing alternator.

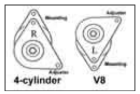
Tip: If you carry an alternator as a spare at any time, then it's a good idea to make sure it already has a pulley fitted. The large nut is very tight and makes it very difficult if not impossible to remove the pulley from a failed unit as there is no easy way of holding the rotor still (except perhaps by wrapping a fan-belt right round the pulley and gripping it firmly). If your spare alt has a pulley, then compare the size with what's on the car. If it's the same size then all well and good. If it's a different size then check now by trial-fitting that it is compatible with your fan-belt! And remember, if the pulley is smaller the alternator will rotate faster than normal, so you may want to limit engine revs a little to avoid over-revving the alternator. If it is larger then it will rotate slower, so you may find the engine needs to be revved a bit higher before it starts charging, will stop charging sooner as the revs fall, and it may not charge at idle. The charge voltage and current during normal driving will also be lower than usual, but if you keep the revs up and/or the electrical load down it should still charge well enough to get you where you are going.

Alternatives/Replacements *April 2021*

A friend of a friend had an alternator seize on his 72 MGB which burnt out the belt. We got a 'universal' 16/17/18ACR replacement rated at 55amps complete with fan and pulley which was about half the price of 'standard' types available from the usual sources. I compared the pulley against the original and it was very slightly smaller, which means it would spin faster for a given engine speed and so boost output, but not so fast that it would damage the alt. However when we came to fit it the belt would just not go on, even using the this tip to get tight belts on. The new belt was the same as the old i.e. a 10900 for CB and pre-77 RB. The alt body was sitting on the engine mount i.e. down as far as it would go, but there was still a good 1/2" of adjustment on the adjuster link that we could not use. In the end we had to remove the front bolt altogether and slacken the rear right off, and that allowed the alt to tip down and across just enough to get the belt in the alt pulley, and than into the fan pulley groove. Getting the front bolt back in was very marginal, and hardly any movement at the adjuster link was needed to get correct belt tension. I wondered about using the later 10950 belt, but felt that might be too long. Anyway it was on, so we tested it - firstly to make sure that the short period of running without a belt and hence no water pump which drive the temp gauge right up had done no damage, and then checked the output. 14.5v at a fast idle, and turning everything on that I could think of i.e. headlights, heater fan, wipers, brake lights, and holding the clutch down in reverse didn't drop the voltage at all. I was a bit bothered by how fast the temp gauge rose towards N, but once it reached there it stopped bang over the N, and stayed there on a short test drive and idling after our return. It's a long time I've seen that - both mine only get about 2/3rds the way from C to N, although the V8 is over N when the fans cut in. However the oil gauge only got as far as 20psi, and stayed there no matter what the engine was doing, and took a couple of seconds to start dropping when the engine was switched off, so I suspect that is a sticking needle in the mechanism. Subsequently asking on the MGOC forum two people said they had found the same thing with this type of alt and had to use the same technique to get the belt on. One of them had been offered a 10925 or a 10950 belt as an alternative to the 10900 but not surprisingly stayed with the original. So I suspect that because he was offered alternatives, the vendor knew there was an issue, and maybe the 10925 belt would be a better bet.

We scrapped a Metro years ago but I kept the alt which is an A115 45 amp. A direct replacement on the roadster, even though the pulley is slightly larger so rotates slower which reduces output, but the belt still fits, and it's good enough to carry as a 'get you home' spare. As it happens the roadster came to me with what looks like an A127 (metal end-plate instead of plastic on the 16/17/18 ACR and A115 types) of unknown output, which are available in 45, 55 and 65 amps with standard Euro plug spade terminals (as mine is), and 70 amps with stud output terminal. These are available from various Mini parts suppliers (including Moss), and given that the Metro item seems to be a direct replacement, these Mini items may be as well if you have additional loads and need a higher output. However given the availability of a universal 16/17/18ACR at 55 amps as recounted above maybe that is a better bet even at the cost of the faff with the belt, and it would be worth trying a 10925.

Whilst fitting the 55amp round at my pal's house his neighbour came round asking if we had any use for an 18ACR from his TVR days. Pal didn't want it so I had it, thinking I might be able to juggle things around and end up with a spare for the V8 as well. It's too long for the V8 which has the rocker cover immediately behind it - 5.5" as opposed to 4.6" of the AC/Delco. But it is a direct replacement for the shorter A127 the roadster came with so was fitted and tested and gives good output, and the A127 was trial-fitted and tested on the V8 so I now have a spare for that as well.



Whilst both alts are on the same - driver's - side of the engine 4-cylinder cars have the mounting ears on top and the adjuster link underneath, but the V8 is the other way round. This makes the V8 a 'left-hand' as opposed to the 'right-hand' of the roadster. But by removing three through-bolts you can rotate one half of the casing with respect to the other and perform a 'gender reassignment'. That needs the pulley and fan to be removed as the fan covers the heads of the bolts, which was where we came 'unstuck' with the 72 MGB above. Thinking we would need to transfer them over as some sources showed a 'bare' alt, but the pulley was stuck fast onto the shaft although the nut itself came off easily with a chatter-gun and one hand holding the old belt wrapped round the pulley. It did eventually come off, but not before a piece of the cast pulley broke off, meaning we had to get one with fan and pulley already fitted. The Woodruff key also took some shifting. But this nut came off with my air-gun and belt as before, and the pulley and fan just fell off and no provision for Woodruff key. After that altering the case was easy, and a trial-fit before refitting the fan and pulley showed that it was a goer, so refitted the original AC Delco. The belt has always been too long on that - right at the end of the adjuster link, and while it was off I noticed the part number was VS1138, indicating that it was 1138mm long instead of 1125mm as it should be. I have a note that I bought a spare on getting the car, fitted when the one that came with the car frayed (and pulled a coil wire off ...). At that time I bought a new 11125 which has been in the back ever since, so that went on now and is the correct size leaving a bit of adjustment left. So another 11125 bought as a carried spare, and the 1138 kept 'just in case' at home. Trial fit both to check the belt fits, it works, and the pulley is aligned correctly.

Ignition Warning Light (aka 'Idiot Light') and Charging Theory Schematics 

Faults
Change to LED?

Why 'Idiot' light? I don't know, but it seems to be an Americanism (that is, it's Americans that seem to use the term, not that Americans are idiots as one seemed to think I meant ...). The only thing I can think of is a point of view that says "Only an idiot would need a warning light telling them the ignition was on." Which shows a complete misunderstanding of the purpose of the light, so who's the idiot now? However someone else said that he has heard the oil warning light (provided in lieu of an oil pressure gauge) referred to as the 'idiot' light, because only idiots ignore it when it comes on then seize their engine. But another view has it that even idiots should be able to understand when a warning light comes on, whereas you need intelligence to understand a gauge. So maybe, in terms of the ignition warning light, only an idiot ignores it until the battery goes flat, and as Jochen Beyer has pointed out the ignition warning light also lets you know your fan-belt has broken before you boil your coolant out.

The ignition warning light always had two wires connected to it which must be insulated from earth as at various times one side receives 12v from the ignition switch and the other side 12v from the alternator or control box. Most of the other bulb holders on CB 4-cylinder cars only need one wire as they can pick up an earth from being plugged into to metal panel or instrument case. V8s and RB 4-cylinder cars have the other warning lights with two wires as well as they are fitted in plastic panels so need a wired earth.

The warning light is like a pair of balance scales between the ignition circuit and the charging circuit, and that is how it is connected - from the white of the ignition circuit, through the bulb, and to the dynamo/alternator via the brown/yellow. (Note that the lamp-holder is unique in that it has two wires - one to each side of the bulb - and the body of the holder should not be connected to earth like the panel and main-beam lamps are.) If both circuits have the same voltage then there is no potential difference across the bulb and it will not light. This is irrespective of whether there is 0v on both circuits (ignition off, engine stationary) or 12v (actually around 14v when charging) on both circuits (ignition switched on and engine running and charging). If the two circuits show a potential difference i.e. ignition switched on but engine stationary, or ignition switched on and engine running but **not** charging, then the lamp will light. This latter condition is a fault (and incidentally the main purpose of the light) which should be investigated before you get stranded. You may also note that when you switch off the ignition but while the engine is still spinning the ignition warning light glows again until the engine stops. This is because the charging system is still outputting while the engine is spinning down, so outputting 14v to the brown/yellow, but with the ignition off there is no longer any voltage on the white. By itself that wouldn't cause the warning light to glow, but as there are several other circuits also powered from the white, each with their own path to earth, current from the brown/yellow passes through the warning light bulb and these other circuits to their earths, and that is enough to make the light glow, until the charging system stops outputting. It is this feature that gives rise to the "won't switch off!" problem that can affect 1977 and later North American spec.

At the simplest level, a glowing warning light tells you that the ignition is switched on but the dynamo/alternator is not charging. It may be obvious that the dynamo/alternator isn't charging if you haven't even started the engine yet, but the beauty is that you can see the warning light itself is working. So if the engine **is** running and the charge **does** fail at some point, then you have a very good chance that the warning light will come on and tell you about it. On alternator-equipped cars the warning light acts as a priming system to start it charging from about 1000rpm. Without the warning it may need to be revved to several thousand rpm to start, and new alts out of the box may not do that. Dynamos are self-priming as below.

Faults: By which I mean not glowing when it should or glowing when it shouldn't.

- The former would be when it doesn't glow when you turn on the ignition. Could be a dead battery or cut-of switch turned off, so check to see if you have any other lights first and if not investigate that first. But if other lights are OK it could be a blown bulb (I don't think I have ever heard of that happening), a bad ignition switch or relay, a disconnection in the warning light circuit, or a faulty alternator including its plug fallen out. For the bulb all are relatively easy to get at with the exception of the 77 and later. If it won't start either then that is a separate line of enquiry that should be followed first. To check the continuity of the warning light circuit remove the alternator plug and with the ignition on, connect an earth to the brown/yellow spade in the plug. DO NOT CONNECT AN EARTH TO ANY BROWN SPADES or you will damage wiring. If the warning light glows then the alternator is faulty, as the 'earth' to light it with the ignition but the engine not started comes from there. If it doesn't glow then you need to check the bulb and the voltages at the bulb holder with the bulb removed. With the alternator plugged in, ignition on, engine not started there should be 12v on the white wire (centre contact) and Ov on the brown/yellow (bulb holder case). With the engine started and running there should be 12-14 volts on both connections.

- The latter would be when it is glowing with the engine stopped and the ignition keys in your hand. Unplug the alternator and if the light stays on the brown/yellow is shorting to a 12v supply supply i.e. brown or a purple, remove the purple fuse to check the latter, but this is unlikely. But if the warning light goes out with the alternator unplugged, and the engine stops as it should with the ignition switch then on an RHD 78 and later it is either a stuck ignition relay or a faulty alternator (with LHD 77 and later and RHD 77 a stuck ignition relay would keep the engine running with the ignition off). If the fuel and temp gauges are still registering then it is a stuck ignition relay, but if they have dropped then probably a faulty alternator. As alternators are not cheap to change on the off chance this can be confirmed by disconnecting the warning light circuit somewhere then testing the two halves of the circuit with the ignition off. For pre-77 cars this is probably easiest done by removing the bulb holder from the tach or dash, then removing the bulb, then testing for 12v on the brown/yellow connection and if you see it the alternator is faulty. For 77 and later it's probably easiest done where here are four white/brown and white wires in a 4-way bullet connector in the mass where the main, rear and gearbox harnesses join. Remove both of the white/brown wires that come out of the main harness and if one of them shows 12, which goes when the alternator plug is removed, then the alternator is faulty.

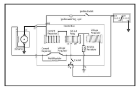
Change to LED? The short answer is no. As stated above the warning light on alternator-equipped cars is used as a primer to start it charging, using the current through the incandescent bulb. If changed to an LED the current is reduced to a fraction of its previous value and won't allow it to start charging at the normal point. The warning is also part of the on-board diagnostics, and current can flow in either direction under various conditions. An LED only glows with current flowing in one direction - unless you go to the bother of installing it with a full-wave bridge rectifier. Although this effect is not an issue with dynamos there is another aspect relating to the warning light acting like a pair of balance scales. It is inevitable that there will be some differences in voltage between the ignition supply and the dynamo/alternator output and this difference in voltage increases as the demand for current goes up i.e. lights, wipers, heater fan and so on are turned on. Because an incandescent bulb is relatively insensitive to small voltages it will not glow, unless there is a fault resulting in a bigger difference in voltage then there should be. But LEDs are much more sensitive to small voltages and will glow when incandescents wouldn't, including when there is no actual fault as such. Even some suppliers will tell you not to fit one in this position.

With the exception of RHD cars from 1977 on with the ignition relay, the white for the warning light always comes off the ignition switch. On RHD 1977 and later cars it comes off the output of the ignition relay which starts off white/brown, then changes to white at the multi-way plug behind the dash. See ignition schematics for more info.

On a dynamo system the warning light brown/yellow is connected to the dynamo output at the control box and hence has a low-resistance path to earth to light it when the ignition is turned on. The initial excitation for the dynamo field always comes from its own residual magnetism, which is why you have to 'flash' the field terminal to battery when you install a new dynamo or when you are converting from one polarity to another. **NEVER, I repeat, NEVER** flash an alternator's terminals to battery. This residual magnetism results in a dynamo output of a couple of volts, which is passed through low-resistance windings on the cut-out and current regulator relays in the control box to the field winding. This voltage now causes the dynamo to output its full voltage, which operates the cut-out relay to connect the dynamo output to the battery so charging it. The cut-out relay has a normally open contact which disconnects the dynamo when the engine is stopped, or the output voltage drops below a certain level. In fact it usually releases at idle, lighting or flickering the warning lamp. If this did not happen the battery would rapidly discharge through the dynamo, which would be acting like a motor trying to turn the engine. The cut-out relay has two windings, one of which ensures the relay releases as the voltage falls. **IMPORTANT NOTE:** If you manually operate the cut-out relay with the engine stopped it will latch in, connecting battery voltage to the dynamo, which will try to turn the engine. This passes a high current through the control box and dynamo **which will burn them out in quite a short time**.

Because it has connections to both the ignition supply and the alternator or control box the bulb holder is a special in that it always has two terminals which are insulated from the body of the bulb holder so cannot short to an earthed metal panel. Various other bulb holders also had two terminals at various times - Mk1 indicator tell-tales for the same reason as the ignition warning light, V8 and RB indicator tell-tales and main-beam warning lights as they are fitted to a plastic panel and so need a wired earth.

Dynamo Control Box *April 2013*

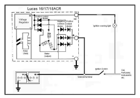


Click the thumbnail on the left for step-by-step information on how the control box does what it does. Considering its technology is so old its method of voltage and current regulation is really clever - a form of time-division multiplexing if you want to be technical. Basically when the battery voltage rises above a certain point the voltage regulator relay will operate. Its contacts (normally closed) open, introducing a resistance into the field circuit. This reduces the voltage at the field winding, which reduces the output voltage and current, and hence the charging current, allowing the battery voltage to fall back slightly. But it doesn't operate just once, oh dear me no, it is usually operating and releasing rapidly all the time unless the battery is significantly discharged. When the full dynamo voltage is connected to the battery, the battery voltage can't rise immediately, but takes a period of time. As it's voltage rises so does the voltage across the voltage regulator relay, which eventually operates. This reduces the dynamo current and voltage, but again the battery voltage can't drop instantly, but takes a period of time. It's only when battery voltage has dropped below a certain point that the voltage regulator relay releases again, so connecting full dynamo voltage and current to the battery again. The really clever bit is that when the battery needs charging it takes a relatively long time for its voltage to rise enough to operate the voltage regulator relay, and a relatively short time for the voltage regulator relay to release again. The result is a relatively high average charging current, to rapidly recharge the battery. As the battery becomes charged the time taken for the voltage regulator relay to release each time increases gradually, and the time taken for it to operate again reduces gradually, giving a lower average charging current over time. The average current as seen on a graph has a relatively steep rise initially when recharging starts, gradually flattening out as it approaches a horizontal 'fully charged' line (ranging from 14.9 to 15.v at 10C to 14.3 to 14.9v at 40C), until it just touches it, at which point just a trickle charge is being put into the battery. In practice, unless the battery is significantly discharged, the voltage regulator relay operates and releases very rapidly, this can be felt as a rapid vibration of the relay armature as it is lightly touched with a finger-tip, and a continuous electrical arc can be seen at the contacts.

The current regulator relay operates on a similar principle, but it only comes into play when the maximum design current of the dynamo is reached. The relay operates, introducing the same resistance into the field circuit, which again reduces the field voltage and hence the output current, to protect the dynamo against overheating and damage. This reduction in current causes the relay to release again, so giving full current, which causes the relay to operate again and so on, giving an average current over time as before. The system is designed such that this average current (19 to 22 amps) is the safe current for the dynamo. With large non-original electrical loads connected to the system it will be the current drawn by these that will cause the current regulator relay to operate to protect the dynamo. The loads are still connected of course, and so is the battery, and it will be the battery that will be supplying them then, at least partially, so gradually discharging it, even though the engine is running and the dynamo is operating correctly.

I've heard a claim from someone who studied the workings of the control box at college (many years ago!) that there is a weakness in the system in that if the battery is less than half charged the characteristics of the control box are such that the battery will never recharge, and you would have to recharge it using a charger before you could use it normally again. Personally I can't see it, the cut-out operates independently of the battery voltage, and even if that then tries to take so much current that the current regulator relay operates, the dynamo is still going to be delivering some voltage. As long as that is more than battery voltage then the battery will charge. Subsequently perusing the Lucas Fault Diagnosis Manual I found the statement that if a battery has been fully discharged, the on-board charging system will never put back more than half the original capacity, so I think that is where the 'half charged' thing comes from. Boost charging will be required to put back the full charge, and this applies to cars with alternators more so than dynamos as the regulated alternator voltage is less than the dynamo regulated voltage under most operating conditions. It's particularly relevant to cars equipped with electronic alarm systems, including modern cars, where these are used infrequently i.e. there is a constant trickle discharge from the battery.

Alternator operation



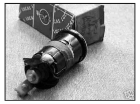
By contrast an alternator system takes much less explanation - unless you get into the theory of semiconductors! In an alternator the warning light brown/yellow connection is connected to the field windings, which because they are relatively low resistance and connected to earth, offers an earth-path to the bulb to light it when the ignition is turned on. So it is the warning light current through the bulb and the field windings which generates the initial excitation for the output windings. This generates an initial output voltage, which is fed back to the fields as well as the output terminal by a set of diodes, to give the full excitation voltage and hence the full output voltage. It is at this point that the bulb has full system voltage on both sides and therefore extinguishes, which is usually at about 900rpm. With the alternator charging, as the engine is slowed the alternator output voltage drops, and hence the field excitation current, until at about 600rpm charging suddenly stops and the warning light will glow.

From this it can be seen that the ignition warning light is necessary to give the alternator its initial excitation, and some schematics do show a resistor wired across the warning light to ensure that this initial excitation current is available even if the bulb has blown or is removed. However, I have never known of this resistor being provided in practice, and also in practice a used alternator has a little residual magnetism that is usually enough to 'kick-start' it into charging, although the engine may have to be revved to 2000 or 3000 rpm before this starts happening. Once it has started charging, it will charge normally i.e. down to about 600rpm as before, but then need to be revved to 2k or 3k again to start charging again. A new alternator just out of the box may not have this residual magnetism and so may not be able to kick-start itself, in which case the ignition warning light circuit is essential. **ON NO ACCOUNT** should you try to generate this magnetism by 'flashing' the alternator connections across the battery like you would polarise a dynamo, you may well blow the diodes or other electronics.

The voltage regulator is a sealed electronic module which constantly varies the voltage fed back to the field windings from the output, according to the voltage of the output - i.e. a closed-circuit feedback system. There is no current regulator circuit as such, the books say that the inherent design of the alternator is such that current is automatically self-regulating. This is possibly from the thickness of the output windings and hence their resistance (higher output units having thicker wires), that being all that is required as unlike a dynamo an alternator has its output windings attached to the case, hence no brushes or commutator to limit current. It does mean that an alternator naturally generates an alternating current in its

output windings (3-phase in fact), hence the requirement for a network of diodes to convert this to pulsed direct current at the output terminals and field windings.

Warning light resistor:



My Leyland Workshop Manual has a schematic of the 16AC alternator charging circuit which shows a resistor connected in parallel with the warning light, but none of the full schematics show this, and as far as I know one has never existed in practice. Apparently the RV8 schematic also shows one, but Nic Houslip has confirmed with one of the engineers that worked on the RV8 that it doesn't exist on that either. If you Google 'ignition warning light resistor' you get a lot of chatter about whether this resistor exists or not. One can see that with alternators if the warning light blows, then theoretically there is nothing to start the alternator charging (although as indicated above used alternators at least will start charging when revved to about 2k to 3k, then charge normally after that down to about 600 rpm). On cars with a dynamo and control box the warning light is purely an indicator, it has no priming function, as the residual magnetism in the dynamo makes it self-priming. A number of comments are incorrect, some say it should be in series and not in parallel, and some cause even more confusion by talking about the use of LEDs in place of incandescents (what on earth for?). But it does appear that there are schematics for marques other than MG that also include them, and for a lot more recent models, for example BMW seem to have started providing this resistor from 1987. An interesting one is Bud Krueger's MG TD site where he shows pictures (reproduced here) of what he believes are original warning light holders for his car, with a length of resistance wire wrapped around the holder of both the ignition and low fuel warning lights. However Bud tells me they are **in series** with the lamps to reduce the brightness. The TD has a dynamo which as I say above doesn't need the warning light to start charging, and a low-fuel warning circuit wouldn't require a bypass circuit in any event.

Testing Output:

Alternator Bench Test

Under normal circumstances, with minimal electrical load, you should have 14v to 15v on, say, the brown wires at your fusebox. As you switch on more and more electrical circuits you will take more and more current from the dynamo or alternator. As that approaches its maximum output current, the system voltage will start to drop, and when the system voltage drops to 12.5v you have reached the maximum capacity of your charging system. Any further increase in electrical load will reduce the system voltage below 12.3v, and some current will be taken from the battery. You can use this 'feature' - voltage dropping as current increases - to check the output of your charging system, either dynamo or alternator. You could put an ammeter in series with the dynamo or output wire, but most home-use multi-meters only go up to 10 amps which is less than half the output of a dynamo let alone that of an alternator, and connecting an ammeter to an alternator is not straightforward. It is easier to monitor the system voltage while gradually switching on more and more electrical circuits, and varying the engine speed, and seeing at what point the system voltage dips below 12.5 volts. Lighting circuits have stated wattages for all the bulbs which can be used to calculate current - add all the wattages together, then divide that by 12 volts to give amps. For example by turning on the parking lights of an MGB you can have four bulbs at the corners and four number plate bulbs all at 5 watts each and four 2.2 watt bulbs in the instruments, giving 48.8 watts in total, or 4 and a bit amps (North American cars with side markers have another four 5 watt bulbs or 1.7 amps). A pair of 45 watt dipped beams adds 7.5 amps, if you have a headlamp flasher and 60 watt main beams that will add another 10 amps. A pair of 21W brake lights will add 3.5 amps, as will a pair of reversing light bulbs, and all that totals 28 amps (30 amps for North America with side markers). A pair of 21W indicator bulbs adds 3.5 amps, and hazard lights with four 21w bulbs will add 7 amps, but of course these and the indicators will be flashing so their effect on the voltage will not be steady so making it difficult to read. However these can be added by bypassing the respective flashers to get a steady glow, and hence a steady effect on the voltage.

For dynamo-equipped cars i.e. with a 22 amp output capacity parking lights, dipped beams, brake lights, reversing lights and indicators take about 22 amps. For alternator-equipped cars these lighting circuits plus headlamp flasher and heater fan give 35 amps. On GTs the HRW adds about another 7 amps, although mine takes 9 amps as it is on a relay, and my V8 twin fans add another 10 amps. With all these there is more than enough load (54 amps) to overwhelm the 46 amp alternator. But don't expect to see the voltage drop below 12.5 volts at exactly the calculated load on your dynamo or alternator. Even if your circuits seem to be working well there are bound to be some unwanted resistances in switches and connections which will reduce the current taken by the circuits, which means you may be able to take more than the theoretical output of your dynamo or alternator and still be at more than 12.5 volts. However if the voltage drops below 12.5v at **less** than the theoretical figure, then either your dynamo/alternator is giving less output than it should or there are bad connections between it and the solenoid. So take another voltage measurement right at the dynamo control box 'B' terminal or alternator output terminal, and if that is more than about 0.5v higher then you have some resistance between the two measurement points which is limiting the maximum effective output.

The Workshop Manual quotes charge voltage for the dynamo at 3000rpm as follows:

10C/50F - 14.9 to 15.5v
20C/68F - 14.7 to 15.3v

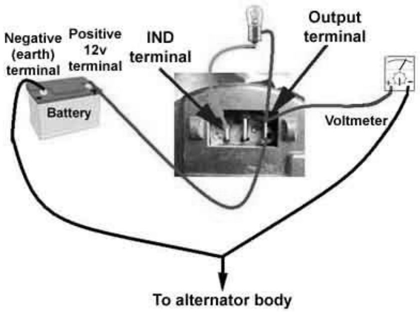
30C/86F - 14.5 to 15.1v
40C/104F - 14.3 to 14.9v

The variation with temperature is because the regulator is electro-mechanical and more susceptible to ambient temperature than electronic systems. You can do some simple tests on the dynamo here.

For the alternator it quotes 14.3 to 14.7v, the closer tolerance due to temperature-compensated electronics. However some suppliers of replacement voltage regulators quote 14 to 14.5v for their products, and another quotes 13.6 to 14.4v. I remember reading some time ago that Mercedes had started using higher voltages to protect against premature battery failure, as the lower the voltage the less capacity the charging system will be able to restore. Lucas states that a battery having lost just 25% of its charge will never be fully recharged by the vehicles charging system - even at the higher of the above voltages, and a battery that has gone completely flat will only regain 50% of its capacity from the vehicles charging system, both situations requiring an external charger at a higher voltage and current for maybe several hours. All this came about from a pal finding that his car took several seconds of cranking to start from cold normally, and he never got more than about 14.1v at the alternator terminals, even after a 30 mile run, even revving the engine, but after being on a conventional trickle charger it fires up straight away. He wondered whether his voltage regulator was faulty, which led to finding the above figures for replacements. However Bosch regulators are available in 14.2, 14.6 and 14.7v flavours, and maybe as high as 15v, and it would be interesting to see if there is a higher voltage Bosch unit that would fit a Lucas alt. There are about 30 Lucas voltage regulator part numbers just for the 16/17/18ACR, and almost as many Lucas equivalent numbers for each Bosch regulator. One would have to try and match each Lucas number with each Bosch Lucas equivalent - patience required! It had occurred to me that perhaps one could modify how the existing voltage regulator was connected and so 'encourage' it to output a higher voltage. A diode would be the obvious way, these have a forward volt-drop of about 0.5v regardless of current, and if connected correctly should result in an increase of 0.5v in the output. Whilst looking for higher voltage Bosch units I came across someone with a similar problem as my pal, and had done just that.

Alternator Bench Test: For an alternator this is quite easy, but you have to be careful with a dynamo as it is very easy to exceed its maximum voltage and cause an internal fault.

For the alternator all you need is a 12v supply, a small bulb to simulate the ignition warning light, a voltmeter, and something to spin it such as a drill.



12v goes to an output spade (usually one of two large spades on the 3-pin connector on all but the earliest alts) and to one side of the bulb. MAKE ABSOLUTELY SURE THE POLARITY IS CORRECT OR YOU WILL SERIOUSLY DAMAGE THE ALT. The other side of the bulb goes to the smallest of the three spades where the output plug goes. Earth goes to the body of the alternator. The meter goes between the 12v supply and earth.

My alternators all have a 22mm pulley nut, and a long bolt through that with the head and washer inside the socket, and a nut and washer on the back of the socket, means the bolt shank can be clamped in the drill chuck.

The bulb should be glowing, set the drill to spin the alternator clockwise as you look at the pulley, and increase the speed. At some point the bulb will suddenly dim right down (but not go completely out) and the voltage on the meter will step up from 12v to 14v+, which indicates the alternator is now charging.

Note 1: The engine typically has to be spinning at 900-1000 rpm to start the alternator charging normally, and the alternator is spinning quite a bit faster than that. With my mains drill, multi-speed Bosch, on the highest setting, two of my alternators need the drill to be at nearly maximum speed before they start, and another one does not start to charge. With that alternator on a car the warning light doesn't go out until the tach shows 1100rpm, so my drill probably isn't quite fast enough.

Note 2: Unless you have 12v connected to the output terminal of the alternator when you spin it, when it does start charging it can generate a high voltage of 30v or more. This is why alternator-equipped cars usually have a label warning that the engine must not be run without a battery connected. I have read of all the (powered) bulbs on a vehicle blowing when the battery became inadvertently disconnected.

Trickle-charge current:

I've also measured the charging current on what should be fully charged nearly new batteries. This was after a 30 mile run i.e. fully charged, still hot so after connecting the ammeter it restarted pretty-well instantly i.e. took very little out of the batteries. Switched off I removed the alternator plug and used a jumper wire with a female spade connector at one end and a male spade connector at the other to link the brown/yellow from the plug to the alternator. Then I connected the ammeter switched to its 10 amp scale between the brown in the plug and the output spade in the alternator. If you have an alternator with a metal back like my A127 instead of the plastic back like the 16/17/18ACR make absolutely sure the connection at the alternator end can't short to the case, also that the one in the plug can't short to anything, and they are secure i.e. do not fall off as the engine rocks on cranking. **Remember that with the engine running if either ammeter wire comes off its connection it is live and can cause damage if it shorts to earth. Also that even when switched off, with one side of the ammeter connected to the alternator plug, the other end of the ammeter is live.** On a hot start the alternator output went to 5 amps, then over a period of two or three minutes gradually reduced to 3.8 amps. It may well have gone slightly lower if I had left it longer. With everything else turned off the alternator is powering the ignition system as well as charging the battery, and with points ignition at least both ballasted and unballasted systems will take about 4 amps while the points are closed. However with the engine running they are taking that 4 amps for only about half the time, and zero current for the other half of the time, so the ignition is taking an average of about 2 amps as viewed on an analogue meter. So 3.8 amps minus 2 amps gives us a nominal battery trickle charge current of 1.8 amps. **Remember, if performing these tests take great care that neither ammeter connection can short to earth, regardless of whether the engine is running or switched off.**

Charging Faults:

August 2022: Helping Martin Ward in Fuerteventura with a charging problem where he needed a new alternator ... and it didn't work! Ignition warning light not coming on but earthing the brown/yellow at the alternator plug it did. More of a pain than usual as he had to pay international delivery charges and import duties post-Brexit, and was faced with having to bring it back as hold luggage. I said under the circumstances it was probably worth getting the end cover off and having a look as it could be a loose connection, sticking brushes or something simple like that. But he contacted the supplier (Beer of Houghton) who suggested rapping it with a hammer ... and it now works, so even easier and probably sticking brushes as suggested. Worth doing a charging check though now and occasionally for a while - should be about 14.5v idling with minimal load, and ideally still better than 13v with headlights, brake lights, heater fan and so on switched on at 2k rpm.

Ignition warning light doesn't glow when it should:
Your ignition warning light should always glow when you first turn on the ignition, before you have started the engine. If it doesn't, and at some point in the future your dynamo or alternator stops charging, you are unlikely to know about it until the car conks out and you are stranded. At which point you will probably blame Lucas instead of yourself.

- Check that with the ignition on (the engine needn't be running) you have 12v on the white at the warning light lamp-holder.
- Check that this 12v flows through the bulb and appears on the brown/yellow at the lamp-holder.
- Check that the body of the lamp-holder is not in contact with an earth when it is plugged into the tach.
- Check that the 12v reaches the control box/alternator on the brown/yellow (wire removed from control-box terminal or harness unplugged from alternator).

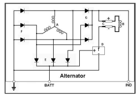
Ignition warning light doesn't glow, and I can't turn the engine off! *November 2013:* Ordinarily at this point I'd advise removing the wiring plug from the alternator, connect an earth to the brown/yellow (**NOT** a brown wire!!), turn the ignition on, and the warning lamp should light. However another scenario has recently presented itself which would make earthing the brown/yellow dangerous. Peter Burgess reported that they had a car in the workshop with a non-working ignition warning light, but also that they couldn't switch off the engine with the ignition key. My first thought for not being able to switch off was a sticking ignition relay, but they were only provided from 1977 and this was a 76. Second thought was that the ignition switch wasn't disconnecting power from the white, and a third possibility was a fault on the ignition ballast bypass circuit, having 12v on it from somewhere when the starter wasn't operating. None of those would have caused the non-functioning ignition warning light, but that could have been from a completely separate fault altogether. Subsequently Peter mentioned the warning light socket showed some heat damage, and when they wiggled the bulb it came on, and after that they could switch off the engine. The light now working could have been due to a loose bulb, but that wouldn't have prevented the engine from being switched off. And it would have to be a significantly higher powered bulb and working some of the time at least to cause heat damage. So I think the likely cause is the wires in the warning light bulb holder shorted together. That would prevent the light from working, and the 12v from the alternator on a running engine would be fed back onto the ignition white in full i.e. without the resistance of the bulb in circuit to limit the current, as if the ignition switch hadn't been turned off. Note this is a different scenario to North American spec cars with an ignition relay i.e. 1977 and later not switching off with the key, where the warning light works normally, which is covered here. Normally the resistance of the bulb is more than enough to reduce the current and voltage on the ignition system to well below what is required to power the ignition. This fault also puts an unrestricted 12v into the alternator via the brown/yellow, so could have damaged that as well. The higher current from the bulb being short-circuited, plus the short probably having some resistance, could well have developed enough heat to damage the holder.

So only earth the brown/yellow if the car switches off normally. If it doesn't, use another test 2.2w bulb to connect an earth to the brown/yellow. If the warning light is operating correctly both bulbs will glow at half brightness. If neither glow there is an open-circuit (which you should have found in the previous test). If the test bulb glows at full brightness, and the warning light not at all or only very dimly, the warning light wires are shorted together.

If you have got this far you should have found any faults in the warning light circuit itself. If the warning lamp glows when you earth the brown/yellow but doesn't glow when connected back up to the control box/alternator:

Dynamo: The warning light terminal is connected to the 'D' terminal on the control box, which has another brown/yellow to the output terminal on the dynamo. With both brown/yellow wires connected back up at the control box, earthing the brown/yellow at the dynamo should light the warning lamp. If this works, but the lamp doesn't light with the wire connected back up to the dynamo, then you have an internal disconnection in the dynamo - follow the circuit through the brushes and the commutator to the body of the dynamo.

Alternator: There may be a simple internal disconnection. If you know what you are doing it might be worth looking for it and trying to fix it, otherwise replace the alternator. But if you fancy a fiddle, some further diagnostics may help narrow the problem down.



The ignition warning light is lit when the ignition is switched on but the engine is stopped by 12v coming from the ignition switch, and an earth from the IND terminal on the alternator. This earth comes through the field winding and its slip-rings and brushes, from the field terminal of the voltage regulator. During normal running the voltage regulator varies the resistance of this earth, to vary the current through the field windings, which controls the output voltage of the alternator.

If there is a problem with the field winding or its slip rings and brushes, or with the voltage regulator itself, then that is almost certainly going to affect the output voltage of the alternator, especially as more electrical loads are switched on. Check the brushes for wear, and try cleaning the slip-rings.

But if the alternator seems able to maintain the correct system voltage with a range of electrical loads, but the warning light does not glow, then there is probably an internal break in the IND wire where it connects to the field circuit. Note that this fault may need the engine to be revved to 2k or 3k before it starts charging, but after that will charge normally down to about 600rpm. Another symptom of this fault is that with the ignition warning bulb unscrewed or unplugged from its holder at the dashboard, there will be little or no voltage on the IND terminal when there is the normal 14v or so on the brown at the fusebox with the engine running. With a fully working and charging system there should be the same voltage on both sides of the ignition warning light.

It glows when it shouldn't:
Typically this is "It glows all the time" or "It glows dimly at night".

It glows all the time:
This usually means the dynamo/alternator is not charging, although it could be a fault in the warning light circuit. Check the system voltage with the engine running at a fast idle.

- If you see at least 14v then the system is charging. Use "It doesn't glow when it should" above to check the warning light circuit, making sure it isn't earthing at any point and is connected to where it should be.
- If you only see 12v then the system isn't charging:

Dynamo: Test the dynamo by removing both connections and bridging the two spades on the dynamo. Connect a voltmeter between here and earth and start the engine DO NOT REV IT. Slowly increase the engine speed whilst watching the voltmeter. Do not allow the voltmeter to reach 20v, this should happen before the engine reaches 1000 rpm.

- If the voltmeter reads 0.5v to 1v then the field winding may be faulty.
- If the voltmeter reads 4 to 5 volts the armature winding may be faulty.
- If the correct voltage is obtained the control box may be faulty.

Control Box: The control box monitors the output voltage from the dynamo and when this has reached 12.7v to 13.3v the cut-out relay operates, closing its normally open contact, connecting the dynamo output to the battery. **DO NOT** manually operate the cut-out relay! It will latch in and connect power to the dynamo that will try to turn the engine. A high current will flow that will damage wiring and the dynamo. If you should happen to inadvertently manually operate it then you must prise the armature back, or carefully open the contact.

The other two relays are the current regulator to stop an excessive load damaging the dynamo, and a voltage regulator to stop overcharging the battery. Both work by opening a normally closed contact when they operate, introducing a series resistance into the field circuit, so reducing the excitation and hence the output current/voltage. In practice they do not open and stay open, they open and close very rapidly which you can feel as a buzzing if you rest a finger-tip on the armatures, and see a continuous blue spark between the contacts.

Alternator:

- Use "It doesn't glow when it should" above to check the warning light circuit, making sure it isn't earthing anywhere, and making sure it does get back to the alternator.
- Check the voltage on the thick brown(s) at the alternator plug (remove the cap but leave the plug plugged in). If this is also 12v then replace the alternator. If you see higher than this then a break in the thick brown between the alternator and where it picks up the battery cable is indicated. The thick brown connects to the battery cable either at the solenoid, or on the V8 at a copper stud under the toe board on the RHS.

It glows dimly at night:
Usually only relevant to alternators. If the warning light glows dimly at night, and increasingly brightly as the load is increased, then faulty alternator diodes are indicated. Open circuit diodes will cause a reduction in output, either voltage or maximum current, so the battery charging may not be immediately affected. Short-circuit diodes are more serious, usually resulting in a reduced charging voltage, and can cause noticeably increased levels of heat and/or noise in the alternator. It may be possible to replace the diode pack inside the alternator, alternatively replace the alternator.

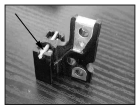
For heavens sake don't do what someone said and fit a diode to 'correct' i.e. hide this problem. If you do you may well have stopped the warning light from glowing dimly at night, but you have also stopped it telling you of complete charge failure. If you want to do that you might just as well unscrew and throw away the warning light bulb and save the hassle of fitting the diode!

However another cause can be bad connections in the white - ignition switch - brown circuit chain which causes a low voltage on the white side of the lamp.

Low voltage: *Update March 2010:*
Mike Polan has reported how low voltage from his alternator was caused by corrosion in the assembly and mounting bolts of the alternator. When charging he discovered that whilst the front of the alternator showed zero volts relative to the engine and body, the rear showed -2v! Cleaning up the assembly and mounting bolts, and the spacer and mounting ears, solved the problem. Incidentally using an ohmmeter with the engine stopped showed no resistances, a reminder that you should only ever use volt-drops in a circuit carrying its design current when looking for bad connections.

Alternator Brush Replacement *March 2013*

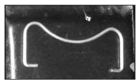
I'd noticed Vee's ignition warning light flickering occasionally and wondered whether that was a sign of worn brushes, having done 100k in my ownership and quite possibly over 200k. Rather than open up the alternator to discover that was indeed the case, then have to either put it all back together so I could use the car then take it apart again, or leave it out so the car would be unavailable which I don't like doing, I ordered a new set up front.



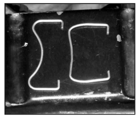
Quite easily done by removing the alternator from the engine and the end cover from the alternator, then the brush carrier from the body of the alt. As you remove this you will hear the brushes ping off the commutator, and wonder how you are going to get them on again. On the V8 AC Delco at least replacement brushes are supplied in a plastic housing, which has a retaining rod holding the brushes inside the housing, pressing back against the springs. You attach the housing to the carrier, and the carrier to the alternator body, and withdraw the rod through a hole in the carrier, and the brushes drop down onto the slip-rings. However. There is no way to grab hold of the end of the rod once the carrier is fitted, and the hole in it is too small for the rod anyway! So you have to replace the rod with a thinner, longer rod or wire at some point, pushing the end through the hole in the carrier, so once the carrier is fitted you can pull the wire out and release the brushes. Refitting old brushes is just the same, depress each brush in turn against its spring while you insert the retaining wire.

In the event the old brushes were hardly worn, but the slip-rings were a bit manky, so I cleaned them and the brush faces and refitted the old ones. Short-sighted having new ones to hand? Well, if the flickering continued it would indicate some other alternator problem, which might need replacement of the whole thing. In the event cleaning seems to have solved the problem, but it has made me wonder about fitting a voltmeter ...

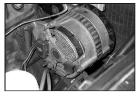
Alternator Harness Plug Clip *October 2014*



Simon Matthews asked about alternator connections on the MGs mailing list, and I responded. He wrote back directly to thank me and say he had sorted it out, and happened to mention that he had replaced the missing retaining clip as well. I suddenly realised that neither of mine have this clip, nor has a spare I took off a Metro years ago, but I do remember them from earlier cars. Did a bit of digging, and find it is 13H 8163 for the Lucas 16/17/18 ACR on the roadster, but nothing found for the AC Delco on the V8. Nothing shown in any of the usual suppliers, or anything useful Googling that part number, but Googling various descriptions I did find one as part of a repair kit from JCR Supplies. Contacted them and they sell them separately, so ordered two. But looking at my alternators the clips are of two different types. Perhaps not surprising given that one is Lucas and the other AC Delco, but ironically the clips I've ordered look like they will fit the Delco, but not the Lucas! That isn't an ACR but a later 1980s model, and the wire clips for that need the ends pointing outwards, whereas the ACRs and the Delco have them pointing inwards.



Whilst one of the clips fitted the Delco the plug top was further away than it obviously is in the ACR series, and the clip wouldn't fit over. But it also moved from side to side in the holes, i.e. the clip was wider than a Delco clip, so it was a relatively simple matter to move the bends to make the legs longer and closer together which allows the clip to fit over the plug top.



But the roadster alt is completely different, the 'feet' point outwards instead of inwards, then the upper part of the plug body is wider than the aperture in the rear case so the legs have to be bent outwards and then upwards again to fit round that, before the top part of the clip can go over the top of the plug. Those extra bends, plus the plug top being further away from the casing like on the Delco, mean the wire isn't long enough to modify. So I sketch the likely shape of the clip, and take a photo of the back of the alt, and send them off the JCR Supplies to see if they can tell me what it is, or ideally have a clip. They get back by return so say the alt is an A127, have located the correct clips and added them to their eBay shop - excellent service! Incidentally web sources indicate the A127 has anything from 35 to 120 amps output, potentially (ho ho) significantly more than the 34 amps of the original 16ACR, although 70 amps and over have an output stud instead of output spades.

Pulleys *August 2019*

The Leyland Parts Catalogue list pulley 12H1278 (in the engine section) for dynamo-equipped MGBs, as does Brown & Gammons, Moss lists 12G2102, and MGOC 12G1178 (not available). Sources indicate the 12G2102 is 3".

For the alternator the Parts Catalogue lists 12H2516 prior to the 77 model year and 13H9514 for 77 and later. Alternative part numbers for the former are given as AUE1238, BAU1461 and AEU1238 which various sources show as 2.5". No alternatives for the latter number but suppliers like Moss and Brown & Gammons do not differentiate between them. Some sites show 12G1054 at 2.75".

For the V8 the Parts Catalogue lists 37H8023, no Google hits for that, Brown & Gammons lists BHM7044 but NLA, no size found.

I didn't know how the above sources measure the size i.e. whether it is the bottom of the groove, the OD, or something in between, but subsequently to originally writing this section spotted in one of my Lucas catalogues a drawing showing it was simply the OD. The roadster has what seems to be a non-standard A127 so the pulley is an unknown quantity, and that measures 2.406" OD and 2.41" on a wrapped belt. Someone else has said theirs (original Lucas as far as they know) measures 2.875" OD. The V8 (original AC/Delco as far as I know) measures 2.96" overall diameter and 2.595" on a wrapped belt so a big difference between measure diameter and running diameter. An old alt from a Metro which I have as a spare for the roadster has a pulley of 2.7" OD and a wrapped belt is the same. OD is not good measure as the flanges can be anywhere from flush with the belt (as on the Metro alt) to several mm above it (as on the V8) and not have any effect on rotational speed.

The pulley size determines how fast the rotor spins for a given engine speed, and as there is a maximum rotational speed for both dynamos and alternators the pulley size is chosen to suit the maximum engine rpm. I can't see a speed given for the dynamo but the WSM specifies 12500rpm for both the 16AC and the 16ACR and 15,000rpm for the 18ACR. The crank pulley size also has a direct effect on dynamo/alternator rpm at a given engine rpm. An alternator is said to spin safely up to 18,000 rpm and a 2:1 ratio of alternator speed to engine speed is often quoted, which would be safe up to 9000 engine rpm (6250 or 7500 in the case of MGB alts). The maximum for a dynamo is typically 1/2 to 1/3rd of the alternator due to its construction. A dynamo rotor has heavy output windings as well as the commutator carrying output current, with the segments constantly connecting and disconnecting that current. The alternator has a much stronger rotor carrying lighter, lower current field windings, and slip-rings carrying that current as a constant flow. For that reason the pulleys for a given engine will be larger for a dynamo (to give a lower dynamo rpm) than the alternator, i.e. 3" as opposed to 2.5" or 2.75" for an alternator. Dynamo and early alternator engines used the same pulley. The oddity is that the V8, with a slightly lower revving engine, has a larger (as measured) pulley, despite having a significantly greater electrical load from its twin cooling fans and HRW, when 1977 and later 4-cylinder cars that had a single cooling fan got the smaller (higher output) 2.5" pulley in place of the 2.75". But then the V8 has a 6" pulley compared to the 5" of the roadster. I.e. 20% bigger, which would imply a 20% bigger alt pulley for the same maximum alt rpm, which would be 3". 2.96" as measured would be logical for the slightly lower maximum rpm of the engine, but the fly in that ointment is that the V8 belt sits well down in the Vee of the pulley and gives an effective diameter of 2.56", so the V8 alt at maximum revs is spinning some 20% faster than even the smaller 2.5" roadster pulley. The old Metro alternator with its 2.7" OD pulley gives noticeably less output than the 2.44" (measured, 2.2" effective) A127 on the roadster.

Converting Dynamo to Alternator

Schematic 

Probably the main reason for converting is to get a higher charging current as the dynamo is limited to 22 amps. Although this is usually adequate for most normal, and particularly 'classic' use, when stuck in traffic with headlights, heater fan etc. on the charge will almost certainly not be adequate which means you will be discharging the battery and on a daily driver this can rapidly reduce the battery to a point where it will no longer start the car. Bad connections will limit current flow,

and will contribute to a drop in system and charging voltage, and I think it is this which people are seeing as much as insufficient output from the alternator. Even 'normal' volt-drops up from the solenoid and particularly with a voltmeter on the green circuit can be enough to reduce the indicated voltage below 12.5v, even though the voltage at the solenoid and hence the battery is above this critical point. A good example of a little knowledge being dangerous. Of course if you are going to significantly increase the electrical load then you may well need to consider an even higher rated alternator from another source.

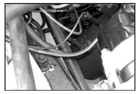
One common misconception seems to be that fitting a higher rated alternator is automatically going to push more current through the wiring, and people get paranoid about uprating it. The maximum current that will flow depends (to the largest extent) on the electrical **load**, not the maximum capacity of the alternator fitted. If you only have 40 amps of load then only 40 amps of current will flow, even with a 60 amp, 80 amp or 100 amp alternator fitted. Having said that high-rated alternators like the 80 and 100 amp **will** be better at maintaining sufficient charge at idle if you have added electrical loads, as well as when running.

About the first thing to say about the process of converting from dynamo to alternator is that unless it has already been done you almost certainly will have to convert from positive earth to negative earth. Positive earth alternators will probably be very difficult if not impossible to find, a negative earth will be tricky to convert to positive, and the availability of used, rebuilt and new negative earth alternators of various types is almost infinite. Also it might be safer to take things one step at a time and do the polarity conversion first, check everything works OK, and only then do the alternator conversion. Getting the polarity wrong with an alternator connected will probably destroy it, and there is only one very simple step which will be 'wasted'. These notes only cover use of a Lucas alternator, there are too many variations in Bosch and GM Delco alternator connections, although the alternators themselves are quite suitable for use.

March 2013: As well as a suitable alternator you will also need an extended bracket to connect the rear mounting point of the shorter alternator to the original mounting points on the block. Unless this is done rigidly vibration can fracture the front mounting ear on the water pump, so extending the existing bracket in some way is not a good idea. Fortunately a number of places sell a suitable bracket - 12G1053, such as Motaclan/Leacy, Brown & Gammons, and Sussex Classic Car.

The usual advice is before starting any of the following work disconnect the battery earth strap first, and only replace it as the final step. However on cars with the remote solenoid it is very easy to remove the brown wire from the spade on the battery cable terminal on the solenoid, and as long as this can't drift back towards its spade while you are doing the work then this is fine.

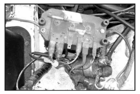
Rewritten November 2012 (following the opportunity to work on Chris Mottram's car):



The dynamo circuit originally had a standard gauge brown/green (field) wire, and a thicker gauge brown/yellow (output) wire. Because of this it's best to use the thicker brown/yellow wire for the output of the alternator, even though this goes against the convention on cars equipped with an alternator from the factory. Therefore the brown/green is used for the INDicator wire, this is method 1.

There is an alternative method if you are adding a lot of significant loads to the cars electrics, and consequently fitting a high-power alternator, and that is method 2.

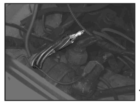
Method 1:



You can leave the control box in-situ and hence use it's spades for interconnecting most of the wires. But you must cut off the small spade from the brown/green and fit a large spade so it can be moved from the F terminal to the D terminal in place of the thick brown/yellow. The displaced brown/yellow then has to have its large spade cut off and be connected in some way to the brown circuit. The method used with a conversion kit from a well-known supplier is a ScotchLok connector, but these have a habit of working loose over time and are not a good idea on things like the alternator output cable which will carry quite a high current, and the slightest resistance will cause significant heat to develop as well as reduce the output of your shiny new alternator. You could instead use a ring terminal of the appropriate size and add it to the solenoid terminal that carries the battery cable. That would give a good connection, **but you MUST disconnect the battery earth cable before working on this terminal**. However in both cases you would need to extend the brown/yellow, which has its own problems as to what method to use. I suggest it's better to bite the bullet and remove the control box altogether, make proper soldered joints, and give better access to other components into the bargain.

Remove all the wires from the control box, and the control box from the panel on the inner wing (easier said than done with those fiddly nuts behind the panel!). The standard gauge brown/yellow from the WL terminal, and the standard gauge brown/green from the F terminal have their spades cut off, a portion of insulation carefully stripped so no strands are cut, twisted together, and soldered. Put a couple of lengths of heat-shrink tubing just over the soldered section, each about 1/4" longer than the soldered joint, heat-shrinking them one at a time. Then fold the 'spare' bit of tubing over, and fit a couple of lengths of larger diameter tubing over that and an inch or so of the insulation on the wires. This circuit supplies the 'priming' voltage to the alternator to start it charging, and indicate charge failure.

The three original browns from the B terminals on the control box, and the thick brown/yellow that came from the D terminal, are dealt with in much the same way. Cut all the spades off, making the four wires the same length, and strip



about half an inch of insulation from each, being careful not to cut through any strands. Check the conductors are clean, using fine emery if tarnished. Twisting four, heavy gauge wires together is not really advisable, so I used the method adopted by the harness manufacture for the sealed, multi-way junctions that exist on some of the MGB harnesses. First I put a short piece of heat-shrink over the **insulation** of all four wires to keep them together. Then I got a strand of tinned copper wire and wrapped it round the four conductors, for the length of the stripped section, to make a good mechanical joint, only then did I solder the joint. As before a couple of lengths of heat-shrink about a 1/4" longer than the soldered joint are fitted over the soldered part, then the 'spare' bit at the end is folded over, and a couple of pieces of larger diameter heat-shrink fitted over that and an inch or so of insulation, as with the previous two wires.

Finally that leaves the earth wire from the control-box. It's best not to leave this floating around, but rather than cut the spade off I folded it over and again used heat-shrink to insulate it. That leaves three heat-shrunk spurs sticking out of the main harness at various angles, but a cable-tie can be used to attach those out of the way against the panel the control-box came from.

Method 2 is very similar but to carry higher currents, if you are adding significantly to the cars electrical load and hence using a high-output alternator, it would be best to use a new heavy gauge (of the appropriate size for your loads) brown wire from the output of the alternator to the battery cable stud on the solenoid at least. You may also need to use similar gauge wire from there to your non-standard, high power loads, the brown from the spade on the solenoid going to the control-box should be enough for all the factory loads. **Again, you MUST remove the battery earth connection before starting work on the battery cable stud on the solenoid**. After that you can leave the browns on the control-box B terminals, and the brown/yellows on the WL and D terminals, using the heavy gauge brown/yellow at the alternator for its INDicator terminal. The standard gauge brown/green should be removed from the control-box F terminal and its spades taped back and insulated at both ends to prevent them coming into contact with anything else. Alternatively you can discard the control box and join the three browns from the B terminals, and join the two brown/yellows, and insulate the earth wire, using the techniques described above.

If converting the polarity at the same time leave the alternator unplugged when connecting the batteries the new way round for the first time, if you get it wrong and the alternator is connected you will blow its diodes and burn wiring. Confirm the polarity is correct before continuing by connecting a voltmeter between a brown in the alternator plug (meter +ve) and an engine earth (meter -ve).

After confirming that the polarity is correct connect an analogue voltmeter (digital meters may give unpredictable results) on its 12v scale in place of the battery earth strap. There should no voltage registered. If there is, it will probably be a full 12v, and means some circuit on the car is switched on (courtesy lights? Boot light?) which should be found and switched off before proceeding. When no voltage is shown plug in the alternator. You may now see a few volts registered, which will be the normal microscopic leakage current of the diodes and can be ignored. If a full 12v is shown the alternator diodes are faulty. If the reading is correct, replace the battery earth strap. If you don't have an analogue meter use a low-wattage 12v bulb instead, such as one from one of the gauges. If there is any glow at all from the bulb, current is flowing, proceed as above. Only a significant current flow will cause the bulb to glow, connecting the alternator should not be enough.

You now have the alternative of going for broke and reconnecting the battery earth strap, or taking a smaller step. For this connect a **high** wattage bulb e.g. a headlamp bulb (e.g. an old one with one filament gone - "If you haven't found a use for something yet ...") in place of the earth strap. This will allow a safe amount of current to flow while you turn each thing on in turn. If any circuit is faulty and is full short the bulb will limit the current and prevent damage to wiring and components. Some things (low current items) will work almost normally, higher current items probably not. Low current items might cause a dim glow from the bulb, higher current items a brighter glow. Only turning the key to crank (nothing will happen) should cause the bulb to glow at full brightness, nothing else. When you are happy, reconnect the battery earth strap.

With the ignition off there should be no glow from the ignition warning light. A glow now indicates faulty alternator diodes or voltage regulator, or incorrect connections to it.

With the ignition on the warning light should glow. If no glow remove the plug from the alternator and connect an earth to the brown/yellow terminal (**NOT** the brown!). If the warning light glows now the alternator is faulty if not then the circuit is broken back towards the warning light, possibly where the brown/yellows are joined where the control box was, or a blown bulb. There should be 12v on the white at the bulb holder and an earth on the brown/yellow to light the bulb.

With the warning light glowing start the car, and with the engine revved above 1000 rpm the light should go out. If the light remains on the alternator is faulty. Only if the revs drop below about 600rpm should the light come back on, stay off till about 1000 rpm, then go out again as before. Early cars had an idle speed of 500 rpm and if the light comes on at idle, particularly with lots of load switched on, then you would be advised to increase the idle speed to, say, 700 rpm to keep the light out at all times. While the light is on the alternator isn't charging and the battery is discharging, which largely negates the effort of converting!

With the engine at about 1000 rpm, and all loads switched off (and the warning light off), measure the voltage between the brown at the fusebox and earth. You should see about 14.5v, much less or more than this indicates a faulty alternator. Now turn on headlights, brake lights, heater fan etc. The voltage will probably drop, possibly to less than 13v with one of the smaller Lucas alternators. Increase the revs to about 3500 and the voltage should rise above 13v again, indicating the battery is still being charged even with everything switched on. If the voltage doesn't rise above 12.5v check the voltage at the alternator output terminal(s), and if similarly low here it indicates the alternator has a low output current fault, however note that the smaller Lucas alternators will probably not be able to supply anything above the standard factory loads at best. If the voltage is closer to 14v at the alternator then there is a bad connection somewhere between the alternator and the brown at the fusebox, check the voltage on each brown wire and the battery cable at the solenoid.

Converting 16AC Alternator with Separate Regulator to Later Alternator with Integral Regulator *Added October 2007*

Schematic 

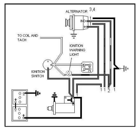
First remove the battery earth strap, and don't replace it until you have made all the wiring changes.

The alternator should have the following wires:

Heavy gauge brown (output) going to the solenoid
Black (earth/ground)
Brown/yellow (Indicator) coming from the voltage regulator
Brown/green (field) coming from the voltage regulator

The voltage regulator should have the following wires:

Black (earth/ground)
Brown (12v supply to the voltage regulator) coming from the solenoid
Brown/green (field) going to the alternator
Brown/yellow (Indicator) going the alternator
Brown/black (Indicator) coming from the ignition warning light



These last two (brown/yellow and brown/black) are probably the most important. They are electrically connected together at the voltage regulator, and they must remain connected together and isolated from everything else after the conversion, so that effectively the Ind terminal on the new alternator is connected to the warning light. As well as lighting the warning light, the current flowing through the warning light to the alternator acts as a 'pump primer' and is needed to get the alternator to start charging. If both wires are in the same spade connector then all you have to do is securely insulate that connector so it cannot come into contact with anything else. If they have two separate spade connectors then these should be cut off, the wires twisted and soldered together, and the joint insulated with at least two layers of heat-shrink tubing (slip these on before twisting and soldering!).

Of the other wires the heavy gauge brown goes to the output terminal of the new alternator (See here for Lucas 16/17/18ACR terminals) and remains on the solenoid.

The two black wires and two brown/green wires at the alternator and old voltage regulator are no longer required and should be taped back out of the way of anything else.

Note that the earthing point to the body for the black wires from the regulator and alternator is also the earthing point for four other wires (heater fan, instruments, wipers and headlights), even if the regulator and alternator earth wires are removed the other four wires **must** still be earthed, you will get some very strange results without it.

That should leave the brown going from the voltage regulator to the solenoid, and this is also no longer required. If the two standard gauge wires at the solenoid (there should only be two apart from the large battery cable and the heavy gauge brown from the alternator) have separate spade connectors it should be easy to determine with an ohmmeter which goes to the voltage regulator and which to the fusebox. The one going to the fusebox must remain connected, but the one going to the old voltage regulator can be taped back both ends. But if these two brown wires terminate in the same spade connector then you have a 50/50 chance of cutting the right wire off. You could cut one wire off and then test, and if you have cut the wrong wire reterminate it on a new spade connector and tape the other one back, or cut both off and test and then reterminate the wire going to the fusebox, taping the other one back. But the best thing to do would be to cut both wires from the existing spade connector, identify the one going to the old voltage regulator and tape that back both ends, then for the other wire that goes to the fusebox reterminate that on a ring connector that will go on the stud with the battery cable. This makes a more secure connection than the spades, as all the current for the cars electrics goes through it. While you are doing that you can do the same with the output cable from the alternator, for the same reason. Later starters did have all the browns terminated with ring connectors on the battery cable stud as standard.

With all the wiring changes done, the new alternator mounted but the brown and brown/yellow not yet connected (make sure they can't short out on anything), and everything in the car switched off including doors etc. closed so the courtesy lights aren't on, check to make sure you haven't shorted any of the brown wires to earth/ground. The safest way to do this is to connect a voltmeter on its **12v scale** in place of the battery earth strap. If the voltmeter shows any reading at all, there is something drawing current. Anything less that 12v shown is a tiny current, could be a clock or the 'keep alive' circuit of a radio. If it shows a full 12v it could be a small current e.g. something simple like a courtesy light left on, or it could be a full short. Connect a test-lamp or other 12v bulb (an old headlamp bulb is best) in place of the earth strap, and if it glows brightly it is a full short which must be investigated and fixed before you proceed.

A cruder check is to tap the battery earth strap very briefly on the -ve post of the battery. You should not get any kind of a spark. If you get a small spark maybe one of the courtesy lights or similar is still on. If you get a big flash then it looks like one of the browns is shorting to earth somewhere, which again must be investigated and fixed before you proceed.

With the brown at the alternator still not connected and protected from shorting to anything, and with the battery earth strap reconnected, connect the brown/yellow to one of the standard sized spades and turn on the ignition. If the warning light glows you can proceed. If it doesn't then turn off the ignition, move the brown/yellow to the other standard sized spade and try again. If the warning light glows now again you can proceed. If not, disconnect the brown/yellow from the alternator and connect an earth to instead end and try again. If the light glows now then possibly the alternator is faulty, or possibly the wire should go to yet another spade if you have non-Lucas alternator. If the light **doesn't** glow with the earth connected however, then either there is a problem where the brown/yellow joins the brown/black, or the bulb has failed, or there is some other open-circuit between the end of the wire at the alternator and where the white from the bulb joins the others at the ignition switch. This must be found and fixed before you proceed, or the new alternator probably won't charge.

With the bulb glowing with the ignition on, carefully connect the heavy gauge brown to the output spade, remembering it is live and unfused. You may prefer to disconnect the battery earth strap again while you attach the brown output wire, then go through the same tests for a short as before. With other types of alternator there can be different connection arrangements, some have an output stud as well as an output spade, use the stud as it will have a better current carrying capacity.

With both output and indicator wires connected to the alternator, start the engine revving it as little as possible, and watch the warning light. The warning light may still be glowing, so slowly raise the revs, and at about 900 rpm the light should go out. Now use a volt-meter on the brown at the fusebox and you should see around 14v. If so the new alternator is charging. With the engine idling turn on the lights, press the brake pedal, switch on any other electrical loads you can, and the voltage will drop to some extent, possibly towards 12v. Rev the engine to about 3k and the voltage should rise again above 12.5v. With everything turned off, and a fully charged battery, and the engine revved to about 3k, you should see a maximum of about 14.5v. With the engine idling again select 4th gear, handbrake and footbrake on, and slowly lift the clutch pedal up so the revs start to drop. The warning light should come on again at about 600 rpm. Dip the clutch again and take it out of gear, slowly raise the revs again and the light should go out again at about 900 rpm. If your normal idle causes the warning light to come on again anyway, it might be an idea to raise the revs a bit so it stays out, that way the alternator will still be charging at idle, rather than the electrical loads of the car draining the battery.

If the light doesn't go out when revved, and you have two standard sized spades on the alternator, switch off, and move the brown/yellow to the other standard spade. Turn on the ignition and if the light glows start up and try the tests above again. If the warning light doesn't go out when the engine is revved, with the brown/yellow on any of the standard sized spades that it glows on with the ignition on, or the voltages don't show as above, then possibly the alternator is faulty.

'One-wire' Alternators *Added January 2010*

Some confusion over these. Some people use this term to describe 'one output wire' alternators i.e. where there is also an excitation wire, as compared to the 3, 4 and 5 wire alternators used on MGBs at various times. Others think that any alternator with internal voltage regulation is a 1-wire alternator - very few are. On the other hand there really are one-wire alternators that do not have an excitation or ignition wire, just a single heavy gauge wire from the output terminal to the battery or starter solenoid. These still need excitation, and it is achieved by having some device that either senses rotation, or senses a drop in battery voltage i.e. cranking. In both cases it then internally connects the output wire (which has 12v from the battery) to the field circuit to commence charging. In the former case it can need revving up to 1200rpm before charging commences, and in the latter it triggers before the engine is turning fast enough to charge, or even when simply turning a light on. In this latter case it will be discharging the battery until it senses that the alternator isn't going to charge any time soon so disconnects again. Not only do these alternators cost more, they also have extra things to go wrong. Hot-rodders with an engine bay stripped of every possible thing like them, but for the rest of us they aren't really relevant, and if you don't mind revving your engine soon after starting you can actually use a conventional alt without the warning light wire connected, previously used examples of which will start charging when revved to 2k or so. If you really are going to use a one-wire, i.e. without a warning light, then you are going to need a voltmeter ... which rather negates the loss of a couple of inches of visible wire from the harness wrapping to the plug in the engine bay!

Batteries and Chargers

Safety First!

It is absolutely vital that batteries are securely clamped into their cradles. Many who switch to a single 12v, or fit battery boxes, seem to leave the batteries unsecured. Although it is an MOT requirement to have a secured battery the tester is not allowed to 'dismantle' any part of the car so unless he looks up into the cradle and prods the battery to see if it moves they are unlikely to spot an unsecured one. Roger Parker formerly of the West Midland Police motorway patrol unit has seen the effects of an unsecured battery and recounts the following:

> The (car) was totally destroyed following an accident on my section of the motorway. Unfortunately the driver died in horrifying circumstances which I believe to have been avoidable. I can now relate the circumstances as the inquest has recently been closed as I feel there are important lessons to be noted.
>
> What happened was the car was travelling along the M6 at about 4am when, for reasons unknown, the vehicle left the road on the nearside and took out a traffic sign. The impact caused very severe damage to the underside of the car as the concrete base to the sign was at cross-member height. This impact also took out the fuel pipes. Now as we all know the electric fuel pump keeps on pumping until the electricity supply is cut. With the electrical circuits still open after the crash this is exactly what happened consequently soaking the underside of the car, which after the crash had come to rest on its offside. The driver had suffered serious but not fatal injuries - MGBs are strong cars - but however he was trapped by one leg.
>
> When a passing motorist stopped shortly after the accident, he saw the driver was trapped and able to talk to him as he was conscious. At this time poor maintenance in the battery compartment then contributed to subsequent events. The battery was not of the correct size and was only resting on the battery tray - it was not secured. In the extreme circumstances of the heavy impact, the battery was able to move and short out on the metal body of the car because of the lack of secure fixings. Now remember the petrol pump was still running and pumping fuel out of the fractured fuel lines and tragically the arcing between the battery and metal body ignited the petrol vapour.
>
> Now I do not have to go into the details but suffice to say the death of a conscious person by burning is one of the worst fates you could imagine and I have had the unfortunate experience of witnessing three such deaths in my service.
>
> **The moral is clear - secure your batteries properly** (gravity is not enough!) and if possible fit an inertia switch as found on the current MG Efi models which would cut the power off from the fuel pump in events of a violent nature. Together these precautions would have prevented the death of this driver. Enough said. Incidentally the fire was so intense that most metal items in the area of the seat of the fire actually melted - including a whole spare wheel.

Securing the batteries:

- MGB batteries were always held down with a strip of angled metal as a retaining bar along one edge of the battery (plastic packing strip to clamp deleted in December 1977), and two hooked rods down from that to holes in the cradle, secured with double-nuts (GHF200) above the retaining bar. The batteries sit on rubber buffer strips (AHH6351) along the front and rear angles of the cradle base.
- CB cars have the retaining bar (AHH6353), with a strip of plastic packing (AHH5169) underneath, along the rear edges of the batteries. The rods (AHH6750) run down and forwards with hooks going through holes in the sides of the cradle. Care needs to be taken with the positioning of the retaining bars and battery connectors as with posts in diagonally opposite corners one of them on each battery will always be very close to the retaining bar. No problem with the earth terminal, but the other three are all 'live'. Originally there was an option of a larger battery that required a rectangular frame (AHH7109 - NLA) to sit on top of the battery and be clamped down by the rods.
- RB cars have the retaining bar (34G2065) and packing (37H3743) running fore and aft along one long side of the battery. 12v batteries have the terminals along one long side, and are normally positioned to put the -ve terminal towards the rear of the car. This means the terminals can be nearer the tunnel (Type 072) or nearer the off-side of the car (Type 075) depending on which type of battery you get, and the norm is to have the posts nearer the tunnel. The retaining bar goes on the opposite long side of the battery to the posts, i.e. normally towards the off-side of the car. The rods (BHH1586) run down almost vertically to one pair of two sets of holes in the angled flanges that form the base of the cradle. In theory the rods could be angled across the short sides of the battery to the other pair of holes, but they would need to be longer, and the ends of the retaining bar would also need to be at an angle to the rest of it, as they are on CB retainers, but RB retainers are the same shape all along. Physical battery size can impact on the security of the retainer unless the rods are angled.
- The physical size of both 12v batteries and 6v batteries can vary, and with the smaller ones you should make sure that the base is fully supported by the front and rear angles of the cradle base. My latest set of 6v are slightly smaller than those I've had before and I've had to add a strip of metal to the rear angle of the base to support the battery properly. With 12v batteries and the rods going straight down there is the additional problem that on a smaller battery they will be angled away from the battery when in the holes, which will pull the retaining bar off the battery. I've had to add some packing between the other side of the battery and the side of the cradle to move the battery further across. Yet another problem is where the battery is shorter top to bottom than the rods can accommodate, and you run out of threads. Many years ago I had to bend new 6v rods into an S-shape to take up excess length, and put thicker packing on top of the 12v battery. The latest 6v batteries are even shorter but I have dies now so have been able to cut more thread.
- Fitting the retainers can be a fiddle. I put the rods in the retaining bars with one nut started, then fit the assembly over the battery. By twiddling the upper end of the rods you can turn the hooks towards the holes and hook them through. The trick is to have the nuts on far enough so that the hook only just goes through, then tighten that a few more turns so it can't come out, while you fit the other rod in the same way. Slide the plastic packing under at that point, before tightening the first nuts and adding the second nuts, tightening the two against each either to lock them without applying too much pressure to the case. The irony is that this process is much easier with smaller batteries than larger as you can get your fingers down the sides more easily!

! When doing any work involving any battery terminal, or the battery cable at the starter solenoid, or any 'always live' wiring such as brown wires, **always remove the earth/ground cable from its battery post first and replace it last. This is regardless of whether the car is negative earth/ground or positive earth/ground, twin 6v batteries or single 12v.** Many sources of automotive information say to always remove the negative connection first before the positive, but they are only thinking of 'modern' cars, not classics. I repeat, always remove the earth connection first and replace it last, regardless of polarity, and that applies to all cars i.e. moderns as well as classics. The reason for this is that if your spanner should happen to touch the body whilst it is also touching the earth/ground post of the battery nothing will happen. Once the earth/ground connection is removed it is now safe to undo the 12v (aka 'hot' or 'live') connection, because if your spanner should happen to touch the body while it is on the 12v post still nothing will happen because the earth/ground connection has already been removed. **If you remove the 12v connection first and the spanner touches the body whilst doing so, you will generate a large spark which can ignite any battery gases that may be present, or maybe even cause the battery to explode in your face!** So it's always **earth** cable off first, and back on last, regardless of polarity.

! Car batteries contain a large amount of energy and can discharge it very rapidly under the wrong conditions, generating large sparks, toxic fumes, even exploding and showering corrosive liquid around. Not all batteries have polarity markings, on classic cars battery cables are not usually colour-coded for polarity, and the battery terminals and connectors do not usually have insulating covers. Great care must be taken to ensure the 'live' or 12 volt terminal does not accidentally contact the car body or a large spark can be generated which can ignite battery gases, and tools or other metal parts can become welded and glow red-hot.

! Many MGBs and other classics of the era have two 6 volt batteries instead of a single 12 volt battery, and the two 6 volt batteries are connected together with a link cable. Both ends of this link cable must be considered as being 'live', as well as the 12 volt terminal, and need the same care to prevent accidental contact with the car body.

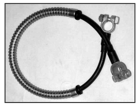
Another warning is never to run the engine without a battery connected, especially on alternator equipped cars. Although the alternator has a voltage regulator it actually generates pulses of AC which are then rectified to DC before being

regulated, and will output pulses of high voltage if a battery is not connected. The battery acts as a very powerful smoothing device which prevent the high-voltage pulses reaching other circuits on the car. Without a battery the high-voltage pulses can blow bulbs and damage electronic circuits.

Battery Voltage

Voltage can vary quite a bit depending on when you measure it, and under what conditions. With the engine running at about 2000rpm and charging normally, and with minimal electrical load, you could see as high as 15.5v with a dynamo and 14.7v with an alternator. With all factory electrical loads turned on at idle you could see as little as 13v with an alternator, or with a dynamo less than that and the ignition warning light flickering. Less than 13v with an alternator indicates the charging system may not be working correctly. Immediately after switch-off i.e. having been on charge from the alternator or dynamo, with no electrical loads switched on, you will see close to the charging voltage and this will take a couple of minutes to reach its normal 'resting' voltage of 12.7, less than that indicates the battery is not fully charged. Ignition on you will see typically 12.2v with good batteries, dropping progressively as more electrical loads are turned on. Less than that indicates the battery is not fully charged, or has lost capacity from either age or having been significantly discharged in the past, and only the standard charging system having been used to recharge it. A battery that has been fully discharged will only reach 50% of its capacity from the on-board charging system, boost charging is need to get closer to full capacity. While cranking a good battery should maintain about 10v measured right on the posts. Do the same test at the starter motor and you will always see less, but ideally not more than 1v less - the greater the difference the slower the engine will be cranking and the lower the voltage for the coil and hence spark. If you see 2v or more less than there are bad connections back towards the battery that should be investigated.

Twin 6v Link Cable

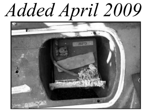


Chrome bumper MGBs (and others of the era) originally had two 6 volt batteries connected in series with a link cable so as to deliver 12 volts. This link cable must be supported by a clip under the battery shelf above the tunnel or it will rub on the prop-shaft.

Here to indicate polarity to others I've wrapped a strip of insulation - a spiral cut off a red battery cable - around the main cable that feeds power to all the circuits on the car, as well as round the positive end of the link cable. Also shown is an armoured link cable available from various sources such as Motaclan/Leacy. This cable goes over the prop-shaft and it is essential that it is clipped to the back of the heel-board as high as possible. The armouring prevents the cable chafing in the clip, if this cable shorts out even though only one battery will be affected fire can still destroy the car.

My roadster came with a single 12v which needed replacing in 1994, but it was too big to lift out through the hole in the shelf. Looking underneath I noticed that the carrier had been modified to take the bigger battery, and I wondered if they had welded it up after getting it in from underneath! But then I had a brain-wave and found that if I turned it over to lie on its end (it was sealed) I could just get it out from the top. It had just been loose in the cradle, so along with the new 6v batteries and interconnecting cable I got two clamp kits. It was apparent that originally the interconnecting cable went through some flexible armoured tubing, but with the clamps already crimped onto the end of my new interconnecting cable there was no way I was going to reuse that. It was rotten anyway so I pulled it out and just put the cable through on its own, installed the earth clamp in the other box, installed the batteries and clamps, checked the volt-drops, and away we went. Not too long afterwards I had occasion to remove the interconnecting cable, can't remember why, and saw with horror that it had been hanging down and rubbing on the propshaft! It had marked the insulation but fortunately not rubbed through. So I installed my own tube to support it up out of the way. That was better than before but the tube still showed signs of rubbing of rubbing so when I had to replace the link cable because of corrosion and got an armoured one I reused the original clip, read on.

Added April 2009




When I fitted the battery cut-off switch to Bee last year I found a mass of corrosion around one of the terminals on the right-hand battery, where the link cable attached, and the fluid level in the cell closest to it was well down. I cleaned it all off (it made a terrible mess of the drive and is only now starting to fade 12 months on) and found it had eaten away quite a bit of the clamp, so bought a new one, this time of the correct armoured type (BHA4348 currently at Moss Europe and Sussex Classic Car). These are supported by a clip at the top of the heel-board directly under the battery shelf between the two batteries. I found this clip is held by a bolt that goes into a welded nut in a box-section I didn't even know was there. Quite a bit of surface rust up there, and restricted space between the battery boxes and above the prop-shaft, but the bolt came out very easily. Almost certainly the first time it had done so since being fitted at Abingdon, so I treated it with due respect! The new cable went in quite easily with the clip and bolt, but when I went to attach it to the battery posts I found it was shorter than the old one, and would only just reach its post by lying tightly across the other clamp - not a good idea. I tried turning the battery round 180 degrees but then the main battery cable was nowhere near its post. Turned round just 90 degrees both clamps fitted, but one of them was very close to the clamping strip, which in any case was hard up against the cover over the refilling ports, again unsatisfactory. Fortunately because I had fitted the cut-off switch in the main battery cable I was able to remove the short length between the switch and the 12v post, remove the lug and connector, and transfer them over to a suitably longer length cut from the old link cable which would reach its post with the battery rotated 180 degrees.

I've seen a couple of comments from people who have flattened the battery, then charged it up in reverse, which seems a really iffy process to me, if not downright dangerous if someone else should go by any + and - markings for reconnection, boosting or even charging. Also some sources stating that +ve and -ve plates are made of slightly different materials which aid battery performance, which would work against you if the polarity is reversed.

Battery Cover *December 2014*

These have a seal around the opening, although it's probably more to do with preventing the lid from rattling than acting as a seal against fumes etc. When I restored Bee 25 years ago either this wasn't available, or I didn't bother getting it, I just used some white foam draught proofing, although of course it never looked right. But when buying several items from Motaclan/Leacy for attention over the winter I decided to add that to the list. I was surprised to see it was a sponge rope seal, I had expected a flat self-adhesive, but looking closely at the picture in Clausager on page 98 you can see it is a rope seal. I was planning to fit the seal to the cover so it isn't damaged by replacing batteries etc., but because of the shapes of the two surfaces this seal would have to be fitted to the shelf - incidentally only on twin-6v cars going by Clausager photos. This would need very careful application of adhesive so as not to squidge out from under the seal and look messy, so in fact I opted to use black flat self-adhesive draught excluder that is 1.5mm thick by 10mm wide that I had previously bought to pad out the bubble-seal on some UPVC garden doors, on the cover. Although 10mm wide it went round the corners quite well, the trick is to press down a very short length of a few mm each time.

Replacement Batteries

It is vitally important from a safety point of view to securely clamp the batteries in the cradles. The factory arrangement was an angled clamp plate across one top edge of each battery and rods running diagonally down from there across the battery case top holes in the cradle. Note that batteries can be of various heights and this may impact on the rods. For example when I converted Bee from an (unclamped!) 12v battery to the original twin 6v I bought the clamp kits as well as the batteries but the rods were too long and I had to put an S-bend in each of them or I ran out of thread. When I had the same problem with a new clamp kit on Geoff's car and having tap and die kits I was able to cut a longer thread and trim the excess. On Vee I had the opposite problem and the rods were too short to run diagonally on a replacement battery so I had to run then vertically to the other set of holes in the cradle. I was concerned that the clamp bar might slip off to wedged a piece of wood between it and the side of the cradle.

CB twin 6v
RB 12v
12v in CB?

From 1st July 2018 it has become illegal to supply sulphuric acid to members of the public without the appropriate EPP licence. So whereas mail-order supplied a dry-charged battery and a set of acid packs, in future and depending on the retailer, either only the dry-charged battery will be supplied and you will have to find a supplier of acid locally and get them filled there, or collect wet-filled batteries over the counter. *July 2019:* At least, that's what advice at the time seemed to say, but wet-filled batteries seem to be available for delivery by courier from some sources now (see below) including the MGOC.

December 2021: Quite the opposite in Vee with her battery having lasted 17 years. But winter weather has meant little running and she has needed the lithium battery pack a couple of times, so so treat her to a new one.

June 2019: Another sudden failure Bee, and it's a case of "déjà-vu all over again"!

October 2014: Sudden failure of one of Bee's batteries and subsequent replacement of both.

Twin 6 volts in chrome bumper cars, single 12v in rubber bumper. Some years ago two 6v were only slightly more than a 12v for a rubber bumper, but now a single 6v is nearly as expensive as a 12v. Nevertheless I intend to stay with 6v. It is frequently said that modern batteries benefit from more recent technical advances but why shouldn't that also apply to 6v as well as 12v? And at least one company offers 59Ah, 73Ah and 88Ah versions in the same package size. Certainly mine last well enough averaging 10 years for each set, and that with very little use for several months over winter with no recharging. The single 12v in the V8 doesn't last any longer much less in fact since I stopped the daily drive to work (after the 2nd battery failed in as little as 18 months I fitted a battery cut-off switch and it has been fine ever since). If you **do** opt to replace the twin 6v with a single 12v then you have the potential to move the fuel pump into a far more accessible position as Peter Mayo did.

The Workshop Manual quotes the original battery capacity as 51 Ampere-hours at the 10-hour rate or 58 Ampere-hours at the 20-hour rate. These days automotive batteries are also often quoted in 'Cold Cranking Amps' (CCA equivalent to SAE) or 'Cranking Amps' (CA) as starting an alternator equipped car is its main use and not a continuous discharge over a period

(unless you regularly park with lights on). Can also be SAE, IEC, EN and DIN and this chart converts between them. However for a dynamo equipped car Ampere-hours **is** more of an issue as at idle or low revs, especially with lights, wipers etc. on, the dynamo won't be charging and you will be discharging the battery, theoretically an issue if you drive in heavy stop-start traffic. CCA represents cranking at 0 degrees F/-18C, for warmer climates CA is more applicable as it represents cranking at 32F/0C. Divide CCA by 0.8 to get CA. One source (unverified) quotes that 6v batteries for the MGB should be 66Ah and 360 CCA. If you regularly start the engine in temps below freezing you may need 360CCA. If normally started above freezing you only need 360CA i.e. a 288CCA (or the next one up) battery. There is little benefit going for a battery with a higher CCA or CA than this unless you have a high-compression (i.e. higher than even the factory high-compression) engine, although the higher the capacity the longer (in years) they are likely be usable. Incidentally this also indicates that modern 6v batteries **have** benefited from modern technology increasing performance in the same package size, and not as some aver. For complete originality I think the original 'tar top' batteries with exposed links can still be obtained, although two sets I have had have cracked round the posts and suddenly failed some time later. They are also available in a more modern construction with internal links and a single fill cap. Exhaust heat has been mentioned as a factor against staying with twin 6v, and as both my sudden failures of tar-top have been on that side maybe that is indeed a factor.

6v batteries for chrome bumper: *December 2022:*
Several places are doing 77 and 80Ah 600CCA i.e. significantly more powerful than the originals at about Ł65 each i.e. Ł130 for two, some including delivery, delivered filled, with variously 1, 2 and 3 year guarantees.

MGOC have D004W 80Ah 600CCA at Ł75/Ł145, concealed links, single fill channel, wet, 2yr guarantee.

Brown & Gammons have dry and wet, standard and heavy duty, at prices from Ł92 to Ł118 all 'collection only', capacities not listed.

Motaclan/Leacy show two types GBY3031D dry i.e. no acid at Ł103 and GBY3031W at Ł98 wet collection only, capacities not listed.

Moss Europe list a 57Ah at Ł115 and a 63Ah 'heavy duty' at Ł126, both dry, acid to be sourced yourself. Wet versions of both (although the cheaper one is shown as 56Ah) at the same prices for collection only.

Alpha Batteries are showing a **pair** of 421 80Ah at Ł160 including delivery, wet, concealed links and single-fill, 2 year warranty.

Tayna Batteries has Exide 421 80Ah 600CCA at Ł126 each including delivery, wet, concealed links and single-fill.

Halfords don't list a battery for a chrome bumper MGB.

421 seems to be the designation used by a lot of suppliers, quite a few possible suppliers in this Google search.

12v batteries for rubber bumper: *December 2021*
Note that the original batteries have the terminals on one of the long sides, not diagonally as on the 6v, so terminal layout is important. As originally installed the terminals were closest to the tunnel, with the positive post closer to the front of the car. The generic UK (at least) designation for this battery is 072. 075 would appear to fit but have the terminals the other way round i.e. positive towards the rear of the car when they are closest to the tunnel. **If the wrong type of battery is used the original way round, or the right type but the wrong way round, you will destroy the alternator and damage wiring.**

MGOC do not appear to be listing any 12v batteries.

Motaclan/Leacy are showing GBY072W as wet for collection only, Ł92 inc VAT, no spec.

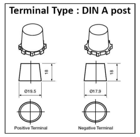
Moss Europe show a dry at Ł153 for delivery (obtain acid locally) or wet also Ł153 collection only, 450CCA 60Ah. They also have a heavy duty 550CCA 70AH at Ł136 (cheaper!) which is also wet for collection only. However all three pictures have labels showing '70Ah 570 Amps'.

Halfords list HB072 with a 3 year guarantee at Ł101, 68Ah, 550CCA, sized at 261mm long by 175mm wide by 220mm high, and Yuasa HSB072 Silver with a 5 year guarantee at Ł124, 75Ah, 640CCA, sized at 269mm long by 174mm wide by 223mm high (this will be a struggle to fit).

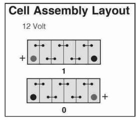
18th December 2021: Vee's battery has needed the lithium jump pack a couple of times while not being used as much in the poor weather. Cranked measuring the voltage on the battery terminals and initially it was 9v (ideally 10v), faded quite rapidly with more cranking checking the voltage on the clamps and the body earth, dropping to 6v with the meter back on the terminals. So time to replace, but fitted in 2004 so not a bad life at 17+ years! Halfords still showing Ł99 for their HB072, Euro Car Parts showing Lion 031 600CCA 70Ah 266mm long 222mm high 172mm wide 3 year guarantee at Ł74 which is a 45% Christmas bonus off the normal price of Ł135. Note Euro almost always have some kind of discount but it varies over time, for example a couple of weeks later it was down to 40%.

Listed for the RB I noticed it was classed as '031' and not '072' and it's 5mm longer than the Halfords 072. This battery table lists all the UK battery types and 031 and 072 are extracted below:

Battery Code	Amp - Hour	Volt (V)	CCA	Length (MM)	Width (MM)	Height (MM)	Weight (KG)	Terminal Type	Terminal Layout
031	70	12	570	258	173	225	19	T1	1
072	70	12	570	265	175	205	20	T1	1



Terminal Type T1 is the correct size and shape for the connectors used on BL cars.



Terminal Layout 1 has the +ve terminal towards the front of the car when they are beside the tunnel i.e. how they were originally.

However that shows 031 as 7mm shorter than 072 and 20mm higher, and neither the Halfords nor the Lion meet those specs exactly except for the voltage and the Lion Ah! But given the listed size of the Halfords HCB072 a couple of years ago (but no longer listed, 269 x 174 x 225mm) which is even bigger it shouldn't be a problem.

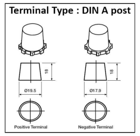
But it's a whopper compared to the one that was in before which was 230mm long, this is 255mm long so I wouldn't like to have to do the Yuasa HSB072! It only just fitted through the hole, with the cables pushed down out of the way and teased up afterwards, and I had to move the clamp struts from the middle holes to the end holes. That has put the front strut under the lip of the shelf and it was a fiddle fitting the nuts, and the +ve clamp is partially covered as well as limiting how it can be orientated to tighten the nut (clamps are tapered to match the posts so should not be turned over even if they are the moulded-on type without screws). But I get it all in and do voltage tests that gives 12.8v open-circuit, and without charging since receipt cranking a cold V8 (with the fuel pump and ignition disabled) gives 11.6v on the battery posts and 10.6v between the solenoid and engine earth which is very good, and it's really whizzing round. Fuel pump and ignition connected it starts almost instantly, but then it had been sucking some fuel in during the battery tests even though the choke was fully home. This is sealed but the old battery has cell caps and there is more than 2" of headroom above the separators, so a 'small' battery in a biggish case, but still rated at 590CCA so basically the same (originally) as this 600CCA

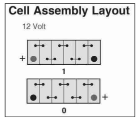
Due to the cramped installation the 12v cable is resting against the clamp plate which means it could eventually short out. Black +ve cable from the factory, but as I have a cut-off switch on the heelboard I'm thinking of getting a red cable from there to the battery, longer to give more options for routing the cable, and a different moulded clamp that can be fitted either way up. I can't find any ready-mades like that, but Halfords have an adapter (HEF366) so their cable with eyelets both ends can be used. However their cables are 9" which isn't really as long as I need to make it worthwhile or 18" which is too long! Whether it came with the V8, the roadster or somewhere else I can't remember but I have an old red rubber boot to go over the cup-type connectors which I slid onto the 12v cable years ago to indicate to anyone else that it was +ve, and have slid that back down the cable a little to act as another thick layer of insulation. I was also a little concerned about the clamp plate sliding off the edge of the battery as the struts are going straight down, they aren't long enough to go diagonally, so have wedged a couple of bits of wood between the clamp plate and the side of the cradle to prevent that happening. All in all, as it's in and working well I leave it as it is. A side-benefit is that whereas the near-side HID wouldn't strike unless the engine was running and the alternator charging it does so with just a couple of flashes now.

But knowing what I know now I wouldn't go for either an 031 or an 072 again. Looking at that battery table and whittling it down to the same terminal type that are smaller than those but with a high CCA I get the following possibilities :

Battery Code	Amp - Hour	Volt (V)	CCA	Length (MM)	Width (MM)	Height (MM)	Weight (KG)	Terminal Type	Terminal Layout
027	60	12	540	243	175	190	16	T1	0
027T	62	12	550	243	175	190	16	T1	0
075	60	12	550	243	175	175	16	T1	0
075T	60	12	590	243	175	175	16	T1	0

Terminal Type T1 is the correct size and shape for the connectors used on BL cars.





However terminal layout 0 has the +ve terminal towards the back of the car when they are beside the tunnel i.e. **opposite** to how they were originally meaning either a longer +ve cable will be needed or the battery has to be turned round to put the posts towards the outside of the car and not the tunnel - which may in itself need a longer cable. **Note that connecting a battery the wrong way round will destroy the alternator.**

Compare with the 031 and 072 repeated from above - heavier as well as bigger:

Battery Code	Amp - Hour	Volt (V)	CCA	Length (MM)	Width (MM)	Height (MM)	Weight (KG)	Terminal Type	Terminal Layout
031	70	12	570	258	173	225	19	T1	1
072	70	12	570	265	175	205	20	T1	1

January 2025: Searching Euro Car Parts for the V8 only brings back 031 type,

The 075T is 590CCA which is actually higher than both the 031 and the 072, albeit at 60Ah, but unless you leave it with parking lights on that's not going to be an issue. Yuasa YBX5075 is an 075T at 640CCA which is even better, 4 or 5 year guarantee, several sources at around Ł74 (Jan 2025 Ł150!) so the same as mine but easier to fit. Ditto various 075s a bit cheaper but around 540CCA. However this type have the terminals the other way round and you would have to extend the +ve cable (significant job without a cut-off switch) and maybe the earth (easier) or position the battery with the posts away from the tunnel instead of beside it. On my second replacement under guarantee all those years ago - under protest saying "Don't come here again" I noticed immediately that he had given me one of these (I suspect deliberately so I would burn out my alternator ...), so I did have to install it the other way round. But that meant the clamp plate had to be nearest the tunnel, pushing the battery towards the outside of the car. There is a large gap that side so the battery was tilting, and I had to put a block of wood in there to keep it square in the cradle. As I've chosen to do that anyway with the 'correct' battery that's neither here nor there and fitting an 075/075T would have been much easier! Next time ...

12v for a chrome bumper? *October 2020:*
MGOC are showing a conversion kit including battery and clamps but WITHOUT acid for Ł120. 50Ah so quite a bit less capacity than the original 6v or RB 12v, and no cranking amps given.

Bottom Gear Bob on the MGOC forum mentioned Halfords HB/HCB202 which is a direct replacement (including the clamp) for a 6v battery at 175mm x 175mm and 190mm high and around Ł80. Check the cranking capacity though as some are lower than the original 6v at 300 amps as opposed to 360 amps, and note the 550 and 570 amps quoted for an RB 12v and 600 amps for MGOC 6v. Ampere-hours tends to be about 20% lower with the HB202 but that's only an issue if you need to leave it parked with the lights on. *April 2024:* Now shown as 390 'starting power' which equates to 312 CCA, 42 Ah, LxDxH 175x185x190mm so 10mm wider, Ł85.96.

January 2022:

Another type 202 is this Yuasa YBX5202. 440 CCA (30% more capacity than the Halfords for the same size), 45Ah, 175mm x 175mm x 190mm high, which is pretty-much the same as an old 6v I have so the same clamp should fit. 5 year guarantee and under Ł50 so a lot cheaper than the Halfords above, less than half the price of the MGOC kit, and less even than a single 6v. Whilst not as powerful as current 6v it's about 30% more powerful than the original 6v, which were always 'adequate' when new, so it's something I'll be thinking about the next time I have to replace them. The posts are down one side instead of diagonal, so for safety with the clamp on the opposite side to the posts that would put the posts towards the front, and the +ve towards the tunnel. Make sure you get the connections the right way round.

May 2022: Another mentioned on the MGOC forum is the Varta C6 at 520CCA and 52Ah, 207 x 175 x 175, Ł62. So more powerful, and although the same width and depth as the other two (17mm taller) which have said to be a direct fit apparently this one needs a bit trimmed off the case to fit. Could cause a problem with any guarantee claim.

April 2024: Euro Car Parts Bosch 202 4 Year Guarantee Amp Hours: 44Ah, 420 CCA, L 175mm W 175mm H 190mm, Ł81.59, posts the same as the Halfords and Yuasa YBX5202.

May 2024:
Yuasa YBX3102 same size and capacity as the Halfords and Yuasa YBX5202 but with the posts the other way round. This may be a factor in the length of the 12v cable.

Americans often quote 'group 26' as a suitable 12v battery for a chrome bumper MGB and this site quotes the dimensions of that as 208mm long by 175mm wide by 197mm high. The Performance Batteries site lists no less than 14 batteries that might squeeze in, but the most powerful is only 52Ah which is quite a bit less than the original 6v, albeit it at up to 520CCA (624CA). The dearest of these is Ł62 inc VAT. Some batteries come with one or two lips on the bottom edge for clamp brackets on modern cars, which can make the difference between fitting and not fitting. I've seen it suggested that these can be cut off, which may well work, but remember you have probably nullified the guarantee by doing so.

Note that 12v batteries have the posts down one long side and can have the polarity either way round. The convention for rubber bumper cars was to have the posts adjacent to the tunnel and the +ve towards the front of the car when installed. Whatever battery you fit you need to check carefully - REVERSE CONNECTION WILL DESTROY AN ALTERNATOR AND BURN WIRING.

About the only good technical reason for converting from twin to single concerns access to the fuel pump by fitting it in the near-side which would mean extending the 12v cable. Peter Mayo said that when fitting a geared starter it needed a longer 12v cable from the battery, so at the same time he moved his 12v battery to the near-side and made the cable long enough to reach that. He went even further by moving the pump up into the off-side box making access to it even easier. Make sure you use the link cable bracket at the top of the prop-shaft tunnel to hold the cable up out of the way, and **always fit a clamp to hold it down**.

I've seen one person doing this had cut the lid in half, which on the face of it might seem to make sense making it like the RB cover, and only having to remove half to either inspect the battery or access the storage bin, but it left one half of the cover with only two fasteners on one end.

And finally... The batteries, particularly the single 12v in a rubber bumper, can be a tight squeeze through the hole. If your new battery doesn't come with a handle it is a good idea to put strong cord or webbing around the battery before you fit it, and leave it in-situ. The next time you come to remove the battery you will congratulate yourself on your foresight. There are 'battery lifters' available, some with eyelets that fit over the posts (don't worry, they are connected by webbing ...) that would work, but others that grip the short sides of the battery with a scissors clamp wouldn't work on an RB as one end of the standard battery is under the lip of the shelf.

Battery Drains *January 2014*

This is when an otherwise good battery seems to go flat when the car is left parked for some time. Ordinarily the MGB should go for a couple of months without being used, and still crank near normally. Less so if you have certain types of alarm as these draw a continual current from the battery. It should only be in the order of 10 or 20 milliamps, but unless you use the car almost everyday the continual slight discharge every time it is left for a week or two will shorten the life of the battery significantly. In my case when I stopped using the V8 every day I had to change the battery twice in three years. Then I fitted a battery cut-off switch, and the present battery has now been in there 10 years.

But back to drains when you don't have an alarm, which could be from many causes, and may even be from the battery itself. However that can be determined by disconnecting the battery earth strap after a decent run, leaving it until you would normally expect problems, then reconnecting the earth strap and trying to start the engine. If it still won't start, then it's the batteries (or maybe the connections ...) but if it starts just fine you have a drain.

To diagnose this it's best to use a voltmeter, but connect it like an ammeter - very confusing to the uninitiated! Disconnect the battery earth cable, and connect the voltmeter in its place. Why not use an ammeter? An ammeter gives a very low resistance path to current, so if you have a high drain a high current will flow. If more than the typical 10A max of a hobbyists meter it could damage the meter, but more importantly create a spark when it is connected and disconnected, which could ignite battery gases. Yes, I know that disconnecting the earth strap might also create a spark, but there is little you can do about that unless you have a cut-off switch, and just one spark is better than several. By contrast a voltmeter offers a very high resistance path, so negligible current will flow even if there is a very large drain, and no spark. For an early positive earth MGB the positive of the meter goes to the earth terminal of the battery, and the negative terminal goes to the car body. For later negative earth MGBs, and those early cars converted to negative earth, the meter is connected the other way round. Digital meters don't usually mind being connected round the wrong way, and will just show a minus sign in front of the reading. If there is any current drain at all, you will see a reading on the meter. There should not be any drain at all on a dynamo-equipped car, unless you have added a modern radio with stations stored in memory (and not all of those), a car-powered clock, or an alarm (in most cases but not all). With an alternator equipped car there will always be a very slight drain, which is from the reverse leakage current of the alternator diodes. This is in the order of micro-amps, and a battery should be able to support this for several months. If you use an analogue meter, the alternator drain may register anything up to 12v on the meter, and you can eliminate this as a cause by unplugging the wiring from the alternator, and an analogue meter should drop to zero. But a typical digital meter is very much more sensitive than a typical analogue meter, and will almost certainly register some voltage even with the alternator unplugged. As long as this is less than 12v then it is

an insignificant insulation leakage that can be ignored, a little dampness or dirt across the solenoid or other 'always live' component can be enough to cause that.

But if registers 12v then it could be significant, and if you don't have an analogue meter to compare it with (which should show zero volts) you will need to switch your meter to current. If that shows something in the tenths of a milli-amp or higher then it really ought to be investigated, not so much that it will flatten the battery (although it will over several weeks) but in case it is from damaged insulation on something that might suddenly get worse and cause a catastrophic short-circuit.

You can use a test-lamp in place of the volt-meter, but as well as even a low-wattage bulb causing a spark on a high drain, a small but still significant drain may not be enough to make even a low-wattage test-lamp bulb glow. A high-wattage bulb should not be used while looking for a drain as it will generate a significant spark on connecting and reconnecting. However a high-wattage 12v bulb in place of the earth strap is very useful when testing a replacement wiring harness as it protects the harness from damage if there should happen to be a short-circuit on any of the unfused circuits, but will allow most circuits to function to some extent.

If you have a battery cut-off switch then you can do these tests without disconnecting the earth strap, which makes things easier as well as safer. Turn the switch off and remove any bypass fuse.

- If your cut-off switch is in the 12v cable going to the starter, then connect the meter between the 12v post of the battery and the brown at the fusebox, and continue as above.
- If your cut-off switch is in the earth lead from the battery going to the body, then connect the meter between the earth post of the battery and a good body earth elsewhere.

Battery Types *Added December 2008:*

Battery technology and hence selection is getting ever-more complicated with technical advances.

Originally there were just lead-acid or 'flooded' types with screw caps on each cell or lids covering all cells. These need periodic checking and topping-up to replace the distilled water lost through gassing and evaporation, which occurs during cranking and charging i.e. normal use. These must be operated in a well-ventilated space and you should not make the last connection of first disconnection or a charger or jump-leads directly on a battery terminal as it can ignite the gasses. There are 'sealed' version of these which are nominally maintenance free i.e. you can't top them up, but they can still gas. You **definitely** should not operate these in the plastic so-called 'battery boxes'. Some modern cars have the batteries within the passenger compartment or boot and these should have a vent tube leading to the outside, which must always be connected to the battery, so it follows that batteries used in this situation **must** have the facility to connect the vent. These are often sold with a little red angled tube taped to the top of the battery.

There are so-called 'sealed' versions of flooded which no longer have a removable lid to check and top-up the electrolyte, but they still gas and again must be used with the same precautions in ventilation, charging or jump-starting, and if inside the car must be used with the vent connected.

'Calcium' variants of the above have a higher capacity for the same physical size, at about 12% more expensive than lead-acid. They are probably all 'sealed' but can still gas so the warnings above still apply.

More recently 'gel' batteries became available, in which the electrolyte is a jelly rather than a liquid. These cannot leak, even when the case is damaged. Under 'normal' use they do not gas, so are safe for use in enclosed spaces, which is why they are used as backup batteries in the event of mains failure for burglar alarm systems and the like. However they must be charged at a **lower** voltage/current than flooded types or voids can develop in the gel which reduces capacity, conventional automotive chargers will damage them unless they have a special 'low-rate' switch position. They also have higher internal resistance so are not as effective as conventional flooded cells when used as starter batteries, so are rarely used in automotive applications. In hot conditions they can still lose water (somehow), which can limit battery life to as little as 2 years. They can stand heavy discharge better than flooded, which is why they are often used in charge/discharge applications like golf carts.

Following gel batteries Advanced Glass Mat batteries were developed. These have liquid acid, which is kept in place by a fibreglass mat which acts like a sponge. They have a higher cranking capacity for a given physical size compared to flooded. However because they need a higher acid concentration than lead-acid they need to be charged at a **higher** voltage, which may have implications on MGBs with standard alternators and high electrical loads, and especially dynamos. The big draw-back is that they are 4 to 5 times more expensive than flooded types so are hardly a practical proposition in conventional automotive use.

Some gel and AGM batteries are described as 'Valve Regulated Lead Acid' (VRLA) types which means they have a valve to the outside that maintains a positive pressure inside the battery, which normally prevents any gas escape. However under very high charge rates gas pressure will build up to open the valve, so again these should really be used in well ventilated spaces. They are also more sensitive to high 'ripple' charging currents, which is another reason why conventional automotive chargers cannot be used. And if you take into account the very high and peaky voltage and current output that can be seen from an alternator when the battery is disconnected (**never run an engine with the battery disconnected**) it seems to me that these shouldn't be used in automotive applications either!

References:

Driver Technology - Battery Types
Arizona Wind And Sun

Plastic battery bins

I can't see the point in these, in fact I think they are being mis-described and mis-sold. If you have converted a chrome bumper car from twin 6v batteries to a single 12v and use one in the empty space as semi-secure storage that is fine. But other than that it seems to me that:

- buying a box to put in the hole,
- buying a battery small enough to fit in the box (particularly an issue if you are trying to put a 12v battery in a 6v battery box),
- cutting holes in the box for the cables and ventilation (battery fumes are explosive and will come up into the cockpit otherwise, particularly an issue in GTs, and the high concentration above the battery will accelerate corrosion),
- sourcing insulation for the underside of the cover to stop the batteries jumping up and shorting out (I've heard of people being advised to wedge thick foam between battery top and cover, i.e. across the terminals, which when the foam absorbs any moisture will trickle-discharge the batteries) or cutting **more** holes in the box for the clamp rods and cutting the clamp plates to fit,

is an awful lot of bother when the upper half of the battery stays pretty clean anyway. And even if you **do** decide to fit the clamps I have been told that the boxes do not sit on the cradle but are supported by the lip, which seems to me like quite a lot of load on a bit of plastic, even worse if you are considering using the boxes because your cradle has rotted away.

Fused Battery Connector *January 2014*

Someone on the MG Enthusiasts Bulletin Board asked what the starter current was. He'd apparently witnessed an unattended MGB burst into flames, over the back axle, possibly from the battery cable shorting to the body, and wondered about fitting a fuse. AES advertise these fused battery connectors in ratings up to 300 amps. However recommended batteries are 290 and 360 cold cranking amps which might be a bit marginal, especially if you need to crank the car out of a dangerous position if the engine has failed, or maybe if someone tries to crank it in gear with the clutch pedal released, both of which will increase the starter current above that for 'normal' cranking. Then again, a modern geared starter would reduce the 'normal' and 'crank out of danger' currents at least. Given information about the car, the starter motor and the recommended batteries AES thought the 260 amp would be suitable, but agreed it was difficult to be sure as there are so many variables, even oil viscosity. You would also need two for the 'live' terminals of twin 6v batteries in case the link cable shorted-out, although maybe you could get away with one in the earth cable of negative earth cars - if AES do a clamp for the negative post.

Battery Chargers *Updated November 2007*

I've just seen an episode in the new series of The Garage on Discovery last night about the 'English Mobile Mechanics' in Spain. They had a BMW with a flat battery so connected a boost charger direct to the battery in the boot (even though my son's BMW has jump-lead connections in the engine compartment). These boost chargers put a very high voltage to the battery and hence a high current, a lot of boiling and gassing. They got it started and the boss told one of the mechanics to disconnect the charger, which he did - by disconnecting one of the battery clips without turning off the charger first. Big spark from breaking the high current, ignited the gases around and inside the battery, and the battery exploded. The mechanic was **very** lucky in that he only got acid up his arm and not in his eyes, nor any injuries from plastic 'shrapnel'. Whilst I suspect that most of us have smaller chargers that would result in less gassing and a smaller spark, I wouldn't want to be the one to find out just how small a spark and an amount of gas would cause an explosion. This is also why the last connection to be made when using jump-leads should be made **remote** from the battery.

Update February 2014:
Another important thing to remember, from the Lucas Fault Diagnosis Service manual:

> If the battery should become fully discharged, it should not be left on the vehicle in the hope that it will become fully recharged by the vehicle's charging system. Unless the battery is charged by an external source it will probably never become more than half-charged, and even though it appears to be working satisfactorily, the plates will harden and the life of the battery will be considerably shortened.

One of the perennial questions is "How do I charge two 6v batteries". The answer is you treat them as if they were a single 12v. Forget any 'buts' about different current or voltage in each, it is exactly the same as having six 2v cells in a 12v battery

- they are all charged in series so get the same current. Yes, they may exhibit different voltages as they age, but that is down to individual cells and applies equally to 12v batteries as to 6v.

As to how to connect the charger it would be easy to get confused by the interconnecting cable and end up connecting a 12v charger across just one of the batteries, which wouldn't do it a lot of good, and it is a right faff getting the battery cover off anyway. If your car has a cigar lighter you can forget the batteries, just buy a cigar lighter plug and connect the wires from the charger to it - **observing the correct polarity!** The +ve wire from the charger must be connected to the +ve circuit in the car, and the -ve to the -ve. This applies to both +ve earth and -ve earth cars. The cigar lighter was an option from the beginning and standard from the 1973 model year, but was wired differently over the years, each needing a different approach as follows:

- Up to and including 1968 it was connected to the brown circuit at the ignition switch hence not fused inside the car. In these cases it would be advisable to add an in-line fuse at the lighter (or at the ignition switch if you can identify the correct wire). A standard 17amp continuous, 35amp blow will suffice.
- In UK 1969 and 1970 cars it was connected to the 'accessories' contact of the ignition switch. Not only was this unfused as on earlier cars, but also needs the ignition key to be in and turned before one can use it for charging. This is likely to be a problem so rewiring the cigar lighter to the purple circuit (fused, always on) as on later models might be the best option.
- In UK 1971 cars it is wired to the green/black circuit, and although this does have an in-line fuse it is still on the accessories circuit so needs the ignition key to be in and turned as above. Again rewiring to the purple circuit may be the best option.
- From 1972 (UK) and 1969 (North America) all cigar lighters were wired to the purple circuit which is fused in the main fusebox and doesn't need the ignition key.

There are two types of cigar lighter plug - fused and unfused. The fused type might seem the safest option but the current travels through a very fine spring to get to the fuse which makes the plug get quite warm during charging. A better option is the unfused type which has a higher current carrying capacity. With a fuse in the car and another in the charger you are quite safe using an unfused plug.

Another option is to use a different plug and socket with the socket in, say, the engine compartment connected to the purple fuse and earth and the plug on the charger wires, but still needs the bonnet to be opened and closed to connect and reconnect. One thing to be aware of is that cranking the engine whilst the charger is connected may blow the charger and/or cigar lighter fuse.

Modern cars with their continual small discharge from ECU and alarm systems can also suffer from battery degradation if not used on a near daily basis, and is why I've fitted a cut-off switch to my ZS as well as to both MGBs. Some years ago I read somewhere that Mercedes were having to select alternator regulators at the higher end of the output tolerance because of the number of complaints about failing batteries. Fast-forward to 2022 and I have bought a Mercedes A-class ... and am getting battery warnings! Looking into that I found a three-page thread on battery warnings on an A-class forum with many people having the same problem and difficulties in resolving it.

I'd take this further and say that if ever the battery becomes discharged enough to need a jump or a bump start, i.e. not fully discharged, an external charger capable of outputting more than the 14.3v to 14.7v of an alternator should be used to fully recharge the battery. It should be quite safe to recharge up to 15.5v with the battery still in the car as this voltage can be reached by dynamo systems under normal use. But a higher voltage boost charger should be used with the battery out of the car and in a well-ventilated space (see above). Again from the Lucas manual, external charger current should be limited to one tenth of the ampere hour capacity of the battery at either the 10 or 20 AH rate. For the original batteries this represents about 6 amps, but replacements from some sources can be 75AH and even 88AH (see above), giving charge current of 7.5 amps and 8.8 amps respectively.

I have battery cut-off switches on all three of my cars, but normally the ZS is only turned off in the summer as in the winter it gets used more. However for various reasons this winter it's only been doing a few miles a week, and I have noticed the cranking speed gradually getting lower. So I took the battery off the car and charged it on the bench using my high-output charger. Initially taking just under 6 amps and showing just over 13v, after several hours the current had dropped to about 4 amps and the voltage risen to 15.5v. Put it back on the car (and checked it would start) and left it over night with the cut-off switch not turned off. Next morning, i.e. with the overnight load of the alarm and ECUs, it was cranking much faster than it had previously. I'll have to start turning the switch off in winter as well now.

There are at least four different types of charger:

- Trickle chargers: These are traditional chargers that supply current to the battery continuously (not the same as 'constant current'). As long as they don't raise the battery voltage over 15v you should be OK to leave them on overnight as an exception, but not for long periods or regularly every night. This level of charging, even though it is the same as when the car is being driven, will cause the battery to 'gas' (incorrectly called 'boiling') to some degree which will cause the distilled water in the electrolyte to evaporate lowering the electrolyte level. Also while in a garage, or even out in the open unless there is free air circulation around the battery i.e. lid off and windows open, you will get a build-up of gas in the battery compartment which could cause an explosion and corrosion of metal parts. For chargers that raise the battery **above** 15v this evaporation will occur to a much higher degree and could even damage the battery i.e. warp the plates. For long-term battery maintenance e.g. when the car is not being used for some months get a 'conditioning' charger. These sense the battery condition and vary the rate of charge accordingly over time.

- Maintenance chargers: Modern chargers that are designed to be left connected for long periods, they monitor the battery voltage and increase and reduce the charge rate as required to keep it 'topped up' without overcharging. However there are a couple of caveats:
  - They are designed to be left permanently connected, to keep the battery topped-up. I think that is fine for long lay-ups without using the car, but if you continue to use it when the car is being used on a regular basis you are never going to know when your batteries are on their last legs, or if the charging system is down on output. Go for an overnighter somewhere, without the optimiser, and it may not start next morning. So put it away whenever the car is being used more than, say once a month.
  - Another caveat is how to use them. My son is in the market for a charger to keep the battery in his 'occasional use' classic BMW topped-up and looked at the Halfords Fully Automatic Charger. On the face of it this charger is intended for extended connection and has a 'maintenance' mode with reduced current, but if you read the Customer Q&A two posts state that the battery must be disconnected from the car for charging, also its maintenance charge level is 1.5A which is too much in my opinion. In fact if you look at the Q&A for **all** the Halfords chargers they say not to use them with the battery in-situ or connected to the car. Utterly pointless, for an intermittent-use classic car if you are going to disconnect them to charge them you might as well just disconnect them anyway, they will hold their charge for more than two months like that, remember when you buy them they have been sitting on a shelf at least that long.

  If you want a charger that you **can** leave connected all the time, while the battery is still in the car and connected, then one of the few suitable ones seems to be the Accumate battery optimiser (cheaper from the MGOC though) which charges down to less than 200mA and is specifically designed to carry the load of alarms, radios/CDs etc. **Note that the Accumate can be switched between 6v and 12v, but the twin 6v batteries of the chrome bumper MGB should always be charged in series on the 12v setting**.
- Battery reconditioners: As well as the 'maintenence' feature above these have a 'recovery' option that will restore capacity to fully flat batteries, remember that the on-board system will only restore about half the capacity (cranking power) to a flat battery. The CTEK MXS 5.0 is one such and Accumate Optimate 5 is another. Note that even with a battery that has only become partially discharged you may need to run the reconditioning program two or three times to fully restore capacity.
- Boost chargers: As above these are high-voltage chargers used to give a quick boost to a battery, they are not intended to be left connected, and you must be careful how you connect and disconnect them i.e. only turn on the power to them after you have connected them to the battery, and turn them off before you disconnect them.

Two others are recommended by AutoExpress here. However for an MGB at least I think a cut-off switch (**without** bypass fuse!) is much cheaper, more convenient, has an immobilising function and more importantly an emergency disconnect function in the event of an alternator fault or short in the many unfused wires. More recently I have come across this Battery Brain which can be used to disconnect the battery more conveniently than undoing clamps, and will disconnect itself if the battery drops below 12.1v. Still less preferable to a cut-off switch in an MGB, but a definite possibility for my ZS which gets little use in summer and where the fitting of a cut-off switch is more involved and the use less convenient, although I did fit one to that as well).

Another question is 'Can I charge two batteries at the same time?'. Firstly if we are talking about twin-6v batteries in an MGB then the answer is that is how they should **always** be charged, and in series as described above. As far as charging two **12v** batteries at the same time then it all depends on the charger:

- If you are using a 12v battery conditioning charger that varies its current over time according to battery condition, which is intended for long-term use when the car is laid up for example over winter, then apart from the case of twin 6v batteries being charged in series you should never use one of these for charging two 12v batteries either in series or parallel. Also long-term connection of a conventional trickle charger is not a good idea, even at very low currents.
- If you have a high-voltage charger that delivers at least 25v or 26v then you can use one of these to charge two 12v batteries, **but in series only**. Charging in parallel with such a high voltage will probably damage the batteries and possibly the charger. It must also be done off-car or at the very least completely disconnected from the cars electrics.
- If you are using a conventional 12v charger then you can charge two 12v batteries **in parallel**. A conventional charger works by delivering a voltage in excess of a fully charged battery voltage. The difference in the charger and battery voltages is what drives the current through the battery, the higher the difference the greater the current. Home use chargers usually can't deliver a constant voltage, and if connecting them to a deeply discharged battery a relatively high current will be drawn, which will tend to pull the charger voltage down. As the battery charges, its voltage will rise, the charging current will decrease, and the voltage will increase. Connecting two half-charged batteries in parallel to a charger is much the same as connecting a single deeply discharged battery. Both will charge, but it will take longer than if only one of them is being charged at a time. When the charger is switched off the batteries should be disconnected from each other, or if one is good and the other a bit leaky, the leaky one will discharge the good one. But safer to charge them separately in the first place.

Modern cars to Euro 5/6 are a whole different container of wriggly things, leading to many confused and confusing statements about charging.

Battery Cut-off Switch

Always disconnect the battery when parked in your garage at home, at least. Ideally with a battery cut-off switch for convenience (if you don't have one of those you should have), or by removing the battery earth (regardless of polarity!) connection otherwise. A pal has a 70 and a 76 in a 'side-by-side' double garage and religiously turns his cut-off switches off when leaving the cars. However one night after working late on one of the cars he forgot, and his family were woken at about midnight by smoke and alarms. Something had happened with the car he had been working on, at the moment he doesn't know what as he can't pull the cars out of the garage until both have been insurance assessed and he can't bring himself to go in there anyway as he is so upset and annoyed with himself. At first sight the 70 is badly damaged, the 76 less-so and the initial insurance assessment on that is cosmetic damage only needing cleaning and detailing at a cost of a few hundred dollars. But he and his family will be out of the house for two to three months as everywhere and everything is covered in soot and smoke damaged. Houses can be repaired and redecorated, but he has no idea yet how much of their personal possessions including irreplaceable memories have been lost.

The benefits of disconnecting the battery are four-fold - for safety when leaving the car as above as there is a lot of live, unfused wiring in an MGB when the car is parked; ditto if something should happen when you are driving the car - you don't want to be searching for the right spanner and screwdriver and removing the battery cover and then the earth connection while the car is burning merrily; for a level of security against simple theft (although if 'they' really want it it 'they' will get it no matter what you do); and protecting the battery from going flat if periodically left unused for several weeks at a time, especially if you have certain alarm systems.

I've had one in the V8 for a number of years, installed because the alarm was flattening the battery when I stopped using the car on a daily basis, and I was having to replace said battery every 18 months or so. I don't get the flattening problem in the roadster - it will go more than a month and still crank well with only a very slight reduction from 'normal', but I fitted one to that as well for its safety aspect.

People often ask whether it should be fitted in the 12v connection or the earth connection. Electrically there is no difference but it is a much simpler job in the earth connection, usually just needing moving the body connection to one side of the switch, and providing a new cable from the other side of the switch to the original position on the body. In the earth cable also means you can work on the 12v battery connector just by turning the switch off, you don't need to remove the earth cable from the battery. Another benefit is that as your changes are in the earth lead any errors or miscalculations that result in a short to the body won't cause an potentially explosive discharge of the battery, although it may mean that when you think the switch if off it isn't. The only difference between twin-6v systems and 12v systems is the location of the earth cable and hence where the cut-off switch would logically go - i.e. probably behind the passenger seat on twin-6v systems, it can be behind either seat on 6v systems but on the passenger side you wouldn't have to remove the battery to fit the switch.

The only real reason for fitting it in the 12v connection is where you need to disconnect drains such as alarms, but still want to keep a clock going. That is a bigger job - space is much tighter for re-routing the 12v cable to a switch and it may need cutting and two large terminals soldering on, and you will need to run a separate 12v supply direct off the battery post or the 'live' side of the switch, with in in-line fuse at that point, all the way to what you want to keep powered when the switch is off. You also need to be careful with the connections, keeping them away from other metal work and fitting insulating covers to the switch terminals.

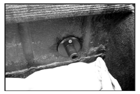
As said above electrically speaking there is no difference. With the switch in either 12v cable or earth cable turned off then working on anything including the solenoid or anything with brown (i.e. 'always live unfused') wires is 'safe', no difference for its immobilisation function or it's emergency disconnect function either. In a Bulletin Board discussion on this topic someone posted that he had seen an unattended MGB burst into flames, over the back axle, so probably the battery cable shorted close to the battery. If that was the last few inches before the battery terminal, then a cut-off switch in the 12v cable at the heelboard would be no use, but one in the earth cable would be - if you could get to it. That person wondered if a battery terminal fuse might be safer, but clearance to the underside of the battery cover can be limited.

There are basically two types of switch - those that cut everything off, and those that have a bypass fuse to keep clocks and radios etc. working. However the latter type still powers everything so any alarm drains will still occur, and if you forget to turn the switch on and turn the key to crank the fuse will blow. There are resettable fuses some manual and some automatic, but that is further faff.

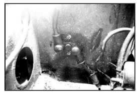
Position of the switch is another factor - really it needs to be easily accessible from the driving seat or leaning in and as above the heelboard is the usual place. If you fit the type with the removable lever mount it so hopefully there is less chance of something dropping down onto it off the seat or shelf and knocking it off while you are driving along!

Because of the alarm situation the switch I fitted to the V8 cut the power completely, but getting fed up with (not 'of' ...) resetting the clock each time I connected an in-line fuse to the battery post (for the minimum length of unfused wire) and took that forward to the clock.

When fitting one to the roadster I got a shock when I removed the cover as one battery post and connector was completely obliterated by a 'growth'! A real surprise, because whilst I only check the batteries once a year these are now several years old and there hasn't been any sign of this in past years. Checked the electrolyte levels and the other battery only needed a drop in one cell, but this battery had all cells down and one needed quite a bit. I guess that even these are on the way out, even though they show no reduction in cranking power. As you can see these are 'modern' versions of the original tar-top batteries with separate cell filler caps. I bought a pair of tar-tops in 1994 (14 years ago) to replace an under-sized single 12v on the drivers side, and although I have mislaid the record of when I bought these it must be at least 7 years ago.



All pretty straight-forward, I made a cardboard template for the complex hole in the heelboard, and cut it out using a combination of drills, little grinding wheels and a metal cutter. However in hindsight although the switch is designed to be mounted on the front of a panel, it makes sense to mount it on the back as only a simple circular hole is required, and there is a lot overlap between switch and panel that can be filled with sealant to prevent any water ingress. Mounted on the front of the panel a long slot is required in addition to the hole, the ends of the slot are very near the edges of the switch, resulting in very little overlap and a greater chance of water ingress. I orientated the switch so that when the handle of the 'key' is more-or-less vertical (I didn't realise that the handle moves a bit more than 90 degrees) when the switch is on, and when it is horizontal it is off. As well as having a certain amount of logic in that the key handle points in the same direction as current flow down the cable when it is on and across the cable when it is off, it is less likely to get knocked by stuff falling on it from above, and it also means the two connections on the back are equally accessible rather than having one on top and one underneath. This also means the cable coming up from below can be left a little longer which makes it easier to work on in-situ when stripping, tinning and soldering the terminal. Only when I could get the switch into the panel did I mark and drill the holes for the fixing screws. Before mounting the switch I laid the heel-board carpet back over the hole and made two cross-cuts where the barrel of the switch would be sticking out i.e. where the hole in the carpet would be required.



Cut, stripped, tinned and soldered the end of the cable leading to the starter in-situ. A bit cramped but easier than trying to remove the cable from the car or at least the rear brackets to be able to get the cable out the side, the last time I tried undoing any of those they all sheared. When I bought the switch and terminals at Stoneleigh last month the seller recommended some rubber 'boots' which were actually quite a bit larger than the terminals and would have been quite loose when fitted. He had some smaller one that I reckoned I could fit on, and indeed I was able to fit them **after** soldering the terminal to the cable, as I didn't want the heat from the blow-lamp to damage them by slipping them over the cable end first and they fit the terminals really snugly. Not only will they resist dislodging and possible shorting, but also water ingress and corrosion. I used a wet cloth wrapped round the cable insulation leaving just the bare end free, and arranged some pieces of metal around the battery compartment to protect the switch, fuel pump and wires etc. while I had the blow-lamp in there (my wife's cook's blowlamp!). By comparison the battery end was a doddle as it could be done off-car. Bolted to cables to the switch, daubing Vaseline around the connections before fitting the boots for protection against dampness and corrosion.

In hindsight it would have been easier to install it in the earth cable, as both ends could have been dealt with off-car. You would need at least one new earth cable, plus perhaps a longer replacement for the original. In that case CB cars with twin 6v batteries would have it on the left-hand heelboard, with RB and CB cars converted to single 12v on the right-hand side, being careful to avoid the 12v cable. In this latter case if you still have the armoured sheath between the battery boxes you could run the (longer) earth cable through it and have the switch on the left-hand side. But if not, and you consider running the cable through the holes and being unsupported between them, be aware that it can rub on the prop-shaft and wear the insulation away. Not a huge problem on the face of it as both are at earth potential anyway - except that if you then need to turn the switch off for any reason power may still be connected.

Cleaned the 'growth' off the batteries, connectors and clamping plate and reinstalled. I will replace the interconnecting cable in due course as its bolt and nut were badly corroded and parts of the connector have been eaten away, but it is OK for the time being. Liberally daubed the battery posts and connectors with Vaseline (before fitting) which really does help keep corrosion at bay (normally!).

I've got into the habit of turning Vee's switch off every time I put her in the garage so shouldn't have much trouble getting to use Bee's. I just hope I never have to use it 'in anger', but I shall be ready. In fact it has become so much of a habit that a couple of times I have turned Vee's switch off before the engine, which is something you should never do. Even though the alternator has a voltage regulator it still needs the battery to be connected for it to work correctly, without a battery you can get very high voltages which can blow bulbs and possibly damage the alternator. I've been lucky, I've seen my coolant level warning (green glows all the time when the level is OK) get brighter and flicker when I've done this, but no lasting damage.

Update April 2009: Very glad I had done this, and put the switch in the 12v cable instead of the earth, as when I replaced the link cable the new one was too short to go between the posts in their existing positions. The only possible way to make it reach comfortably then meant the 12v cable was too short. By having the switch in the 12v cable it was a relatively easy matter to remove the short piece between 12v terminal and switch, turn that battery round, then make up a new, longer cable to go between the new position of the 12v post and the switch.

Indicator/turn signals and hazard flashers

June 2018: **Warning!** It seems that new Lucas indicator flashers SFB115 (for Mk2 cars and later) from some suppliers at least contain hazard flasher internals, three from different suppliers so far, with two different batch numbers. The differences are subtle but have safety implications. The most obvious difference is immediately you operate the indicator switch. With the correct indicator flasher the lights should come on straight away to give an immediate indication to other road users, then after a pause start flashing off-on-off-on. Hazard flashers by contrast do nothing when first operating the switch, then after a short delay start flashing on-off-on-off, which delays how soon other road uses will see your intentions. The other more important difference is that the correct indicator flasher unit will only flash if both main bulbs are working, if one has failed the other (and the tell-tale) is permanently lit so alerting the driver. Hazard flasher units are designed to flash anything from one to four bulbs, some of which may be out of action following a collision, so when used as an indicator flasher the driver has no idea that a corner may have failed, and other road uses may not be aware that you are about to slow down or change lane or direction. I've written to Lucas/Elta and they were not aware of the problem, but were interested enough to ask for pictures of the markings on the item and packaging, and the Technical Manager said he would get some out of stock for testing. No feedback was ever received. There is an issue even with nominally correct indicator flasher units in that some are designed to flash two corners and a tell-tale as with the MGB, and others to flash those plus a side repeater and if these are used in an MGB they give a slow flash rate. For information on a modern flasher unit with a good flash rate as well as lighting up immediately and indicating if a corner has failed see here.

Indicator and hazard flasher units are not 'relays' as often stated, if anything they are 'switches', but that would cause confusion with the manual switches, hence 'units'. A relay receives an input voltage from one source which powers an electro-magnet to close a contact which completes a separate electrical circuit. It isolates the two circuits so that the electrical characteristics of one can't affect or damage the other. By contrast an indicator or hazard flasher unit takes the input voltage and extends it through to the output i.e. it is simply switching the input voltage on and off.

Indicators: For Mk2 and later go here, but for Mk1 read on - it's complicated, as complicated as Mk2 but in different ways.

Mk1 cars had a cylindrical 3-terminal indicator flasher unit originally GFU103 FL5 but it's completely different to 1980s 3-pin electronic flasher units. Terminals can be screwed or Lucar/spade, one is for the 12v supply in (B or X, green), one for output to the indicator switch and the lights at the corners of the car (L, light-green/brown), the third terminal (P, light-green/purple) is used for flashing the dash tell-tales. This supplies 12v to both tell-tales at the same time, the other side of each tell-tale goes to additional contacts on the indicator switch which provide an earth to the appropriate tell-tale when the switch is operated to one side or the other. The tell-tale flashes in anti-phase to the corners of the car, and comes on as soon as you operate the switch and only goes off after a short delay, which means the corners of the car don't light up until after a short delay, then start flashing on-off-on-off. From brief exposure to one of these units with one bulb not working the other bulb only makes a very brief flash, barely visible to other road users, the tell-tale may be on for much longer with only a brief period off. **Note that to use a two-terminal flasher unit you would need to connect the light-green/brown and light-green/purple wires to one of the terminals with green connected to the other**. But note the warnings on using modern SFB115 units at the top of this page, units intended for hazards, and any number of so-called 'universal' and LED types, elsewhere in these pages.

If that wasn't enough there are at least two types of this flasher unit - one for MGBs and one for Triumph TR4 and earlier, and the difference is in how the tell-tale is operated. Helping a pal with the indicators on his TR4 he had bought what he thought was the correct flasher unit ... but the tell-tale was on all the time with the ignition, albeit flashing when the indicators were being used. From what I knew about the Mk1 MGB system I realised that what he had was an MGB unit, which has the additional contacts on the indicator switch so the tell-tale is off when they are not being used. The TR4 only has one tell-tale for both sides, and no extra contacts on the indicator switch, so it needs a flasher unit where the tell-tale

contact is not live until the unit starts flashing. Paradoxically it wouldn't matter if the TR4 and earlier unit was used on an MGB, so the question has to be why the MGB had a different one (the MGA apparently had two different systems, one the same as the Triumph and the 1500 which is completely different as it involves flashing the brake lights).

Current replacements can be stocked as GFU101, GFU2101, GFU103, GFU2103, SFB105, FL5, FL54, C16729, 35002, 35003, 35010, 35028, 35028A, RTC3560, UD1511 and probably others! Some of them are for Triumph but will work equally well in the MGB (unlike the other way round). Some Triumph sources report similar problems to the Lucas SFB115 two-pin flasher unit for Mk2 including being a hazard flasher and not an indicator flasher.

Mk2: A simpler system with only Lucar/spade two terminals on an 8FL flasher unit - 12v to B (green) and L (light-green/brown) to the indicator switch, and no extra contacts on that switch. The two dash-tell-tales are simply wired in parallel with the bulbs at the corners of the car - one per side, so come on and go off with the corners. These units have the safety feature that as soon as you operate the indicator switch both the corners that side (and the dash tell-tale) light up, and after a pause start flashing off-on-off-on. However there are a number of 8FL units and some are not correct for the MGB. There is a 'type' number on the original Lucas can which can be 36, 41, 50 and maybe others and this relates to the current they are designed to work with which is dependant on the number of bulbs and their wattage.

A second safety feature is that if one corner fails the other corner and the tell-tale will glow steadily instead of flashing, which is a warning to the driver that they may need to start using hand-signals.

A drawback of this system is that the flasher unit is very sensitive to voltage and current, and with low voltage or increasing resistance from ageing connections and bulbs the flash rate gets slower and slower as well as reducing the brightness of the bulbs, and this is where some have changed to using three-pin electronic flasher units. Many of these (but not all ...) have the same safety features of lighting up straight away and indicating when a corner has failed, except that in the latter case with one corner not working the other corner and the dash tell-tale will flash at double speed. Being electronic they don't suffer from slowing down with falling voltage or increasing resistance issue and give a much more consistent flash rate, BUT ... bulbs that are dim from poor connections will remain dim. It's a significant exercise to investigate that, and there can be very many small extra resistances throughout the circuit to find and fix, although fixing the greatest resistances first will have the greatest effect.

Current stock replacements are the aforementioned suspect SFB115 as well as SFB114, GFU125, GFU2125, 8FL, 35049. Note some of these may be cylindrical, the can won't fit the original rectangular clip but may come with its own clip. Also that rectangular ones may be double-height but they fit the original clip. Confirm that the packaging or can states '48W' or '50W', and/or '2 x 21W' (may also include '+6w +2w') and NOT '12A', '96W' or '4 x 21W', however even then some types will flash slower than they should. When fitted immediately test and confirm that as soon as you operate the indicator switch the lamps light up, then after a short pause start to flash - may well need the engine to be running to flash at an acceptable rate, also that with one bulb disconnected the flash rate changes markedly.

That leaves LED bulbs which are whole different world of pain in the indicator flasher unit department.

Hazard flashers:

Flasher unit originally ATJ8880 9FL, now SFB130 (many equivalents) labelled '21w x 4 + 5w', 94W, or similar. These operate differently to indicator flashers and are a different construction internally. For a start when you first turn on the hazard switch nothing happens, then they start flashing on-off-on-off. Secondly they are capable of flashing anything from one to four main bulbs (plus side indicators and tell-tales) if for example the vehicle has been in an accident and one or more corners are damaged. Secondly they are relatively insensitive to falling voltage as they may be left operating for some time without the engine running, and flash at a relatively consistent rate. Two-pin devices (like the Mk2 indicator flasher) - 12v to B (brown) and L (light-green/brown) to the hazard switch which links the two sides and connects the flasher unit to them. The flasher switch has two more contacts that are normally closed with the hazards off and these feed fused ignition power (green) to the indicator flasher unit. These contacts disconnect that when the hazards are operated, otherwise if the indicator switch was left operated power from the hazard flasher to the corners of the car could feed back through the indicator switch and the indicator flasher onto the green and white circuits, and hence power the fuel pump and the ignition even with the ignition key in your hand - an obvious safety hazard in the event of damaged fuel lines.

Unfortunately having two spade terminals like the Mk2 indicator flasher unit they can be substituted for each other in error. With a hazard flasher in place of an indicator flasher things will appear to work, but there will be a delay in the corners lighting up when the indicator switch is operated, and there will be no indication of bulb failure. The other way round is more obvious as with an indicator flasher trying to light all four corners there is only the briefest of flash lighting them before they go off again.

With LED bulbs at the corners the standard hazard flasher **may** work if there is are incandescent bulbs in the tell-tale, but probably not if they are LEDs as well.

Hazard lights were standard on North American spec cars from the start of Mk1 production in 1967, on all V8s, and non-North American 4-cylinder cars from the start of the 1974 model year i.e. the last chrome bumper cars according to the list of detailed changes in Clausager ... or is it? He says in the text that they were also available as an optional extra on home market before that, but that the information available is 'conflicting', and it is. He says the 1973/74 GT brochure for home market cars quotes them as an optional extra, but no mention at all in the 1974 roadster brochure. '1973/74' could be taken to mean both 1973 and 1974 models, but could also be the model that was built during the second part of 1973 and the first part of 1974 which would be the 1974 model built from August 73 at chassis number 328101 (roadster) and 328801 (GT) to September 74 at chassis number 360301 (roadster and 361101 (GT). Elsewhere he says they were 'probably' fitted to **all** home market cars from the start of the 1974 model year. The Leyland schematics show it for 1974 models but not for 1973 models, in neither case as an option. The Parts Catalogue shows hazard switch BHA5267 being used for RHD chassis number HD5-328801 which is specifically **GTs** from the start of the 1974 model year, but it doesn't indicate it is an option unlike for fog and spot light switches. Flasher unit ATJ8880 is specified for chassis number 328101 (roadster) and 328801 (GT) i.e. **all** 1974 model cars and again no indication of being optional. The only clear thing is that all RB cars had them. It may be that when the 1974 model brochures were being produced it got into the GT one but not the roadster one, and by the time it came to build the cars they had decided to fit them to both roadster and GT anyway (why would they fit it to one but not the other?). Who knows, other than looking at actual cars of the period, but even that is fraught.

Brian Wall has said his November 72-built GT has them i.e. a 1973 model built between August 72 and August 73, which raises the possibility that they were an option in 1973. But that could be a mod by a previous owner, possibly with a rewire, it looks like that was the only electrical change between 1973 and 1974 models. If it had been an option the later harness could have been installed on the line as required, or maybe it was on all of them and the switch and flasher unit not provided. In which case there would need to be a dummy 'switch' on the connector to link the two green wires together or the indicators wouldn't work, in which case to add hazards would just be a case of adding the switch and flasher unit to the connections. The option could also have been a sub-harness added to the earlier standard harness, which is what I did.

Adding hazard flashers is not simply a case of tapping into a 12v supply and the wiring to the corners of the car which is easily done. The hazard switch when on has to interrupt the power to the indicator flasher unit for safety reasons. Feasible with a sub-harness as it would be a case of simply removing the 12v feed from the indicator flasher, connecting that to the sub-harness, then connecting another wire in the sub-harness back on the indicator flasher. But if the main harness had provision for optional hazards there would need to be an link (insulated from coming into contact with anything else as it would be part of a bunch of wires not attached to anything i.e. flapping around) between the two green wires going to the switch, removed when the switch was provided.

May 2019: A puzzling problem for Steve Henson-Webb on the MGOC forum. When using his indicators the dash tell-tales worked, but when using the hazards they didn't. The appropriate corners of the car flashed when they should. Unfortunately he didn't mention until later that when using the indicators **both** tell-tales were flashing, but dimmer than usual, which made things much easier to understand. The problem was the earth wire to both tell-tales had become detached. That meant that when using the indicators the tell-tales were effectively in series to earth via the indicator bulbs on the side of the car that **wasn't** flashing, so both flash, albeit dimly as each has only 6v instead of 12v. When the hazards are on both tell-tales have 12v on their 'live' sides, but no earths on the other, so neither flashed. The puzzling thing is that it was a 1974 CB, but on Mk2 tin-dash cars (e.g. my 73) there is no earth wire for the indicator tell-tales that I'm aware of, the bulb holder picks that up from the bracket they are pushed in to, which is attached to the back of the dash. He says it happened after fitting a radio, maybe that interrupted the dash earthing somehow, but seems unlikely. Mk1 cars (which didn't have hazards from the factory of course) did use 2-wire indicator bulb-holders as the 12v supply was switched from the flasher unit and the earth supply came from the indicator switch. North American Mk2 with the padded dash, all V8s and all RB cars also have 2-wire indicator bulb-holders as they are mounted in plastic panels so need a wired earth.

The indicators are powered from one of two green (fused ignition) circuits - originally the one in the fusebox. But sometime in 1978 when the ignition relay circuit on RHD cars was modified to add a second in-line fuse between brown/white and green wires under the fusebox, the indicators (and tach, heater fan and GT GRW) were powered from one of these - the one with the thinner wires, the other with thick wires being for the cooling fan. For more information see the ignition schematics. On cars equipped with hazard flashers the green circuit goes via the hazard flasher switch to be connected when the hazards are off, and disconnected when they are on.

By all accounts indicators are the bane of an LBC-ers life. But like all things, they worked when it came out of the factory. If it doesn't work now then there must be a reason (or two or three), so it can be found and fixed.

But first - know the difference between indicator/turn flasher units (they are not relays, strictly speaking they are thermo-switches) and hazard flasher units:

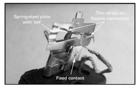
- With indicator flasher units as soon as you operate the switch the lamps should light up, and after a short pause they should start flashing off-on-off-on.
- With hazard flasher units as soon as you operate the switch nothing happens for a short period, then they should start flashing on-off-on-off.

However that only applies to the 2-pin indicator flasher units used on Mk2 and later cars. Mk1 cars used a 3-pin cylindrical flasher unit that operates differently. It appears to be the same - i.e. when you operate the column stalk and look at the dash tell-tales they come on straight away, then after a pause they start flashing off-on-off-on. But if you look at the corners of the car you will see they are operating in anti-phase, i.e. when you first operate the stalk nothing happens, then after a pause they start flashing on-off-on-off, i.e. the same as hazards! This is because the tell-tale contact on the flasher unit shows 12v when switched off, and is why the column stalk needs two additional contacts to connect the appropriate tell-tale when the stalk is moved. This caused some confusion on a pal's TR3, which only has one dash tell-tale for both sides, which is wired direct to the flasher unit. This was glowing all the time the ignition was on, and operated in anti-phase to the corners of the car. He had been supplied an MGB flasher unit, whereas the correct Triumph flasher unit has the tell-tale contact normally off, so the tell-tale operates in synch with the corners of the car, and the indicator switch doesn't need any additional contacts. Incorrect supply for Triumph owners must be very common, as many suppliers quote the MGB item as being suitable for the TR2/3/4, but I did find the correct Triumph Lucas FL number (since mislaid) for my pal and he was able to get the correct item from the same supplier.

If you substitute an indicator flasher for a hazard flasher it will appear to click at the correct rate but will only send power to the bulbs very briefly, not long enough to fully light them, and may burn-out quickly as they are only designed to flash two 21w bulbs (plus a 5w wing repeater on the 2-pin types) not four. But if you substitute a hazard flasher for a 2-pin indicator flasher it will at first seem to work correctly, unless you notice the sequence (as above) is incorrect. This is a safety hazard, as it delays the lights coming on and hence the warning to road users. So many people these days seem to operate the indicators at the same time as they turn the wheel that the rest of us need all the warning we can get!

There are also 'universal' or 'heavy duty' flasher units that although they may have the correct sequence for indicators i.e. they come on as soon as you operate the switch, don't have the built-in 'bulb failure warning' of the originals. Really when fitting an alternative flasher unit you need to disconnect one corner and confirm that you still get this warning. On original MGB types this warning is that flashing stops altogether, and only one external bulb will be lit. On modern electronic units the remaining bulb should flash at double-speed.

To complicate matter even further there is another type of after-market indicator flasher unit intended for use with after-market LED bulbs, more on those here.



Originally the MGB used a cylindrical 3-pin flasher unit (GFU103, Lucas FL5), but this is not the same as modern electronic 3-pin flashers. On the originals the third pin is used to flash the dash repeaters via additional contacts in the indicator switch, whereas on electronic units the third pin is connected to earth. Mk2 MGBs used a rectangular 2-pin indicator flasher unit (SFB115 (was GFU107), Lucas 8FL) as the dash repeaters are now connected to the wiring going out to the corners of the car. Both the original MGB types are 'thermal' type flashers and the following information is from Steve Blakeway who was an employee of Lucas working on the 2-pin thermal flasher units and their electronic replacements for nearly 30 years:

> The moving contact is on a metal plate pressed from thin spring steel. The blanking and pressing of the spring steel gives it a 'set'. The thin strip was then welded diagonally such that the plate was deformed against the set. When the indicator switch is operated and passes bulb current through the thin strip it heats up and expands, which allows the plate to ping back to it's original set, opening the contact and extinguishing the bulbs. The current ceases and allows the thin strip to cool and contract. This pings the spring-steel plate back to it's previous position, closing the contact, illuminating the bulbs, and heating up the thin strip again, so repeating the process. It works rather like the Pop-o-Matic Dice Shaker in the game 'Frustration'.

As well as straight-forward disconnections causing non-working bulbs, the 2-pin MGB indicator/turn flasher is very particular about the amount of current it needs to work - it doesn't have to drop very far due to low battery voltage or bad connections before you start to get slow, or non-flashing where the lamps stay lit all the time. Incorrectly rated lamps will cause problems, as will 'tired' bulbs that were originally the correct rating but have become high-resistance internally with age. This is another difference to the Mk1 3-pin flasher units, which even with one bulb disconnected will try to operate and can give a faint click and a very brief flash of the other bulb. It's unfortunate that the change in design that meant they light the lamps immediately the switch is operated, also made them so sensitive to current. But on new cars out of the factory that wouldn't have been a problem, only to us 40 years down the road!

Hazard flashers, on the other hand, are designed to work irrespective of how many lamps are working. The car may have been in an accident and a corner may be smashed, but you want as many lamps as you have left to flash a warning to other road users, even if only one lamp is left working. Hazard flashers will also continue to flash even as the battery discharges and the voltage and hence current drops. Again, you want to warn other road users for as long as possible. Hazard flashers can be useful in de-bugging indicators. North American Mk2 cars had hazard flashers fitted from the factory. The circuit diagrams shows these as being cylindrical 3-pin with the third pin flashing an additional hazard tell-tale lamp even though the indicator/turn signal repeaters are also flashing. However the ATJ8880, Lucas 9FL flasher unit listed in the Parts Catalogue only has two pins, and from 1972 the circuit diagrams show the additional tell-tale being connected to the hazard switch instead, and a 2-pin hazard flasher unit is shown. V8s have the same part number listed which is shown as 2-pin in the diagram, and the same applies to UK cars when they got hazard flashers in 1974. UK cars never had the additional tell-tale. However there **was** a

Lucas cylindrical 3-pin hazard flasher available at the time, similar to the original MGB indicator flasher, so perhaps that is where the confusion on the diagram stems from.

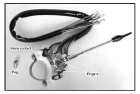
Some suppliers are showing SFB115, GFU2124 or GFU2125 as replacements for ATJ8880, but these are indicator flashers only capable of operating two 21w bulbs, they are not hazard units which need to flash four 21w bulbs. The correct item is SFB130, aka 35053.

When can they be used? Passing a car travelling slowly on the inside lane of a dual carriage way with its hazard warning lights on the other day I said to The Navigator "I'm not sure that's legal". From years ago the only scenario I was aware of was to warn of a stationary hazard, such as a breakdown or obstruction in the road. More recently on motorways and dual-carriageways people use them to warn of sudden braking ahead - and that is what The Highway Code rule 116 basically says, although it's not entirely clear. It says "You MUST NOT use hazard warning lights while driving or being towed unless you are on a motorway or unrestricted dual carriageway and you need to warn drivers behind you of a hazard or obstruction ahead" with no punctuation as if the whole sentence applies to 'driving' OR 'being towed'. I suspect the actual case is that you must not use them while being towed, but can use them to warn of a hazard or obstruction ahead. Of course if you are being towed AND see an obstruction ahead ... Really the towing vehicle's should have a repeater board on the back of the towed vehicle, otherwise the towed vehicle would need it's ignition on so brake lights and indicators are visible to following traffic.

One motor insurance company has this to say "You're driving slowly in poor weather conditions, such as fog. In this case, your hazard warning lights will make you more visible to other road users." Maybe so, but that's what rear fog lights are for, and they have their own rules. It goes on to say "Some specialist vehicles might also make use of hazard warning lights in certain situations. For example, an ice cream van may flash its hazard warning lights when it's stopped to sell ice cream."!!

It's becoming more common for vehicles to turn on the hazard warning lights automatically if involved in a collision, and some turn them on automatically in very heavy braking, as well as flashing the brake lights automatically.

Indicator/Turn Switch *Updated December 2009*



No less than 13 variations over the years, although several were to cater for LHD and RHD of course, plus other territorial variations.

1. Cars to chassis number 161086 had a switch with contacts for selecting which dash tell-tale would be lit as well as contacts for controlling which side of the car would be lit. There were three variations on that - the second being to angle the stalk closer to the steering wheel, the third had what Clausager describes as "longer peg for more positive location". Only one replacement switch seems to be available - BHA4628
2. From chassis number 161087 non-North American cars up to chassis number 187169 (roadster) and 187840 (GT) had a switch with a headlamp flasher - BHA4898, except Japan which had a switch without the headlamp flasher - BHA4897.
3. North American Mk2 cars and non-North American cars from chassis number 187170 (1969 model year) up to chassis number 219000 (1970 model year) had a switch with dip/main, headlamp flasher and horn functions - BHA4948
4. From chassis number 219001 (1971 model year) until 410001 (1977 model year) all markets had the horn button back on the steering wheel, 37H8050 for chrome bumper, 37H8101 for RHD rubber bumper and all V8 with legends for function, 37H8523 for LHD with words for functions.
5. For the 1977 model year for the remainder of production the horn button returned to the indicator stalk, AAU4991 for RHD, AAU4995 for USA, AAU4993 for Canada. These act as the mounting plate for wiper switch (AAU4992, AAU4996, AAU4994).

August 2023: Replacing the indicator/lighting/horn stalk on a pal's 78 (indicator contacts not functioning) with a new Lucas-boxed unit the mounting collar on the switch has a tab that is supposed to locate into a cut-out on the column outer. This tab can clearly be seen on the earlier switch (above the legend 'Contact fingers') and prevents the switch assembly from rotating about the column outer as the stalks are operated. Or it should but the tab on this new switch will not go into the cut-out, I think I can feel where it is trying, but is maybe too wide. On a subsequent visit I was determined to resolve this so took the switch off and did a trial fit of the old switch which went straight into the location notch. Took that off and put the new one back on ... and that also went straight into the location notch! Weird.

Cancelling:
For cancelling, cars up to chassis number 187211 (basically 1970 models that began at chassis number 187170 in September/October 1969) had a peg screwed into the column. After that until 1977 the steering column has a clip which is

a tight fit but can be slid round to the correct position. For 1977 on a different arrangement was used where the steering wheel itself interfaces directly with the indicator switch.

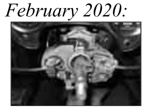
The inconvenience with the early peg is that the whole column has to be turned in the UJ to get the correct alignment, and then the wheel turned on the column, whereas the clip can just be slid round to the correct position. Both types slide under fingers on the switch and lift them out of the way as you make the turn. With the early type as the wheel is returned the peg catches the metal finger, which lifts up the spring that is holding the stalk to one side, and the stalk should return. *June 2015:* Note that this type of column inner slides freely in the tube and if removing and refitting or replacing the column as a whole you may have to adjust the position of the outer in its clamp brackets, i.e. slide it up or down relative to the inner, to get the indicator switch in the correct position relative to the cancelling peg, even though the switch position on the tube can be adjusted to some extent. The position of the inner is determined by the U-joint and rack.

I've always had my clips facing the indicator switch with the wheel in the straight-ahead position and that way the wheel only needs a 1/4-turn in order to cancel when the wheel is straightened again. However three people on the MGOC MGB forum stated that their pegs face away from the switch, and the wheel needs to be turned 3/4 before it will cancel the indicators. The 77 and later indicator switch has a collar that is continuously rotated by the wheel and has an identification rib on one side of the collar. If that is facing the switch then again only a 1/4-turn of the wheel is needed before it will cancel as the wheel is straightened. If it faces away from the switch then it needs a 3/4 turn before it will cancel. Obviously off the car it can be positioned anywhere, but having looked at half a dozen suppliers photos they all show the rib facing the switch, so I'm pretty sure that is how they should be on the car. Also checking on my Mercedes A-class that only needs the wheel to be turned 45 degrees to hear the click of the cancelling mechanism (how agricultural ...) which will then cancel the indicators as the wheel is straightened.

On the later type of indicator switch with plastic fingers the cancelling cam engages with the end of the finger and physically pushes the switch back to the central position. The fingers can wear such that the cancelling cam just lifts the fingers up again rather than bearing on them to cancel the switch, as well as the fingers having broken off or the cam being in the wrong place or missing.

Note that the clip-type cancelling cam or striker changed twice - once in June 73 on 4-cylinder cars from BHH254 to BHH1301, and again in September 74 for rubber bumpers to BHH402. This later change was for the full energy-absorbing column and column-stalk mounted OD switch that V8s had always had, but neither column nor switch seem to have changed on 4-cylinder cars in June 73. Roadwarrior says one was taller than the other, but he also says that when that is fitted to the wrong car the problem is that it causes the indicators to cancel as you start making the turn as well as when you straighten up again. But that is a different problem to the one that led up to him making that comment on the MG Enthusiasts Forum - non-cancelling - and may be the same cause but in the other direction i.e. the lower cam fitted where there should be the taller one. I've had to build-up the one on Bee, possibly after I changed the switch but I can't be sure. The V8 with the original switch (not changed by me at any rate) and striker has never been a problem.

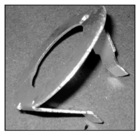
February 2020:



I get both cowls off and compare the cams and columns. The upshot is that the V8/RB cam **is** 'taller', but as well as that the column shaft is wider. So whilst in error the CB cam could perhaps be forced onto the V8/RB shaft it may well not be tall enough to push the indicator switch fingers back. Also whilst the V8/RB cam being taller may operate the CB indicator switch better, it will be a looser fit on the smaller column so may not stay in place. Possibly 'pinch it up' enough to grip, but the curvatures would still be different.

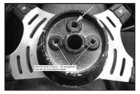
Update September 2007:

1977 (and later) model-year cars have a special wheel boss with two projections that engage with a cancellation collar on the indicator/turn switch itself. In some ways this 77-on arrangement is best because all that needs to be done is to correctly align the steering wheel for the straight-ahead position. But if an after-market wheel is fitted, or if the later dual-stalk column switch is fitted to an earlier column, the wheel won't have the necessary protrusions to engage with the slots in the cancelling collar. The later clip could possibly be fitted to the column shaft, but is too wide to fit in one of the slots in the cancelling collar. A peg screwed into the column shaft would work, but I would draw the line at drilling a hole for it. On a friends car with a non-standard wheel I made a part out of a bit of scrap metal which joined together two handy holes in the back of the wheel boss, to the two slots in the switch cancelling collar.



Shortly before getting my hands on this 1980 UK model Barrie Robinson was seeking advice on cancelling indicator/turn switches on his car, which is a bit of a mish-mash of years, and he wasn't sure which column he had. He had bought a new 77 and later switch as the old one broke, but having a Moto-Lita wheel was left with this problem and didn't really want to splash-out for a new switch. I sent photos of what I had done to him, which gave him the ideas as to what to do with his wheel, making a neater job of it than I did.

June 2018:
Another possibility where there is an existing through-hole in the boss, is to use a rod or bar in the hole to engage with one



of the slots in the indicator switch. Pre-1977 and after-market wheels may have a suitable hole, originally used for the centre horn-push pencil or connection wire, once the slip-ring for the horn connection is removed.

Where is the flasher unit? *April 2020*

Indicator flasher units seem to be in much the same place for various years and markets, to the left of the wiper motor. Originally the hazard flasher and its fuse were behind the centre console. Eventually - probably 1977-on - the fuse moved to a more logical (and accessible) position below the fusebox, and the flasher unit to beside the indicator flasher.

Dash tell-tales: *October 2019*

Mk1 cars have two wires to the tell-tales as they have connections to both the flasher unit and the indicator switch and need insulated bulb holders 37H5181 similar to the ignition warning light. The bulb is an MES E10 screw-fitting (GLB987).

Mk2 CB RHD (and LHD without the padded dash) cars have a holder with only one wire to the tell-tale (13H1924), the holder picking up an earth from the bracket on the back of the dash panel. Each of the gauges should have a wired earth for the night-time illumination (as well as the tach electronics) so a combination of the gauge clamps passing that earth to the dash plus the dash being screwed to the body supplies earth to the tell-tales. The same MES E10 bulb as above. In front of this bracket is a tube which concentrates the light onto a green plastic lens, which is positioned behind an arrow-shaped cut-out in the dash panel.

Early padded dash have a unique dash fitting and a two-wire (green/white or green/red and black) claw-type bulb holder similar to Mk1 cars, and takes the same MES E10 bulb.

Later padded-dash, V8s and rubber bumper tin dash have a tubular lens pushed into the front of the dash panel, secured from the back with a spire clip retainer. The bulb holder has two wires, the second providing an earth as the mounting panel is insulated, and pushes into the lens from the back. The bulb is a BA7S (GLB281) i.e. bayonet-type.

From 1977-on the Parts Catalogue shows the same bulbholders and retainers securing the four warning lights round the fuel gauge. With the smaller squarer rocker switch the rear fog-light switch has an internal bulb (LES GLB921 screw fitting) for the tell-tale function showing orange as well as the night-time illumination showing green.

Fault diagnosis:

Indicators/turn signals
Hazards
The curious case of the fuel pump that didn't click when turning on the ignition *February 2022*

The first and easiest step for either flasher unit - once you have located - is to bridge the two wires at the unit - green and light-green/green for indicator and brown and light-green/green for hazards. If the lights now come on with the appropriate switches operated (ignition on and indicator switch operated to either side for indicators, hazard switch for hazards) but don't flash then the flasher unit is faulty and these are GFU103 or FL5 for Mk1 indicators, SFB118 or 8FL for Mk2 and later indicators, and GFU2204 or SFB130 for hazards. But if still no lights, read on.

Indicators/turn signal faults: *Updated July 2015:*

From 1962-67 a cylindrical 3-terminal flasher unit was used, not be confused with later electronic 3-terminal units. After that a smaller 2-terminal rectangular unit was used, and the two differ as far as fault diagnosis is concerned. On the later type if a bulb fails or there is a disconnection in the wiring to it, then the indicator won't tick, the bulbs won't flash, but the working bulb and the dash tell-tale will glow continuously, making it easy to see which end you need to investigate. But on the early type this won't happen, except that you may get a very brief and faint flicker on the working bulb.

If neither side lights (including dash tell-tale) or flashes it's probably the flasher unit, the voltage supply to it, the indicator switch, or connections between them. If you have hazards and they don't light or flash either then it's either a fundamental problem at the hazard switch, or two or more separate faults.

Apart from that where both corners light but don't flash one side it is probably weak connections that side and this printable schematic and chart should help you to plot the voltages through your circuits and locate those connections. You don't need the engine to be running but it is more realistic if it is from a voltage point of view, and won't flatten the battery (dynamo-equipped car may need a bit of fast idle to extinguish the ignition warning light). If you don't run the engine (saving fuel) then disconnect the coil to prevent it overheating which it almost certainly will do with the ignition left on for a long time (with the exception of certain electronic ignition systems). Non-flashing could be due to a failed flasher unit of

course as well as bad connections. An ammeter in place of the indicator flasher unit should ideally show 3.5 amps, if it shows 3.2 amps or higher but doesn't flash then the flasher unit is probably faulty. With bad connections a new flasher unit may well start them flashing again, but this can simply be due to its being new and more sensitive, as it 'burns in' they will probably slow and stop again. If you are investigating slow flashers, and they continue to flash slowly, it makes measurements easier if you bridge the two connections on the flasher unit to stop it flashing. See here for the results of the tests on Vee.

This sensitivity to current was deliberate to give warning to the driver if a corner should have failed, otherwise traffic around you may not realise you are preparing to turn. Modern flashers use electronics (instead of a heated bi-metallic strip) and flash rapidly if one of the main lamps fails and are nowhere near as sensitive to slightly bad connections as the original 2-pin units. Some people fit a modern electronic flasher to their classic car when they get slow flashing from poor connections, not realising that they will still be there and causing the lights to be dimmer than they should be. A pal fitted one of these a while ago, but on doing voltage tests for another issue more recently found he was getting less than 8v at each rear light. Whilst fitting an electronic flasher unit to get round 'slow flashing' problems because of bad connections may seem to have done the trick - temporarily, eventually you may have to find and fix the root cause(s), you might as well do it now and get brighter lights. Be aware that some aftermarket types flash at the same rate regardless of current and therefore give no warning of lamp failure, so if you wimp-out and fit an alternative flasher unit disconnect one of the bulbs with it fitted and **make sure** that the flashing speed changes. If not, you run the risk of being rammed up the back because the person behind had no idea you were going to turn so didn't expect you to slow down. Electronic flasher units have their own problems - or at least people have problems with electronic flashers, as I have known of at least two occasions where the driver was blissfully unaware that because one side flashed at twice the rate of the other it indicated bulb failure, they hadn't even noticed! As Einstein reputedly said "Only two things are infinite - the universe and human stupidity, and I'm not sure about the former." Likewise LED Bulbs have their own issues.

As mentioned before the indicators circuit is: Battery - starter cable - brown circuit - ignition switch - white circuit - fuse (note 1) - green circuit - hazard flasher switch (note 2) - green circuit (note 3) - indicator flasher - light-green/brown circuit - indicator flasher switch - green/white (RH side) and green/red circuits (LH side) - indicator bulb holder - indicator bulb - indicator bulb holder - body earth (note 4) - battery earth cable. CB cars with twin-6v batteries also have the battery link cable. 

Note 1: Later cars have an ignition relay and white/brown circuit between the white circuit and the No. 2 fuse.

Note 2: The indicator flasher is wired via the hazard switch so that it is disconnected when the hazard flashers are turned on, and only works when the hazards are turned off. This prevents the outputs from the hazard and indicator flashers from conflicting with each other, but more importantly prevents the hazards feeding power back through the indicator switch, indicator flasher, green circuit, fusebox and onto the white circuit and so energising the fuel pump and ignition (my thanks to Mark Childers for pointing this out). So don't be tempted to bypass the hazards switch if it is that which is causing your indicators problems.

Note 3: The 'green' circuit from the hazard flasher switch to the indicator flasher should really have its own tracer colour as it is no longer part of the 'real' green circuit.

Note 4: Rear light clusters on all cars and front indicator/parking light clusters on CB cars have the cluster picking up an earth from their physical fixings to the body. RB front indicators have a wired earth shared with the headlights/front parking lights.

Typical indicators faults can be "They don't work at all" or "They don't work on one side" or "They light but don't flash or flash too slowly" or "They flash but so do other lamps" or "They don't cancel".

"They don't work at all"

Do you have hazards?

Yes - do they work?

Yes, but only some of them work - follow through the continuity of the lamps that don't work. Could be bad connectors, corroded lamp holders, blown lamp or bad earths. If only one side flashes with the hazards switched on it could be a dirty contact inside the switch or a bad connector in the green/white or green/red circuit as applicable. Then follow the following paragraph.

Yes, they all work - if all lamps are flashing then that indicates that there is continuity at the lamp ends of the green/white and green/red circuits, although they could still have connections bad enough to affect the rate of flashing of the indicators. Now check the green circuit for 12v through the hazard switch (which needs to be off. Note that dirty contacts in the hazard switch are a frequent cause of indicator problems that affect both sides) and the indicator flasher to the indicator switch (if you suspect the flasher unit itself just bridge its two contacts. The lights should light, but not flash). Then through either the green/white or green/red circuits out toward the lamps. Pay particular attention to any volt drops anywhere except across the indicator flasher itself, which typically drops about 0.25 volts when the lamps are lit (and 12v when they are in the 'off' part of the cycle).

No - see below.

No - check the green circuit for 12v through the indicator flasher to the indicator switch. Then through either the green/white or green/red circuits out toward the lamps. Pay particular attention to any volt drops anywhere except across the indicator flasher itself, which typically drops about 0.25 volts when the lamps are lit (and 12v when they are in the 'off' part of the cycle). If you suspect the flasher unit itself just bridge its two contacts. The lights should light, but not flash.

"They don't work on one side"

If neither lamps on one side flash or light you could have one fault in the common circuitry e.g. the switch or the connectors by the steering column (in which case the dash tell-tale won't light either), or two (or more) independent faults in the wiring out towards the lamps. Track the 12v through the indicators switch and the green/white(RH side) or green/red (LH side) wiring out towards the lamps.

"They light but don't flash or flash too slowly" *Updated April 2013*

This is an indication of either a failed flasher (which affects both sides equally) or bad connections out towards one or more lamps. Pay particular attention to the front indicator, although chrome bumper and rubber bumper are obviously different, both are subject to water and salt being thrown forwards by the wheels and hence corrosion. Chrome bumper cars earth through their physical fixings, and whilst rubber bumper units have a wired earth shared with the headlights it's connection to the light unit is external and unprotected, using a type of bullet. The bullet is large and hollow i.e. not crimped to the wire as elsewhere. The wire is stripped, pushed up the middle, and the conductors folded down the outside, then this is pushed into a flimsy clip. The result is poor - worse than the body earth arrangement of CB fronts and all rear light units. One of these on mine was losing nearly a volt, and the other nearly half a volt. Removed and cleaned up got then down to 0.2v and 0.1v respectively - a big improvement but twice the rears. If the shared earth i.e. from the bullets by the headlights to the body earth is high resistance the indicators may not flash with the headlights on. If you replace the flasher unit with an ammeter ideally you will see about 3.5 amps drawn per side. The more this drops, the slower the flash rate will be, particularly with the engine stopped. But if you see 3.2 amps or above (i.e. satisfactory connections through the whole of the circuit) and it doesn't flash then almost certainly the flasher unit has failed. Note that replacing a **slow** flasher does have a good chance of speeding things up, but they usually have a 'burn in' period then slow a bit to their 'normal' flash rate, meaning you end up no better off. If you see 3 amps or less it might be an idea to go to the corners of the car and do the last few tests first, as it could be that you have incorrectly rated or very tired bulbs. As bulbs age the filament thins, which reduces the current, and that will slow the flasher. The symptom of this would be a good voltage at the light unit but still a low current at the flasher.

Investigating slow or non-flashing where the cause is low current is probably the most difficult electrical job on the car, and can be very frustrating, the only way to deal with it is in a logical and methodical manner. As well as being the most sensitive circuit on the car to bad connections, there are more connections in this circuit than any other - around 30 just to flash two bulbs on one side! Any electrical circuit will 'lose' some voltage in wiring and connections when carrying current (and ours have up to 50 years of oxidisation to contend with), so my recommended methodology involves taking voltage measurements at certain points along the circuit, all of which can be done with minimal disturbance to wiring and connections. By working along the circuit you can spot a sudden drop in voltage, which means there must be a problem between this point and the previous one. However rather than testing every single one in strict order, it's more efficient and will save time if you test certain key points first, then use that to decide whether the intermediate points need investigation or not. For example if you only see a 0.1v drop between two points that have three other connections between them, there is no point testing those three other connections. The first half of the tests are all on circuitry that is common to both sides, but after the indicator switch you needs to take one set of measurements for each side, and shortly after that one set for each corner. Whilst slow or non flashing both sides will lead you to think it must be a common problem, it's just as likely for there to be problems on both sides.

The ignition will be on with the engine stopped for these tests, so the coil should be disconnected to prevent that overheating. It also reduces the load on the battery. With 3 amps or more you will still be discharging the battery noticeably, and you will need to know when to stop or whether to connect a battery charger during the tests to avoid discharging it too much. The other thing is that while testing, and discharging the battery, its voltage will be dropping anyway, so you need to take this into account when you are testing along the circuit by periodically remeasuring the first test point, or you could be led to think there is more voltage being lost the further you go along the circuit than there actually is. If you only operate the indicator switch long enough to take each measurement, and turn it off while moving the meter from point to point, you will minimise the drain on the battery. Finally it's not going to be easy measuring voltage on either an analogue or most digital meters if the flasher is going, even slowly, so it makes sense

to bridge the green and green/brown wires at the flasher unit so the lamps are glowing continuously while taking the measurements.

This schematic and list should help you plot the voltages through the circuit. The list works along the circuit connection by connection, but some are conditional i.e. only performed if a test earlier in time, but later in the circuit, shows a bad connection. You will probably end up with a progressively dropping voltage as you go from point to point. Writing these down you will see where the biggest drops are, and tackling those first will give you the biggest improvement. That way, when you get fed up, the worst ones should have been done! Note that the last few are earth tests so in an ideal world these will all be zero, so switch your meter to a lower range if appropriate. Any voltage seen in these tests indicates a bad earth. Note that as well as the centre contact of the bulb being a possible cause of a bad connection, which is inaccessible without removing the bulb, there is also a connection between the bulb base and the holder, the holder and the light unit, and the light unit and either the body (chrome bumper front lights and all rear lights) or the wired earth (rubber bumper front flashers), all of which can cause problems.

The attached shows the measurements on my V8, not because I had a problem but as a practical indication of the sort of figures you might get. The first thing to say is that I have a quality AVO analogue meter, and a cheap digital, and I got some weird and inconsistent results between the two. The first problem was that at the battery connections the analogue read 12.2v but the digital only 11.2v, both with everything switched off. I've seen this before with a digital dash voltmeter - which rather goes against the point of its existence. Subsequently I compared those two with a third, analogue Gunson's instrument, and with all three connected at the same time I got 0.5v difference between the original two, and the additional analogue instrument was lower again! It would be tempting to say the digital must be the most accurate, and the AVO reading high and the Gunson's low. But when doing earth tests at the first light unit (right front) with the digital it didn't matter whether the probes were connected or disconnected, the display kept hunting around the 200-300mV area. If I connected the probes together, or even put my thumbs on them, the reading stepped down to zero. So I tried my AVO and that immediately showed 0.9v on the bulb base, holder and light unit. So that, together with previously having found it increasingly more inaccurate as the resistance value got higher, means I don't have full confidence in it. Nevertheless, it is comparative values along the circuit that we are going to be looking for rather than absolutes, and as the digital is much smaller than the analogue I used the digital to move around the car and left the analogue connected to the battery so I could monitor it's reducing voltage through the test process. In the event I got half way through without seeing any drop (from 11.9v under indicator load) so stopped recording it for a while. I checked again near the end and it had dropped to 11.3v, after maybe 3 hours of switching the indicators on and off and moving from point to point.

"They flash but so do other lamps"

This usually affects rear lamp clusters and front lamp holders of CB cars and is usually caused by a bad earth. Most noticed when another circuit in the cluster is powered at the same time as the indicators as other lamps flashing in time with the indicators, it is caused by current flowing backwards through any other lamps that share the same faulty earth to whatever other earth it can find. All rear lamp clusters, and CB front parking/indicator light units, earth via their physical fixings to the wings.

"They don't cancel" *Updated September 2007*

A mechanical problem, this, rather than electrical. Up to the 77 model year cancelling is performed by a cam or peg at the top of the steering shaft engaging on one of two fingers projecting out from the switch. Early columns have a peg screwed into the shaft in a fixed position, later columns have a cam which is a tight sliding-fit on the shaft. With the indicator switch in the 'off' position the cam or peg clears the switch fingers as the wheel is turned in either direction. Operating the switch moves one or other of the fingers into the path of the cam or peg as the wheel is turned. When turning **in** to the corner the peg or cam passes under the finger, lifting it out of the way. Then when you straighten up the peg or cam pushes against the end of the finger to cancel the switch. From 1977 on the switch (both stalks on a single plate) fitted over the steering column instead of bolting to the side and includes a rotating 'cancellation' collar with two notches. The steering wheel itself engages with these notches to turn the collar and cancel the indicator stalk if it is operated. After-market wheels probably won't have the ability to engage with this collar, and so won't cancel, see here for suggestions on how to interface an after-market wheel to this type of switch. Cancellation is the same as before, i.e. on straightening up from a corner, but the mechanics of the operation are concealed inside the switch.

For both peg and cam types, with the wheel straight-ahead the peg or cam should be pointing at the middle of the indicator/turn switch. For the 77 and later type there is a rib on one side of the cancellation collar, and again this should be pointing at the middle of the switch. If the peg is in the wrong position on the shaft to cancel the switch correctly the column shaft, UJ and rack shaft have been incorrectly assembled. The UJ is clamped onto each shaft with a bolt, and this bolt passes through a cut-out in the shaft so that even if the bolt becomes loose the shaft cannot pull out of the UJ (the bolt has to be completely removed to withdraw either shaft from the UJ). However, although the column shaft only has a notch for the bolt, meaning that it can only be inserted into the joint in one position, the rack shaft has a groove machined all the way round so that it can be assembled in any position. Use this feature to get the peg in the correct position. You will probably then have to alter the position of the wheel on the column shaft (click here for how to remove the steering wheel) to get the correct 'straight-ahead' orientation of the wheel.

Problems can be caused by worn or broken fingers on the switch. Building up the height of the cam or judicious bending of the fingers with heat (don't break them!) can compensate for this. Broken fingers may be able to be jury-rigged - you will have to judge.

The sliding cam can become loose on the column and slip round instead of cancelling the switch. You could try removing the cam and closing it up a bit making it a tighter fit on the shaft, or degreasing and roughing-up both surfaces, gluing, or as a last resort drilling a hole and fitting a small screw through cam and shaft (but drilling holes in things like steering shafts isn't really recommended).

Hazard faults:

The hazard warning circuit is: Battery - heavy current cable - brown circuit - in-line fuse - another brown circuit - hazard flasher - light-green/brown - hazard flasher switch - then out on the green/white (RH side) and green/red (LH side) circuits to the lamps at the corners of the car as with the indicators.  The hazard flasher fuse was originally behind the centre console - inconvenient! - moving to under the fusebox, possibly around 1977.

Note: The indicator flasher is wired via the hazard switch so that it is disconnected when the hazard flashers are turned on, and only works when the hazards are turned off. This prevents the outputs from the hazard and indicator flashers from conflicting with each other, but more importantly prevents the hazards feeding power back through the indicator switch, indicator flasher, green circuit, fusebox and onto the white circuit and so energising the fuel pump and ignition (my thanks to Mark Childers for pointing this out).

These tests should be done with the ignition **off**, and all wiring connected, except where specified otherwise.

First check for 12v on the brown and light-green/brown terminals of the hazard flasher. Note: North American cars prior to 1972 have a third terminal on the hazard flasher with a light-green/purple wire. From 1972 on this wire was on the hazard switch. This is for the hazards tell-tale and should be ignored in all tests.

No 12v on either - check the in-line fuse.

12v on the brown but not the light-green/brown - hazard flasher faulty

12v on both - move on to the hazard switch

Hazard switch: Check for 12v on the light-green/brown.

No 12v - break in the light-green/brown back towards the hazard flasher

12v present - operate the switch and check for 12v on the light-green/brown again

12v drops to zero - check the light-green/brown back at the hazard flasher again

No voltage - hazard flasher faulty

12v still present at the light-green/brown at the flasher but not at the hazard switch - bad connection between these two points. Note late model cars have a multi-way plug and socket concealed behind the dash.

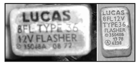
Light-green/brown at hazard switch still at 12v - turn **off** the hazard switch, turn **on** the ignition and operate the indicators to either side. Check for 12v on the green/white (RH side) or green/red (LH side) at the hazard switch

No 12v on either green/white or green/red with the indicators flashing - break in the green/white and/or green/red between the flasher switch and the wiring between the indicator switch and the corners of the car. Note that on North American spec cars the green/red joins at a six-way bullet connector in the mass where the main and rear harnesses join together at the firewall by the fusebox, whereas the green/white joins on the back of the multi-plug for the indicator switch. After that, and on UK cars, both green/red and green/white join at the multi-plug.

12v flashing on and off with the indicators - hazard switch faulty. This can be confirmed by cancelling the indicators and turning the ignition off again, then bridging the light-green/brown to either the green/red or the green/white (or both together) wires that go to the hazard switch, removing the plug from the switch if required. If the remainder of the hazard circuit is good it will start to flash the lights.

Indicator Flasher Replacement *Updated June 2024*

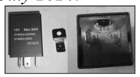
Fraught with pitfalls even as far as the original as far as the two-pin Mk2 MGB type is concerned. The 'Type' number on original Lucas 8FL indicator units tells you what bulbs they are designed to flash, and there are Type 36, Type 41, Type 43



and Type 51 where the type number specifies the current they are designed to work with i.e. 3.6 amps, 4.1 amps, 4.3 amps and 5.1 amps, each with a different part number 35048, 35049, 35057 and 35052 respectively. The colour of the printing also varies - Type 36 are usually black, Type 41 yellow, Type 43 blue, and Type 51 green but seemingly not exclusively so. The reason for the subtle variation between units is that this design of flasher unit is very sensitive to current flow, which is dependant on the number and wattage of bulbs, and will give an incorrect flash rate when used on the wrong vehicle. The MGB has two 21w bulbs at the corners and one 2W tell-tale on the dash. Together this comes to 44W and at a nominal 12v this results in a current of 3.6 amps and the type 36 flasher unit is the correct one to use. Type 41 are expecting 4.1A i.e. 49 watts and that needs an additional 5W repeater flasher bulb front wing to flash at the correct rate (the other two need even more bulb current) and on the MGB they will either flash slowly or not at all. Current-stock generic no-name flasher units labelled '21WX2+5W' are effectively Type 41 and even with the engine running i.e. dynamo/alternator charging they can be flashing at below the legal limit which is 60 fpm, and those labelled '(2X21W)+(6W)+(2W)' as Lucas SFB115 will be the same unless you connect up additional bulbs somewhere! However three SFB115 I tried had hazard flasher internals instead of indicator internals which raises two completely different issues, and so-called 'universal' flasher units are the same.

The upshot is that the MGB needs 8FL Type 36 30548 only available as NOS and rare, or (supposedly!) Lucas 35048. Googling that brings up loads of motorbike sources, one ordered for testing. However on arrival it is effectively a hazard flasher as it only comes on after a pause instead of immediately, and it doesn't change the flash rate on bulb failure. So as three SFB115 I purchased did exactly the same which I put down to a manufacturing error, I'm wondering now if they are all deliberately like that to get round complaints of slow flashing! Maybe the only alternative to NOS 8FL Type 36 (rare!) is the next generation electronic flasher unit for filament bulbs used in the 80s and 90s which is nowhere near as sensitive to voltage and current and has the bulb failure warning which in this case flashing the remaining bulb at double-speed when one corner has failed. But remember, if the slow flashing of the standard flasher unit is down to some high-resistance connections that will be making the bulbs dimmer than they should be, even though they will flashing at a good rate. As an aside my Mercedes A-Class with LED lighting has the indicators lighting immediately for both indicators and hazards, good flash rate engine not running, don't know about 'corner failure' though.

July 2024:



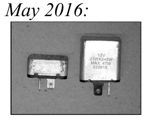
I was beginning to think I had dreamt the 'flashing at double speed if a corner has failed' as flasher units for MG, Rover and land Rover models from 1983 such as YWT10003 state "21Wx2+(5W) 21Wx4+(2X5W) Max.98W" which implies they will flash either four or two at the correct rate, so how can they flash at a different rate with only one indicator bulb working? But Googling throws up loads of references that flashing at double-speed **does** occur to show that a corner has failed when using the indicators. I purchased one and it is indeed clever enough to flash either two (indicators) or four (hazards) at a better rate than the standard 2-pin flashers, ignoring changes in voltage, but if only one corner is working it will flash at double-speed. Unlike the original 2-pin which will work connected either way round these have to be connected correctly - green (12v supply) to terminal 49, green/brown (indicator switch) to 49a, and earth to 31. The first click lights the bulbs at the corners of the car and is almost instantaneous. But as I say above if the slow flashing of the standard flasher unit is down to high-resistance connections they will be making the bulbs dimmer than they should be, and that will still be the case even with this electronic unit flashing at a good rate.

In the following video with the engine not running see how the flash rate of a good standard flasher unit (as indicated by the voltmeter tick rate) is slow with no additional electrical loads, and slows even further with lowered voltage when the twin cooling fans and HRW on the V8 are turned on. With the YWT10003 unit the flash rate is better to begin with, and maintains that rate with the increased load/lowered voltage. The final clip shows this unit flashing one bulb at double-speed when the other bulb has been disconnected:

However having tested it in Bee with a buzzer in circuit to give a louder audible warning it is buzzing faintly all the time the indicators are off, so the output terminal must have a partial path to earth - probably part of the electronics and bulb failure warning, whereas with the original unit the only path to earth is via the indicator switch to the bulbs, so more research required. It might be possible to use a diode to block the earth from the buzzer, but because that results in a volt-drop that would reduce the brightness of the bulbs slightly so not a good idea. A pair of diodes on the output of the indicator switch (to prevent cross-feeding from one side to the other) would work, but then the buzzer would sound with the hazards. Further down the diode rabbit hole using a full-wave bridge rectifier with the output wires connected to the polarity-sensitive buzzer and the input wires connected one to the left side and the other to the right will only sound the buzzer when only one side is powered i.e. the indicators. When both sides are powered i.e. hazards there is no potential difference between the input wires to sound the buzzer. This does mean that the buzzer is earthing through the unlit side i.e. passing a current through the bulbs, but in a test there is no sign of the corners glowing that side which means the current is too low to have an effect, so is my preferred solution. That may be different if using LED indicators at the corners of the car, but I don't use them, and they may make prevent the buzzer from working.

August 2024: Duly installed it works as expected, so I get another flasher unit of the same type for Vee. No buzzer on Vee and the new one is definitely quieter, so I'll see how it goes. Doesn't take many miles to determine it **is** too quiet - virtually inaudible. So I go to resurrect the plans to use a solenoid as a sounder from Feb 2020 ... but of course I can't find the sounder I bought then so have to order another.

May 2016:



I'd noticed Bee's flash rate was getting quite sedate, even driving along i.e. full voltage, and they wouldn't flash at all with the engine stopped apart from a brief click as you switched from one side to the other. I did my voltage tests and with one exception there was very slightly less voltage lost end-to-end than Vee, the one exception being in the 'new' indicator switch assembly which was slightly higher, but that only brought it back to the same as Vee overall. Two 21w bulbs directly on the output of the flasher unit were the same, the only thing that got them to flash - albeit slowly - (with the engine off remember) was when I added a 2.2W bulb to the 21W bulbs. So I reckoned the 1978-vintage flasher unit was probably getting tired, and ordered a new one from the MGOC. Generic and no-name I was surprised to find that was twice the height of the old one labelled '2 x 21W + 5W'. Installed it does flash with the engine stopped albeit quite slowly of course, although I'm sure it's quieter. However I know these units are slightly more sensitive when new, which reduces after a short period of use to a 'long term' flash rate. After a weekend away it definitely is quieter, but more importantly noticeably slower then the old unit when the engine is running. The old unit gives 80 flashes per minute, the new one only 64, which is only just above the MOT minimum of 60 flashes per minute. Roger Parker said that in these days of frantic traffic one needs them flashing faster rather than slower, and recommended that the club shop send me another. They did, but that is even slower at 56 fpm and so below the legal minimum. I did some more tests with my three bulbs, and also powering the flasher unit off the purple

circuit, which when combined eliminates almost all the cars wiring, on both the roadster and the V8. The upshot was that the fastest I could get a new flasher to run at was 76 fpm which is just about OK. The original unit connected the same way was flashing at 116 fpm, which is almost too fast, the legal maximum being 120 fpm. Whereas the original unit showed a 60% increase in flashing rate between the two extremes of connection, the new units showed only a 15% and 20% increase. Neither do the new units exhibit the slight slowing when applying the brakes that the original units do. Whether this is just because they are new, or whether the bigger can means they are different inside I don't yet know. The new units do seem to be able to ignore connection and wiring resistances much better than the original units, much as the 3-pin electronic units do. If only they flashed at a better rate when connected normally, they would be an improvement but as they are I think they are incorrect in this application. I've sent the results of my tests to Roger, and await developments. In the meantime I opened up one of the new flasher units to find - not surprisingly - it is the same as another I have. I tried tweaking the contacts, which did make it flash at an acceptable rate at 12v, however with the engine running i.e. at 14v it's initially very erratic either galloping or not flashing at all before settling down to an acceptable rate, so on balance I have put the original unit back in. It seems to me this unit would only be acceptable if you added a 5W bulb or 30 ohm resistance to the circuit to draw the current that this unit is expecting. You could add one to each 'leg' of the indicator circuit i.e. one per side, however a single one connected on the output side of the flasher unit would do the same job - at the 'expense' of the bulb glowing all the time or the resistor taking current all the time the ignition was on even when the indicator switch hasn't been operated. This is because the indicator flasher is 'normally' closed, to give the immediate lighting of the lamps at the corner of the car as soon as the switch is operated.

July 2018:

Happened to come across an NOS 8FL indicator flasher in a red bubble pack for Ł5.50 on eBay so snapped it up. Ticks faster than either of the units that came with Bee and Vee, and on Bee flashes with the engine stopped, so far so good. However it's noticeably quieter, so a couple of times I've found I've left it on after a turn. *September 2020:* while testing other aspects of the lighting the indicators have gone back to not flashing with the engine off, just one tick changing from one side to the other as before, proving that there is a 'burn-in' period and they deteriorate slightly for the bulk of their life. Still plenty fast enough with the engine running. Subsequently I purchased two more supposedly NOS but without packaging and whilst they lit they didn't flash even at charging voltage. Took it up with the supplier who pointed out mine was type 36 and his were type 41 which needed an additional 5W repeater on the front wing to work correctly. Mea Culpa, but he did refund me on return.

July 2023: Just lately the indicators have been noticeably slower, so I was thinking that perhaps the NOS 8FL above had aged a bit now and was as bad as the others. I still have the after-market ones that were slower than an old FL, tried them and they were no better, in fact one of them kept blowing the fuse because one of the terminals had pushed through the plastic base when I was fitting the spades and was shorting-out internally. That was because when I pulled the spades off the 8FL they didn't seem very tight so I had pinched them up a bit. Went back to the 8FL and with the tighter connections it speeded up significantly, and has remained so.

Note that while modern 3-pin electronic flasher units don't suffer from the slow flashing problem, neither do they warn you of worsening electrical connections that will be resulting in dimming bulbs.

Adjustable flasher units: *June 2024* The question of indicator flasher units cropped up on the MGOC forum again and I recommended looking for NOS 8FL as bought a few years ago. I found an eBay seller with two, so bought them, but on receipt whilst they lit the bulbs they didn't flash, even with the battery charger connected. I complained sending a photo of my existing unit which worked (of course), and he said that's because mine is a Type 36 whereas his are Type 41 and only suitable with additional bulbs, which led to the paragraph at the top of this section, so returned them for a refund. Whilst looking to see if I could find any more I discovered loads of 'adjustable' types advertised for motorcycles, saying they were suitable for 2X21W filament bulbs **or** LED bulbs which take a very much lower current, just turn the adjuster on the base for anywhere between 50 and 200 flashes per minute. The first one I came across was Ł15, but referenced in the eBay ad were loads at Ł5 and less, so one of those was ordered for testing. But they're exactly the same as the Lucas 35038 above with delayed bulb lighting and no bulb failure i.e. they are no better than hazard flasher units except that you can increase the flashing speed to whatever you want.

LED indicators *Updated December 2017*

Many new cars these days are being fitted with external LED lighting including indicators, so it is inevitable these are being offered by aftermarket suppliers as replacements for filament bulbs. The first thing to be aware of is that in the UK at least, and at the time of writing, external LED lighting is **not** legal for use on public roads, only off-road or at shows, and vendors for the UK market have to state 'off-road use only' somewhere in their advert . They are not specifically banned for cars before 1986, but there is enough conflict between two sets of regulations currently in force in the UK to make it a 'grey area'. Whilst the Police almost certainly won't stop you, and the MOT only checks for function (and adjustment of headlights), you should check with your insurance company first. I did, and was told they would not be acceptable, and they could affect any claim, even if I had informed them of the change (which you have to do). UK law changed on 6th February 2023 to allow them but you may still need to check with your insurance company.

Secondly they will not work correctly with either the original thermal or 'standard' electronic flashers - in the former case both bulbs will light but not flash, in the second case they will flash but very quickly indicating bulb failure. Some vendors supply a load resistor with LED lamps so that the original flasher units (thermal and electronic) flash at the correct rate, but then the 'bulb failure warning' feature in the original flashers will only detect resistor failure, not LED or wiring failure!

You can get indicator flasher units specifically for LED lamps which should flash them at the correct rate - 2-pin and 3-pin where the third pin goes to earth. But again, these do not tell you when a corner has failed and so are equally as unsafe as load resistors with standard flashers, and with some types if you connect more than one filament bulb to them you will burn them out. Also some contain a relay and make an audible click and some do not. *April 2018:* Out of interest I purchased a 3-pin type advertised as being for 0.02A to 20A so apparently suitable for anything from all-LED to all-filament indicators and hazards. But on all-LED they just flashed once, even though there was a current of 0.9A. It needed an filament tell-tale bulb added to boost the current to about 1.3A before they would flash repeatedly. *Ends*

A supplier of a 2-pin type claims that they are the units fitted to BMWs (but at only Ł14 I find that unlikely). Also I'd be surprised if modern cars were allowed to get away with there being no indication of failure as IMO it is a significant safety hazard. On questioning the supplier they defended themselves by saying LED bulbs were much less prone to failure than filament which is correct, but there can still be wiring or connector failure as before which will have the same effect. They defended **that** by saying failure warning types were being developed but had no date for availability, something I find difficult to believe when they are supposed to be OE units. I've not been able to establish yet whether OE use does or doesn't have failure warning, but recently I was behind a Range Rover with these bulbs which stopped in the middle of the road prior to turning across the traffic without indicating. Cussing the driver under my breath I then noticed as he turned that the side marker **was** flashing at the correct rate! Which indicates (ho ho) that Land Rover at least may well be fitting these with no failure warning.

Note that if you fit LED lamps and the LED indicator flasher unit you will probably need to change the hazard flasher as well. Whilst hazard flashers are designed to flash anything from one to four 21w filament bulbs, they do still need a certain amount of current flowing through them, and the current from even four LEDs can be less than one filament (21 watts i.e. 1.75 amps). My 'standard' hazard flasher will - just about - flash a single 6w filament but it won't flash two 21W-equivalent LEDs and I don't have four to try.

About the only excuse for fitting LED indicators is they can be left operating for a lot longer in the event of a breakdown or accident without flattening the battery - unless you have installed load resistors at the same time and retained the original flasher unit!

Direct replacements? *October 2024:*

I have become aware of a type of replacement LED bulb with an internal load resistor which would seem to be a direct replacement for filament bulbs and work correctly with the original flasher units, variously described as 'CANbus error free' or 'no hyper-flash' for use in 1993 and later cars that originally had filament bulbs such as MG, Rover, and Land Rover. 'CANbus' includes a system that senses the current flowing in external bulbs and raise a warning on the dashboard if that drops below a certain level i.e. a bulb has failed. 'Hyperflash' is what you get with 80s/90s cars with filament bulbs - if a corner fails the tick, the tell-tale and the remaining bulb all go at about double speed to warn the driver. With the original MGB thermal flasher units bulb failure stops ticking and the remaining bulb and dash-tell-tale glow permanently while the switch is operated which still warns the driver and by looking at the corners makes it easy to see where the problem is likely to lie.

So far so good, but to be directly equivalent LED replacements would have to take the same current as filament bulbs, which means they would get at least as hot (I have seen one type described as having an internal fan!), and still be subject to slow flashing if there are weak connections anywhere in the circuit, which may also affect brightness. Also the correct flash rate only comes from the load resistor, if some other component inside the bulb fails and it stops lighting up then you won't know about it from the tick rate or dash tell-tales. However CANbus systems accept currents within a range - which can vary from vehicle manufacturer to manufacturer. Anything in that range will flash correctly, but step outside that and it instantly goes into hyperflash mode and/or raises a dashboard warning. For that reason suppliers like Classic Car LEDs say that despite their BA15s (the MGB fitting) being 'no hyperflash' they are not suitable for the original thermal flasher units, and even on more modern cars with CANbus may still need a ballast resistor to extinguish 'bulb failure' warnings. They also say "We recommend that you only use your Hazard lights in an emergency. Unnecessary prolonged use of your hazard lights can lead to early failure of the LEDs." This may be a reference to the heat generated by the internal load resistors - semi-conductors do not like heat.

Some LED replacements are described as 'ballast included' but look carefully, they may consist of a 'standard' low current LED with an external ballast component you will have to wire in, where the tick rate is simply controlled by the ballast resistor (typically one 6 ohms 50W per side) and the dash tell-tale will flash correctly even if both corners fail to light up.

I've already replaced the flasher units on both MGBs with 1980s electronic units to get a good flash rate but would still like brighter bulbs. I tried a couple described as 'Built-in load Resistor & IC Driver: Canbus error free, plug-n-play, Wide voltage & constant current' (but no mention of 'hyperflash') and with both replaced one side they flashed at about double-speed i.e. hyperflash. Even with only one bulb replaced the flash rate was slightly higher and the reason for this is that each LED bulb only takes half the current of a filament bulb (probably to reduce the heat generated

which is bad for electronic components) so two of these bulbs on the same side take the same current as filament bulbs where one has failed - hence the double-speed flashing. The ones I had were significantly brighter (described as 1200lM each, which Classic Car LEDs says is headlight power so almost certainly incorrect, their indicator bulbs being 700lM and their headlights 700 dipped 1200 main) but are obviously unusable without an additional load to slow them down when used as indicators. Used as hazards here (LED on the right obviously) that flasher unit is independent of current so they flash at the 'normal' rate:

Far more 'urgent' as well as bright, the question is are they too bright! If the suppliers claim of 1200 lumens per bulb is correct this equates to 95 candelas (1 candela = 12.57 lumens). I can't see any intensity information for indicators in The Road Vehicles Lighting Regulations 1989 but for stop lights which have the same wattage on the MGB as indicators it should be between 20 and 60 candelas. 60 candelas converts to 754 lumens, with Classic Car LEDs versions being 700 lumens i.e. just within the maximum. Out of interest the Regulations documents don't have an intensity figure for headlamps but they do for 'running lamps' e.g. DRLs and that is 200 to 800 candelas or 2500 to 10,000 lumens, so 1200 lumens for main beam and 700 for dipped beam as quoted by Classic Car LEDs seems pitiful, but it is in the right area quoted by other sources.

Powered from the indicator flasher I calculated I would need an additional 8.6 ohms in parallel to flash at the correct rate, and a resistor for that would need to be rated at 20 watts to cope with the current and heat. However in tests with two LEDs on one side it needed closer to 6 ohms (which is the value of the ballast resistors sold for use with non-CANbus LEDs) to flash correctly. Is it worth it? Especially bearing in mind the warning about extended use? Another thought is that if I do fit ballast resistors will the flasher unit still detect loss of one bulb? If not then it is no better than cheap non-CANbus LEDs with ballast, but in more tests it **did** detect the unplugging of either bulb, clicking and flashing the dash tell-tale and the remaining bulb at double-speed as it should. But at Ł11 per corner with VAT on top (the bright pair I tried were Ł11 the pair delivered) they come out at Ł55 (at least shipping is 'free' for four or more ...) for one car or in my case Ł110! Plus ballast resistors!

Remember that cheap non-CANbus LEDs need either ballast resistors or LED-specific flasher units and will lose the failure warning which means the flasher unit will tick and the tell-tale will flash at the correct speed even when one and maybe both of the corners has failed.

Adding hazards to earlier cars

Adding to Bee

Hazard flashers were standard in the North American market from the start of Mk2 production in late 1967, but not added to other models until the either the 1974 model year or rubber bumpers, it's not entirely clear. Before adding hazard flashers to earlier cars it is vital to understand that the hazard switch **must** disconnect the standard indicators in some way, otherwise it is possible to have the fuel pump and ignition powered even with the ignition off and the key in your hand, which is obviously a serious safety hazard (pun not intended) especially in the event of a collision. If a hazard circuit is simply added to the indicator wiring then with the hazards turned on and flashing the lights, if the indicator switch should happen to be operated, power will feed **backwards** through the indicator switch, indicator flasher, onto the green circuit and through the fusebox onto the white circuit. Factory flashers power the indicator flasher unit through the hazard switch in the 'off' position, disconnected when the hazards are turned on, for retro-fitting this reverse current path can be disconnected either with a suitable switch, a relay or blocking diode.

Options are:

- Obtain a factory-style rocker switch and wire it as per factory wiring. This will require diverting the green circuit that feeds the indicator flasher unit as well as connecting to the green/white and green/red lamp circuits, and connecting the new hazard flasher via an in-line fuse to a brown circuit. A good option for UK cars with the earlier style of rocker switches as there is an empty space in the centre console, and could also be used on toggle-switch cars in a supplementary panel.

- Use a generic double-pole double-throw switch with the green/white and green/red wires from the corners of the car connected to the two common terminals, the normally closed contacts connected to the green/white and green/red wires from the indicator switch, and the normally open terminals connected together and to the hazard flasher. Requires diverting both the green/white and green/red circuits which can be done at the bullet connectors between the main and rear harnesses in the engine compartment if you don't want to cut wires.
- Use a generic on/off switch and two relays, one relay tapping into the red/green and red/white wires for the hazards, and the other disconnecting the indicator circuit when the hazards are in. This disconnection can be done where the light-green/brown wire connects to the indicator flasher unit.
- Use a generic on/off switch and diodes to connect the hazard flasher to the green/white and green/red circuits via two diodes, with a third blocking diode in the green circuit feeding the indicator flasher unit.
  Note: Inserting diodes into circuits results in a small volt-drop which means that slightly less voltage will be reaching the lamps. With incandescent bulbs there there will be a small reduction in brightness, it's up to you whether you consider this to be acceptable, MGB indicators are not the brightest to begin with. Note also that diodes can fail, disabling either hazards or indicators, or could cause both sides to flash with the indicators and damaging the indicator flasher (but then so can relays and after-market wiring).
- Hazard flasher conversions are available as after-market add-ons, make sure these do disconnect or block the existing indicator circuit to prevent this reverse current flow. The vendors may have no idea what you are talking about, so always test after fitting by looking for 12v on the white or green wires at the fusebox with the ignition off, hazards on, and indicator switch operated to one side or the other. If the circuit is **not** blocking this reverse path you will see 12v switching on and off as the hazard flasher unit clicks. It's up to you whether you are happy to use it or send it back.
  Note that a kit advertised in the MGOC 'Enjoying MG' magazine showed the detail of the connections in the October 2013 issue and did **not** interrupt the indicator circuit.

There is also the hazard tell-tale to consider. According to the schematics UK cars don't seem to have had these (why would you need one when both the dashboard indicator tell-tales will be flashing anyway?), but North American spec always did. From 1972 this was fed by a light-green/purple wire off one of the contacts of the hazard switch and a 2-wire hazard flasher unit was used. In this case only the first option above can be used, as the tell-tale needs to be isolated from the hazard flasher unit and the indicator wiring when not in use, and only the factory switch (or similar hazard-specific switch) does this. The schematics show that from 1968 to 1971 a 3-wire hazard flasher unit was used, with the third wire feeding the tell-tale, and this type of flasher and tell-tale wiring can be used with any of the options above. 3-wire hazard flashers seem to have been used on a number of British cars of the era, still seemingly available from the likes of Rimmer, Canley Classics and others. Check they are capable of driving at least 4 21w bulbs, they may also be marked 'heavy duty'. Alternatively it may be possible to wire a tell-tale bulb in parallel with the 2-wire hazard flasher i.e. directly to its two terminals. This will flash the tell-tale in anti-phase to the corners of the car instead of in phase as with the factory and 3-terminal options, but should be legally acceptable for inspections.

Finally power to the hazard flasher must come from an always on, fused source. 'Always on' because the hazards need to be available with the ignition off and the key out, fused in case one of the corners of the car is damaged and the lamp holder or wiring is shorting out. Without a fuse this could cause a fire, adding to your woes. Factory cars were wired from the brown circuit via an in-line fuse solely for the hazard flasher, originally in the very inconvenient location of behind the centre console! Whilst it is technically feasible to power it from the purple circuit which is also always on and already fused, as this feeds the horns and other circuits accident damage may have shorted out that wiring elsewhere on the car and blown that fuse. This means that if you are going to the trouble of adding hazard flashers, a separate fuse off a brown wire is really the only sensible option.

Adding to Bee: *August 2013*

After a pal had his TR6 written off by being rear-ended, just a couple of weeks after completing a two-year restoration to make things even worse, I decide I really need to fit hazards to Bee (Vee has them as standard). The TR6 didn't have them, although in that case I don't think it would have made any difference. The car had broken down on a dual-carriageway, was only half on the carriageway and half on a grass verge next to a crash-barrier, in clear visibility on a straight road just after a roundabout, with my pal back up the road warning people to keep over. Nevertheless this ... chap seemed totally oblivious of both my pal's warning as well as the car, almost hit him, then smacked right into the TR6's off-side rear corner which caused the perpetrator to spin and roll, coming to rest on its side. But anything that might improve visibility of these, by today's standards, small cars has to be of benefit and I decide to fit hazards before going any further with DRLs which a pal and I have been pondering for some time.

August 2023: Checking Bee over prior to an MOT - lights, wipers, washers, horn. Main lights - fine. Hazards - fine. Brake lights - fine. Indicators ... no indicators. I'd only been out in her a couple of days previously and they were fine then. The hazard switch disconnects power from the indicators (as explained above) so flipped the hazard switch on and off again and the indicators worked again. Only installed 10 years using the standard switch as there was a spare position in the centre-console, they are probably only used twice a year - pre-MOT and MOT, so hardly 'worn out'. I tried the switch a few times and most of the time it worked as it should but every now and again if I switched it off slowly the indicators didn't work.

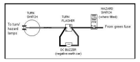
Quite co-incidentally a pal I'm helping with his electrics gave me a new hazard switch of the correct type just the other day which he had bought for his car not realising it used a different switch. Fitted that, working again.

I'd had the same thing on Vee's hazards not long after buying her 30 years ago, opened up the switch and it was full of hardened grease. Dug that out and replaced with fresh, worked again and has done ever since. I'm almost certain that is the original switch. Opened up this switch, only a little grease and certainly not hard. Cleaned that out anyway and scraped the contacts (as I had to do with said pal's brand-new main lighting switch straight out of the box) and with a test meter that seems OK now, so has gone in the spares box.

When I restored Bee just over 30 years I replaced all the dash switches as the logos were a bit faded, then some years later the new main lighting switch started getting intermittent. As the logo on that was getting a bit faded I put what was almost certainly the original switch back, and that has worked ever since.

New stuff is rubbish even though it looks exactly the same as the originals.

A louder audible warning



Never the loudest ticking, particularly at higher speeds in either roadster or GT, and some without the hearing sensitivity of a bat might find themselves inadvertently leaving the indicators on when they shouldn't be, you can add a buzzer to give more of an audible warning. Get a 12v dc buzzer and simply connect its two wires to the two terminals on the indicator flasher. Some electronic 'buzzers' are polarity conscious and will have red and black wires in this case, and for negative earth cars connect the red wire from the buzzer to the green on the indicator flasher and the black to the light-green/brown wire. For the earlier positive earth cars connect the buzzer the other way round. This may work on 'modern' cars with three-terminal flasher units but see below.

When you first operate the indicators you won't hear anything - don't panic! It is only when the lights go **out** on the first click of the flasher that the buzzer will sound, i.e. it operates in anti-phase to the lights. If you find the buzzer too loud you can always wrap a couple of turns of insulating tape or similar round it. However the cheap electronic buzzers make a pretty horrible sound, and even the piezo type can get annoying, so I'm experimenting with something to make a louder clicking noise with my NOS original which although flashing quicker is quieter than the old one.

August 2024: I've been wanting to change the flasher unit for a more modern OEM electronic unit from the 80s/90s for a while now to counteract the slowing of the flash rate when sitting waiting to turn with the brakes on, which I've never been happy about, and they are slow at the best of times. It took a while but I did eventually find one, which worked well, but in the roadster with my GPO sounder (which has a more pleasant sound) connected it emitted a slight sound all the time which wasn't acceptable, so the output terminal must have a partial connection to earth internally - probably part of the electronics and bulb failure warning, whereas with the original unit the only path to earth is via the indicator switch to the bulbs. Reluctant to do without it, it would be possible to use a diode to block the earth from the buzzer, but because that results in a volt-drop that would reduce the brightness of the bulbs slightly so not a good idea. A pair of diodes on the output of the indicator switch (to prevent cross-feeding from one side to the other) would work, but then the buzzer would sound with the hazards. Further down the diode rabbit hole using a full-wave bridge rectifier with the output wires connected to the polarity-sensitive buzzer and the input wires connected one to the left side and the other to the right will only sound the buzzer when only one side is powered i.e. the indicators supplying 12v and the other side has a virtual earth through the bulbs. When both sides are powered i.e. hazards with 12v on both sides there is no potential difference between them to sound the buzzer. This does mean that the buzzer is earthing through the unlit side i.e. passing a current through the bulbs, but in a test there is no sign of the corners glowing that side which means the current is too low to have an effect, so is my preferred solution. That may be different if using LED indicators at the corners of the car, but I don't use them, they may make prevent the buzzer from working, and you cant use one of these flasher units with LEDs anyway. Wired as described it works well although at the first flash instead of sounding straight away at full volume as it did with the thermal flasher unit it fades in over a fraction of a second, although after that it is as before, and I will ignore it.

September 2024:

> Fitted the same flasher unit to Vee with the same benefits, but even in the GT it is very quiet when driving. I only have one GPO buzzer so go back to the solenoid idea, needless to say I can't find the one I bought four years ago so bought another. It's a bit quiet by itself particularly as one end has a rubber O-ring to cushion the return stroke so it needs to hit something. Both ends are 'open' so with the right size 'box' one end can hit on the 'go' stroke and the other on the return, and a short section of square drain down-pipe (again!) is the perfect size. A simple bracket clamps it to one wall of the 'box', cable-tied on top of the bracing tube behind the dash, wires ScotchLok'ed to the green/white and green/red wires in the main harness by the connector to the indicator switch. One wire from the solenoid to each, no need for diodes as it's not polarity sensitive, and as before power to the indicators one side supplies 12v and the earth comes from the bulbs on the other side to power the solenoid well. Also as before being wired like that means it doesn't sound with the hazards on as then the solenoid has 12v both sides, and no visible 'leakage' to the bulbs on the unused side. Cable-tied to the top of the bracing bar behind the dash it works well - too well as it is quite loud with a 'clack' sound so will experiment with damping it down a bit - inserting a suitable resistor probably the easiest.

Then it struck me that a standard 12v Bosch-type relay clicks as it operates and releases. Dangling from wires it's not really any louder the the flasher unit (which is screwed to the bulkhead), held on top of the bracing bar behind the dash (where the solenoid was) it's slightly louder but probably still not loud enough. Then I thought if I could attach it to the back of the dash by the fuel gauge it would use the dash as an 'amplifier' - and it did. But how to secure it? Double-sided sticky pads is a possibility, but damps the sound back down again. Then trying various positions round by the fuel gauge I discover it wedges into the space between the bottom of the fuel gauge and the top of the lower edge of the dash that turns back under the gauges. Sounds pretty good and is held firmly, so I'll see how that goes. Still too 'clacky', so move it to the bracing bar with a sticky-pad. Still a bit quiet so cable-tied a non-sticky side to the bracing bar - better when driving, but 'clacky' stationary! At this rate I should have reverse-engineered the GPO sounder! But doing some Googling just on the offchance not only did I find a circuit diagram for the GPO buzzer, but also two sources of the buzzer itself, and for the princely sum of Ł5 Vee now has the same buzz as Bee.

February 2020: An enquiry on the MGOC forum reminded me that I hadn't updated this. My first thought was to wire a small loudspeaker in series with a capacitor. The theory being that although the impedance of a typical speaker is far too low to wire across the flasher unit and would affect both it and the lamps, adding a capacitor would prevent that but allow to capacitor to 'charge up' and discharge via the speaker each time the flasher contact opened and closed. I used to have a couple of speakers from small transistor radios I messed with decades ago, but couldn't find them. Got one off eBay but it was much smaller than expected and was way too quiet.

Next thought was a solenoid where the ends of the plunger were exposed, and positioned in a box or by a bulkhead the plunger would hit the sides of the box or the bulkhead so making a noise each time it operated and released (in a box) or just on the one stroke (bulkhead). Ordered one of those, but in the meantime I discovered an old GPO electronic sounder with three volume settings. Tried that and like Goldilocks and the three bears one setting was too loud, another wasn't loud enough, but the third setting was just right. It's also quite a melodic sound very different to the harsh 12v buzzer, so that's as far as I went.

The MGOC forum reminded me that I had also seen buzzers for motorcycles, including one type with a delayed response of 20 flashes or so before it started buzzing. Some of these have an additional feature that if you sit there with your brake lights on the buzzer is muted until you release them. As Dave Birkby said - "bizarre". Whilst I can understand car drivers sitting at traffic lights with a foot on the brake (instead of selecting neutral and applying the handbrake ...), do bikers habitually do that? Even though modern bikes light the brake lights from both front and rear brakes? And one motorbike forum was discussing a system where the buzzer only sounded once every ten or so flashes. Both relatively easy using a chain of bistables or JK flip-flops, should you be so inclined - four to give you a count of 8, five for 16. One of the products included the following in the description: "Built by my strusted and quilfied staff.". Fills one with confidence ...

Lighting Starter Wipers

Lighting

1st March 2023: MOT rules changed yet again to clarify conversions to LED and HID conversions on cars first registered before 1st April 1986. The previous legislation dated 22nd March 2021 was confusing not to say incorrect as it seemed to differentiate between halogen and sealed-beam.

1st January 2021: MOT rules have been changed to fail cars with LED headlamp conversions:

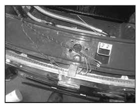
> 4. Lamps, reflectors and electrical equipment
> 4.1. Headlamps
> 4.1.4. Compliance with requirements
> "Existing halogen headlamp units should not be converted to be used with high intensity discharge (HID) or light emitting diode (LED) bulbs. If such a conversion has been done, you must fail the headlamp."

The irony is the phrase 'Existing halogen headlamp units'. Most MGBs came out of the factory with non-halogen headlamps, so even this has created another 'grey area', they probably should have used the term 'filament' instead.

October 2020: The legality or otherwise of LED external lighting, from Classic Car LEDs and the Federation of British Vehicle Clubs.

Chrome bumper front and all and rear park/brake/indicator light clusters rely on the physical fixings to the wings to pick up an earth, as do number-plate lights that are mounted on the bumpers and overriders. Corrosion, particularly at the front where both front and rear of the panel are exposed to water and salt, can cause problems with these lights, rear clusters being inside the boot/load space are protected to a large extent. When there is a bad earth feeding a light unit with more than one bulb or filament such as chrome bumper front park/indicator light units and all rear light units you will get interactions between them when more than one is powered, i.e. some being dimmer than they should be and others glowing dimly when they shouldn't, known as 'discoing'. Rubber bumper front indicators have a wired earth, shared with the headlights, as do the front 'parking' lights which are part of the headlamp assembly, and these can also experience unwanted interactions if the fault is in the earth wiring or its connection to the body. Reversing lights and number-plate lights that are attached to the number-plate backing-plate also have a wired earth.

With any bulb you can get a bad connection between the bulb base and the bulb holder causing dimness, with dual-filament bulbs it can cause unwanted interactions between brake lights and parking lights as well, but the single filament bulb for indicators (usually) will be unaffected. If multiple circuits on both sides are affected particularly when the indicators are being used i.e. 'discoing' then the problem is more likely to be where the light unit is attached to the wing.



One oddity on early cars (for those used to later ones) is that the main harness only has one group of bullets at the front, not one by each headlight as on later cars. This reaches to the middle of the car i.e. behind the latch, and the tails from both headlights and parking/indicator lights also reach the middle of the car. At least, they did originally, but it seems some current stock has tails that only reach the later main harness bullets by the

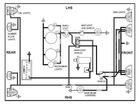
headlights. These tails are not itemised in the Parts Catalogue, suppliers have them as BAU2110 (for CB cars, BAU2111 for RB)

Later harnesses have a group of bullets by each headlight, which should be relatively easy to access on cars other than V8s and 4-cylinder 1977 model year and later from between the radiator and the slam panel. On the others you have to remove the mesh grille, and access is still pretty restricted.

For 1977 until the end of production on all models the main lighting switch moved to the side of the steering column cowl - right-hand side on RHD cars and left-hand side on LHD. Care is needed on refitting the cowl as it is possible to trap the lighting wires, which being unfused will burn the harness.

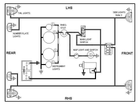
Parking lights (aka sidelights or position lamps, not to be confused with North American 'side-marker' lights!)

Up to 1970:



The parking lights were not fused originally. Mark II cars introduced fuses, although for 1968 and 1969 the fronts were on one fuse and the rears on another, so if you had a fuse fail you lost both at one end, a particular problem at the rear as you lose all lighting until you brake or indicate. The fuses were of the in-line type, installed where the rear harness joined the main harness near the fusebox. Fuses can be added to Mk1 cars quite easily to make them the same as 68/69 cars.

1970-on:

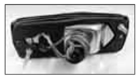


For the 1970 model year a four-fuse fusebox was provided, the additional two fuses (at the top) separately fusing each side, with additional wires run to the front and the rear of the car. This was a much better arrangement which in the event of a short and a fuse blowing you still had one front, one rear, and the number plate light on one side still working. There is only one wire (red/green) feeding the front of the parking light fuses - they are linked there, which means if refitting these fuseboxes you must be careful to fit it the right way up, or you can get the brown and purple circuits linked to the green and white circuits, i.e. effectively powering the ignition all the time. If one side has failed check the cleanliness of the fuses, fuse holders and connections. Be aware that the fuse holder is riveted to the connection spades on the back of the fuse block and corrosion can also occur here.

From 1970 North America used a dual filament 21w/6w bulb for the front indicators and parking lights for both CB and RB models, with an all-amber lens. Prior to that it seems that the lens used with the two separate bulbs could be either mixed amber and white as per non-North American models, or all white.

CB front units:

Did the front indicator/side-light assembly move closer to the grille in 1969 to meet a new European requirement that the position lamp be vertically below the centre of the headlight? See the end of this article on History of the Australian assembled MGB By Tom Aczel. However that doesn't really hold water as any number of UK cars sold after 1969 had the 'parking' lights nowhere near the vertical centre-line of the headlights. Also noted in that article is that Australian-built Mk2 cars until 1969 had the indicator/parking lights units reversed to put the indicators outboard of the parking lights, put back to their original positions in 1969 when the units moved closer to the grille.



At the same time the location of the studs on the front indicator/side-light unit seem to have moved from being in-line in the centre of the light unit to being in opposite corners. Clausager says some export markets may have required the indicator part to be outboard of the parking lights instead of the other way round as in the UK which studs in line would allow, and may have been done inadvertently on other cars. But if you think about it with the studs in opposite corners the light unit can still be reversed! They would both need to above or below the centre-line to prevent that but still sit correctly on the plinth, so the reason for the change remains a mystery. The Leyland Parts Catalogue and suppliers such as Moss Europe and Brown & Gammons only list one light unit (BHA4966), and with suppliers showing both types of wing (with Moss showing the two different stud arrangements) it begs the question of how can the one light unit fit both wings? This question arose when Dave O'Neil wondered why, when he needed to replace one on his Mk1, neither of the NOS units he had in stock had studs in the right place for his wing, in fact one didn't have any studs at all! In the end he decided not to drill the wing (as someone suggested), but to drill holes in the correct places on the unit he had with no studs. He went to the extent of squaring them off, and used the studs from his old light unit, they pressed out and back in quite easily (as I found with a number-plate light unit). The wing aperture is also different but that doesn't seem to hinder fitting modified later units to the earlier wing.

This reminds me of an issue I had fitting new ones to the roadster - the chrome surround was pressed up against the paint when everything was screwed together, and I'd seen that had cut into the paint on a concourse example at the Classic Car Show. I ran a nut onto each stud first and that spaced it away, but left visible gap through as the sponge pads are not thick or dense enough. But a couple (from memory) of extra pads each side solved that.

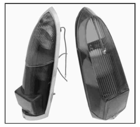
RB front units:

UK RB cars have the front parking lights as 'pilot' lights inside the headlamp.

North American spec cars got the same one-piece amber lens in the front bumper as RHD and other LHD cars, but the light-unit is different as it contains a dual filament 21W/6W bulb with offset location pins, the same as the stop/tail lights. This means that when the lights are on the indicators flash bright-dim-bright-dim instead of on-off-on-off. The Leyland diagrams are confusing as they still show the same two-bulb light unit as for chrome bumper cars, instead of a single bulb with two filaments as are shown for the stop/tail lamps. As the Advance Autowire diagrams show all lighting filaments separately there is no indication as to which is shared with which, for light units or bulbs.

Having upgraded the headlights to HID it left the halogen pilot lights looking distinctly yellow, and the same would be true for LED. I could use LED pilots - mine are wedge 501 T10 - but I have also pondered using them as DRLs if I can get some bright enough. Halogen are 1.7W but LED are classified in lumens (as well as colour) and can range from 300lM single element to 900lM multi element. Check the physical sizes as while many are the same as halogen at 25mm the brightest can be 34mm or more. I settled for 500lM which were the brightest I could find in the standard size, being in the headlight length probably wouldn't be an issue but I didn't want to risk it. I did find some 900lM at 34mm but the postage on those was more than the bulbs. The 500lM have an element on the front as well as a series of them round the side which I hoped would shine in the reflector, but unfortunately they don't.

Rear units:



The only significant change in the rear light clusters was for the 1970 model year when the lenses changed from rounded to angular.

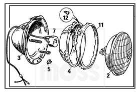
Special 'nuts' (BHA 4242 'Dotloc', NLA, use 10/32" UNF with star-washer) were used to attach the rear light clusters to the wings. These have a spike that scratches through the paint to get a connection - pretty crude but there we are, and being in the boot/load space it's better protected from wet and salt weather than other light units. I've also heard of a problem causing interactions between dual filament stop and parking light circuits where the connection between the bulb-holder and bulb was good, but the bulb holder was making a poor connection to the base of the light-unit. You can test for this from the back i.e. inside the boot or luggage space. *March 2020:* This has just cropped up again on the MGOC forum where the owner noticed the parking lights had started coming on every time he applied the brakes, but there were no interactions involving the indicators. Cleaning everything in sight seems to have fixed it, but no root cause tested for or identified. Incidentally he first noticed this when all-LED lighting was installed, still there when standard bulbs were installed. Now the standard bulbs work as they should, but LED stop/tails cause the original problem again.

LED park/stop/tail lights

Many new cars these days are being fitted with external LED lighting including stop/tail lights, so it is inevitable these are being offered by aftermarket suppliers as replacements for filament bulbs. The first thing to be aware of is that in the UK at least, and at the time of writing, external LED lighting is not legal for use on public roads, only off-road or at shows, and vendors for the UK market have to state 'off-road use only' somewhere in their advert. They are not specifically banned for cars before 1986, but there is enough conflict between two sets of regulations currently in force in the UK to make it a 'grey area'. Whilst the Police almost certainly won't stop you, and the MOT only checks for function (and adjustment of headlights), you should check with your insurance company first. I did, and was told they would not be acceptable, and they could affect any claim, even if I had informed them of the change (which you have to do). Information on legality or otherwise from Classic Car LEDs and the Federation of British Historic Vehicle Clubs.

Headlights:

As far as I can tell up to the 77 model year MGB headlamps were sealed beam. In the UK prior to 1970 GLU101 60/45W, then it gets a bit confused. The Parts Catalogue says for GLU101 'use before BHA4999' but that number isn't listed in the catalogue index nor does Google show anything for it. The next entry for 1970 to the end of chrome bumpers for 4-cylinder and V8 says GLU106, which the V8 Driver's Handbook (only CB cars) says is 75/55W, but the late CB 4-cylinder Driver's Handbook says 'GLU101 75/55W'. For rubber bumpers GLU123 is listed, and again I can only find two references both saying it is a sealed beam 75/50W with pilot light. For 1977 on H4 GLB472 halogen bulbs were used which any number of sites say is 60/55W. There were many variations for other markets and years.



The headlamp always used a 3-pin connector. On sealed beam rubber bumper cars it was combined with a holder and shroud for the pilot light to hold the pilot light against a 'window' on the sealed beam unit. From 77 on the halogen connector supports a gaiter that carries a separate bulb holder and positions the pilot bulb in a hole in the reflector assembly.

Headlights were never fused from the factory and if uprating them with higher power halogen and particularly with relays consideration should be given to fusing them.

Headlights have a wired earth, to a bolt near the right-hand headlight on early cars, moved to near the fusebox on later cars, probably with the alternator in 1968, but definitely with the starter relay in 1970.

On these later cars the main harness has several bullets and a tail by the right hand headlight for lighting and horn that side. The three headlamp wires are duplicated as one set brings power in to that point, and the second set feeds power back in to the main harness which then goes across to the left-hand side. Additionally there are single wires each side for the parking and indicator lights, and a 2-wire (until 1977, then a single wire) tail each side for the horns. One disadvantage of this arrangement is that the main and dipped beams for the left-hand side have to go via double bullets by the right-hand headlight as well as single bullets by the left-hand headlight, giving more opportunities for poor connections than the earlier arrangement, and these bullets suffer most from corrosion due to their exposure to the elements.

You have to be careful with replacement headlamp units as some are too deep to fit in the bowls.

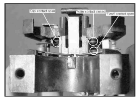
Brighter halogen bulbs are a direct replacement in these 77 and later cars, but to fit them to earlier cars you also need an H4 conversion. Many variations of these, some are described as having 'flat' glass, Vee has H4 with a domed glass (presumably a PO mod), although the dome is only half the height of that on Bee's sealed beams. They both have various ribs and patterns moulded into the glass so you have to see them side by side or measure the protrusion of the lens to see the difference, and some of them are too deep to fit in the bowls. The truly flat moulded glass variants are a little more obvious. But there are also variants with plain flat glass where all the focusing and beam shaping is done in the reflector rather than having a plain reflector with the moulded glass as originally, and these look very different. There are also LED conversions originally produced for Land Rovers which make the headlight black to a greater or lesser degree and these look truly horrible on an MGB.

There have been comments about how poor sealed-beam headlights are and at one point they were uprated slightly for the UK market. When converted to H4 halogen the wattage reverted to the earlier value, however it's quite likely that the perceived brightness did increase which can be done through manufacturing techniques while keeping the nominal wattage i.e. current drawn the same (see Uprated Halogen). However the difference between sealed beam and H4 on the MGB is negligible compared to the difference between H4 and HID on modern cars.

Needing to replace one of Vee's headlamps (with the same type - Moss quad-optic) I was surprised how 'misty' the reflectors/back of the lens had become with the new one fitted, so had to replace the other one.

Dip-switch:

There was a floor-mounted dip-switch until the 1970 model year, column-mounted after that.



The column mounted dip-switch can be a bit difficult to puzzle out as it incorporates a headlamp flasher, indicator/turn signal, and on some years the horn wiring as well. The accompanying pictures show which contacts are which as far as the dip/main/flash circuits go. Several problems can develop with this unit, like failure to flash or light the appropriate lights, failure to cancel, loss of spring tension, etc. There is some scope for repair, although like many components of that and later eras they were only intended for one-off assembly and use, replacement thereafter, which isn't cheap.

As far as the wires go:

- Blue is the headlight feed into the dip/main part of the switch.
- Blue/white goes out to the main beams.
- Blue/red goes out to the dipped beams.
- Purple is the feed for the main beam flasher (goes out on the blue/white).
- Light-green/brown is the feed in from the indicator/turn signal flasher.
- Green/white is the feed out to the right-side indicator/turn signal bulbs.
- Green/red is the feed out to the left-side indicator/turn signal bulbs.
- Purple/black is the feed out to the horns.

The dip-switch should have three fore and aft (towards you and away) positions: Clicked towards you lights the dipped beams. Clicked away from you lights the main beams. Both of these are only when the main lighting switch is in its 'headlights on' position. In the dipped beam position the lever can also be pulled towards you against spring pressure to light the main beams in 'flash' mode, and this is independently of whether the main lighting switch is on or off. When released the lever should return to the central/dipped beam position to extinguish the main beams. If the lever is pulled towards you when the headlights are on, the main beams will be illuminated from the headlamp flasher circuit as well as the dipped beams from the main lighting circuit.

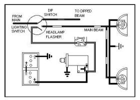
Some of the contacts are fixed and others are 'springy'. The springiness applies pressure to the contacts to give a good electrical contact, but all the contacts can burn and blacken over time which can reduce headlight brightness and cause the switch to get warm in use. Cleaning of all the contacts and careful bending of the spring contacts can restore functionality, but it is easy to overdo it and mess things up even further. The contact springs are nothing to do with limiting the fore and aft movement of the stalk or the spring return from the flash position, they are derived from plastic 'springs' on the switch body and arm, as indicated in the accompanying pictures.

Main-beam Tell-tale:

Fitted in the speedometer on Chrome bumper cars except V8, in the panel by the speedometer on V8s and RB cars. In the former case it uses a 'claw' type single-wire instrument bulb holder 13H1924 picking up an earth from the metal case of whatever it is pushed into. In the latter case it uses a 2-wire bulb holder and a wired earth (BCA4780) as it is fitted to a plastic panel. I suggest the original reason for fitting them was with the push-push dip switch as that gives no feedback as to which way it is switched. Our column stalks will tell you at a touch, but modern pull-pull stalks take us back to 'no feedback' and are an abomination, I **have** to look at the tell-tale on my ZS 180 to see if they are on or not when first turning on headlights. It would be better if they didn't 'latch' to main-beam while not turned on. **Should I use an LED in this position?** It's up to you, but I wouldn't want the additional brightness of an LED when I'm driving on unlit roads at night. Also with column stalks as said above you can tell at a touch if you are on main beam, and I suggest you would need to be driving a very long time after switching them to main beam to forget to dip when you see approaching traffic.

Headlamp Flasher:

Optional as part of the indicator switch on Mk1 cars, standard after that. Until the dip-switch was moved to the column stalk for the 1970 model year the headlamp flasher was powered from the brown (unfused) circuit, but it should be relatively easy to add a fuse. After that they were powered from the purple fused and always live circuit.



For 1970-on the headlamp flasher switch was part of the dip switch, see here for wiring and operation.

If your lights fail while you are driving at night, and if you have the presence of mind when suddenly plunged into blackness at 60mph on a mountain road, try the other beam (dip to main or vice-versa) or pull on the headlamp flasher. Because the headlamp flasher gets its supply from a different source it bypasses any problems in the main lighting switch or dip switch. It may just be enough to enable you to bring the car to a safe halt.

Trim Ring:

Clearance to wing

If you have done any work involving removal and refitting of the front wing or any headlamp components, I would strongly recommend you leave the rings off until successfully passing the headlamp alignment test in the MOT or remove

them yourself beforehand, likewise if taking it somewhere for headlamp alignment for other reasons. You don't want some scruffy oik in a garage levering them off.

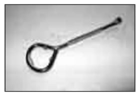
The theory is that the top is retained by two lips on the headlamp bowl, and the bottom by a spring-clip attached to the bottom of the bowl that rests in the curve of the trim ring when fitted. The clip is supposed to slide out of the curve as the bottom of the ring is eased forwards, however open to all the weather the clips and the trim ring can rust and make this extremely difficult. Going by the Parts Catalogues all MGBs had the same trim ring regardless of year - 57H 5296, although late models seem to have had rings with notches in to allow for adjustment without removal.

When Bee and Vee came to me more than 30 years ago they both had non-magnetic trim-rings so probably chrome-plated brass. I replaced Bee's at that time and those are magnetic, so probably steel-based, nevertheless still perfect. Vee's are lightly 'patinated' but I didn't bother replacing any of the bright-work (bar the heater intake) with the repaint as it all seems too 'blingy' and the quality of replacement parts these days is not good. The heater intake was looking a bit rough so I did get a new one - and true to form it has the wrong curvature!

Some years ago I replaced one of the bowls on Vee as it had rotted, and the replacement from the MGOC came with a screw fitting instead of the spring-clip. This is standard for cars using the same headlight like the Mini, which has a screw-hole in the bottom of the ring (one of the Parts Catalogue drawings does show such a screw, but this must be an error as the part number is the same as the others), however there is no access to such a screw on the MGB. Fortunately the spring-clip on the old bowl was reusable and I could change them over. Subsequently I worked on a car with aftermarket Wipac plastic headlamp bowls that also had the screw, but no option to replace that with a clip as it was a one-piece moulding. But the screw had been fitted to the bowl before the ring, and adjusted such that the head just fitted into the curve of the ring. Careful adjustment **is** needed to get the screw just right so the ring doesn't fall off (screw in too far) or jam (screw not in far enough), but get it right and it is easier to get the ring off and on than the original spring-clip.

But back to the original arrangement. There seems little option but to lever the bottom of the ring forwards somehow until hopefully it pops off the spring-clip at the bottom ... but that has never happened for me. Brute force has been needed to pull the bottom of the ring off the clip which bends the clip forwards and it has to be pushed back again to refit the ring, with the risk of eventual fracture. Pressing down hard on the top of the ring with the other hand can help, until you can see what is going on inside. Tackling Vee's which hadn't been moved for about 10 years or so I could see that instead of a recess in the spring sitting on the rear edge of the trim ring, the end of the spring had lodged behind a lip on the rear edge of the ring. This means that instead of the ring sliding off the clip as the ring is eased forwards, the clip has to be bent right forwards, severely distorting it. With the bottom pulled forwards this far I did then try levering the ring upwards to get the top of the ring unhooked from the two lips at the top. I could get the one side off but not the other, so had to resort to putting a small screwdriver through the gap at the bottom and levering the clip up off the ring, but as often as not the screwdriver slips off. I put fresh Waxoyl on the back of the ring and on the clip and tried refitting it with the recess of the clip sitting on the rear edge of the ring, but as soon as I pushed it home the end of the clip dropped down in front of the rear edge of the ring just as before, and trying to remove it again even with fresh Waxoyl I was back to square one. I then tried pushing the spring as far back and upward as it would go, and this time the recess in the clip did stay on the rim of the ring. This did make it easier to remove, although still required some force, and pulled the spring downwards and forwards again, so had to be pushed back and up again before refitting. If there were a small cut-out in the rear edge of the ring such that you could rotate the ring to line that up with the clip it would make life easier, and indeed some of the rings in the Parts Catalogues do show a cut-out in that location, but again the part numbers are the same as before. It's possible that the design was changed at some time, but kept the part number as the change was so small and it was fully backwards compatible. But replacement rings bought in 1990 for Bee do not have the cut-out. However you get the ring off, daub the back of the ring with Waxoyl to protect that from rusting through from the back as well as to aid fitting and removal, and daub the spring-clip as well.

Combined trim-ring puller and beer-bottle opener! *December 2020*



Many years ago and occasionally since I have heard Americans talking about using a 'paint can lid remover' to get these rings off. But since I've been using screwdrivers to open paint cans for the past 55 years I couldn't imagine what they were like and how they were any better, and there were no images and precious little internet in those days. More recently a pal in Philadelphia happened to mention it, and asking him about it he made a video to show what it was like and how he used it, and because I was interested he very kindly sent me four. Initially I had Googled 'paint can lid remover' and although there were a few of a similar design in the UK for a couple of pounds the end of those was basically flat and not much different to a screwdriver, whereas the American ones are almost a right-angle at the end. Then I found them on Amazon UK, but they are supplied from the US at £10 including P&P which is quite pricey. The bonus feature of this ring-handled type is that they can also be used to open beer bottles!

I start off at the side but because the end is bent at a right-angle the ring can be pulled forwards rather than levering against the wing. As the lower half of the ring comes forwards, the tool is moved down and round to pull the ring further forwards at the bottom.


With the ring pulled forwards 1/2" or so the clip is visible, but trying to lever it up off the ring with a screwdriver doesn't work as it just slips off nine times out of ten. Brute-force has to be used which bends the clip right forwards, and it has to be pushed back again to refit the ring. How long it would stand up to that treatment without fracturing I don't know.


The difference with this tool is that with the end angled upwards under the clip it can be levered up from the ring very easily, the clip is not bent, and the ring just snaps back into place when refitting. To check it wasn't a fluke I tried it on the other side of Vee a couple of times with the same result. I haven't tried Bee yet as I'm not expecting to have to remove the rings any time soon, but on Vee with the new uprated headlights they may need adjustment at the next MOT. Nevertheless I shall keep one in each car - just in case.


Without a tool such as the above there seems little option but to lever near the bottom of the ring with a screwdriver using the curve of the wing as a fulcrum, and a thick pad to protect the paint. Note that sound wings are required to perform this manoeuvre! Then use brute-force to pull it off the clip. It's the only method that worked for me for 30 years, fortunately not a frequent operation.

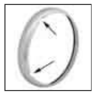

Even though I used the tool previous 'brute force' had obviously taken it's toll as removing one of Vee's the end of the clip snapped off, but replacements clips BAU1460 are available on only take moments to replace ... once you have removed the lens and reflector, inner bowl from the outer bowl, and the outer bowl from the wing ... Note that once the spring has been detached the inner bowl should rotate off the adjuster screws without needing to remove or alter the position of those screws, which avoids upsetting the beam alignment.

February 2023:

Had occasion to remove the other trim-ring from Vee and that clip snapped off as well. I'd already used both I had bought previously so bought two more, and this time replaced it with minimal dismantling. Once done I found that on refitting the trim-ring it dropped into the notch in the clip as it should, rather than lodging behind it, and came off again with the puller much easier than any of them had before, but still held firmly.

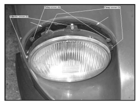
Clearance to wing: *October 2021:*

Graham Moore on the MGOC forum has been having problems fitting new trim rings as part of his restoration because there is insufficient clearance to the wing at the inner edge. I've had the same problem on Vee with what are probably original rings, and so has a PO as the passenger side ring is slightly flattened in that area. Measuring old and new rings - the thickness of the flange where it contacts the rubber gasket - Graham's old rings were 2.8mm and new 4.5mm. I have an old set from Bee replaced 32 years ago and they and the original ones on Vee measure 2.6mm. Bee's 'new' ones measure 2.85mm ... at one point but increasing as you go round the rim to 3.45mm! Originals have a welded seam that has to go in the area of the bottom inner corner limiting scope for placing a thinner part by the wing, but modern ones have no weld so can fitted with the thinnest section in the smallest gap. Graham is handy for the MGOC shop and early CB wings (wide spaced sidelights) have plenty of clearance between rim and wing - 3-4mm, all the later ones had less than 1mm. He also spoke to the workshop who confirmed that they never fit later cars, and they need to grind the wing before painting and reduce the weld size right in the corner too, as well as slotting the holes in the bowl so that can be slid across to make more room. As Graham says - Great! Looking at Bee and Vee here is just enough clearance on Bee - about that 1mm Graham mentioned, and on Vee's driver's side, but on Vee's passenger side there is no clearance even having slid the bowl across as far as it will go without grinding the (freshly painted!) wing, and the ring has been flattened in that area as well.


Whilst only originally provided for North America during the last year of production a number of UK suppliers have the headlamp ring with cut-outs for adjustment meaning removal of the ring is not required. On-car they do look a little 'odd' though.

Headlamp Adjustment:

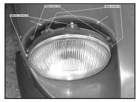
First, remove your trim-ring! With the possible exception of later models (which may have a notch in the ring to allow for adjustment without removal) these can be a right pain.


And now for the adjustment! By comparison with trim-ring removal it is simplicity itself. The adjuster screw at the top tilts the beam up and down, and the one at the side moves it from side to side. You can adjust the beams without the aid of a beam-setter if you have at least 37ft 8 ½ inches (25 ft plus the length of the car!) of flat and level surface back from a vertical surface such as a wall or garage door. Drive the car up to the vertical surface and mark the position of the centre of each headlight e.g. with electrical or masking tape. Now comes the confusing bit. Various sources now say to place two more marks 3" below the centre of the headlight, or 2", or 1" down and 1" to the left, and others just seem to use the original marks. UKMOT.com has a diagram showing that the datum lines should be 0.5% to 2% down, and 2% to the left, which for MGB headlights

typically 24" (Vee) off the ground (i.e. less than 850mm or 33.5") equates to 0.12" to 0.48", and 0.48" respectively! Or is that percentage of the screen width and height!? The junction of the two lines ('break' point here) should be between 0.5% and 2% below the headlight centre, and between 0% and 2% to the left. In the past I have set mine using the centres and they have failed the MOT as being too high, and what has passed puts a pool of light just a few feet in front of the car on dipped beam, and still on the road albeit further forward on main beam i.e. to me too low. So probably better to err on the side of lower rather than higher. The MOT should check them with someone sitting in the drivers seat, so if you do yours with the car empty (beautiful/handsome assistant not being available/willing) that will give you a bit of a margin.

Back up so the front of the car is 25ft from the vertical surface and turn on the dipped beam (obviously doing this at night is preferable!). Each dipped beam should have a flat and horizontal top edge on the right-hand side, and the left-hand side should be angled upwards, this upward angling lights up the left-hand side of the road. Note that other European countries don't have this which is why they don't need beam deflectors when driving here like we do when driving there. A typical MGB won't have a sharp cut-off at the top of the beam like many modern cars do, having some upward scatter, but there should be a visible point where the horizontal part joins the angled part - the junction. Adjust the headlamps so that this junction is on your secondary marks. Switch to main beam and the centre of the beam should also be on these secondary marks. Note that if your reflectors are cloudy, bulbs old and blackened inside etc. the junction may not be clear enough and it can fail the MOT. Any misalignment of the bulb, reflector etc. could result in one beam to be correctly adjusted but the other not, with the same result.

Headlamp Mounting: *January 2017*


The headlamp glass and reflector (a single unit) is clamped into a chrome-plated surround with four small screws. The rear half of the surround has a tab at the top and one on the outer edge for the special beam adjuster screws to slot into. These screw into nylon sockets fitted into the headlamp bowl, and as they are turned move their part of the surround plus headlamp assembly back and fore to get the correct height and side to side adjustment. The back of the reflector should have a tag with a hole, and a spring goes between this and a similar tag inside the bowl, to pull the headlamp assembly plus clamp ring into the bowl, and it is pushed out against spring tension by the adjuster screws to get the correct beam adjustment.


The bowl attaches to the wing with four screws - top, bottom and at each side, with a rubber gasket between bowl and wing. The gasket has sleeves for the adjuster screws, to prevent dirt being thrown forwards onto the headlamp and down the outside of the wing as well as to protect the screws from the worst of road dirt to some extent. The four bowl screws go into a reinforcing/mounting ring which is spot-welded to the back of the main body of the wing. This reinforcing ring does not appear to be separately available for the MGB, but should be the same as the classic Mini item which is part No. 14A6993 from many sources.

Uprated Headlamps

Relays and Fuses
Halogen
LED
HID

Relays and Fuses:
Main beam/flasher problems
The full current for the headlights is fed through the main and dip switches. Not only does this involve considerable lengths of wire and several connectors, but ageing switches can be less than perfect, all of which produces less light from the lamps and heat in the switches, in extreme cases melting them and causing total loss of lights. Uprated headlights almost certainly take more current which will make the foregoing problems worse, and you will not see the full benefit of the extra power. Always consider fitting relays with uprated lamps, which will result in more power at the lights and less strain on the old switches and connectors. Two relays will be required - one for the dipped beam and one for the main. The difference can be remarkable, as seen with a set I fitted to a car with uprated headlamps. Beforehand when switching from dip to main and back again there was a finite period when there was virtually no light at all! Afterwards the switch was near instant, and the lights were significantly brighter as well.

The next consideration is fusing. The headlights were never fused by the factory. Because you are adding wiring it does make sense to fuse it, but simply providing one main fuse (e.g. the MGOC and Moss kits) could result in total loss of the headlamps if it should fail, so think in terms of providing one fuse per beam as a minimum if not one per filament. This will protect the wiring from just after the relays out to the lamps, but still leaves the relays and wiring to them unprotected. By positioning the relays close to the point at which you pick up the supply from a brown connection point and properly routing and harness-taping you can minimise the risks but some might still want to fuse the main supply as well. In this case you should use a rating at least double that for the filaments, otherwise a problem by one headlight could blow the main fuse and not the filament fuse. I would recommend using 10amps per filament or 15amps per beam, which is about double the typical current flow, and 30amps minimum for the main fuse. That may seem high, but the headlamp flasher needs to be considered. From 1970 when the dip-switch was on the column stalk the headlamp flasher used its own fused supply, but with relays all that circuit does is operate the main beam relay. If the headlights are on dipped beam and the stalk is pulled towards you to flash the main beams, both relays will be operated and all four filaments will be powered, so any main fuse will be carrying getting on for 20 amps, and needs to be in excess of that. If you are not using a main fuse in series with filament or headlamp fuses then the filament and those fuses can be standard 17/35s.

Click on the link for the schematic and suggested layout. The standard wiring on most MGB has two double bullet connectors by the right-hand headlight one for dip and one for main. These have three wires - a supply wire and another wire in the main harness that goes across to the left-hand headlight, the third wire from a tail going to the right-hand headlight. At the left-hand headlight there are two single bullet connectors each with a wire from the end of the main harness and a tail leading to the headlight. Early cars have this junction in the middle of the car with two long tails - one to the left and one to the right. Position the fuses close to the relays. One fuse per filament will see four fuses on the output of the two relays, one fuse per beam will see two fuses feeding power to the relay. To avoid cutting into the harness, and to make the changes easily reversible if required, make up a sub-harness that picks up the blue/white and blue/red wires from the main harness via two single connectors and routes them to the relays, two wires from the relays to the fuses, and four wires from the fuses back to four single bullet connectors to join up with the wires to the headlamps.

October 2016: Relay kits are available from MGOC and Moss Europe (with the latter being a lot more expensive!) or Moss US. Both kits only seem to include a single main supply fuse, which should it blow will kill both dipped and main beams. Daniel Stern Lighting recommends one per relay, and this kit from Advance Autowire has one per filament, but no main supply fuse, so opinions obviously vary! For both MGOC and Moss kits it would be easy to add a second fuse and have one per relay, and not much more work to add one per filament, just by adding in-line fuses with the appropriate spades and bullets. However note that the Moss and Advance kits use relays plugged in to sockets. There are two configurations of relay terminal, and with sockets you have to use the correct configuration, more info here.

November 2020: In the space of a couple of days I was asked for advice about improving the electrics with relays and fuses from two separate people, and a pal in America sent me a picture of heat-damaged wiring at his lighting switch. All of which set me off thinking about Vee's headlights as we do occasionally use her at night.

But first I decided to see just how much difference a relay might make. I took a length of the heavier gauge wire that is used for headlights, put a bullet on one end and fitted that to the spare hole in the main-beam bullet connector by the right hand headlight, and positioned the other end (which happened to have a ring terminal) by the battery terminal post in the engine compartment. Turned on the headlights as normal, then tapped the ring connector on the battery terminal post. Not only did they brighten significantly, but the connection even sparked confirming that significantly more current was flowing, and the voltage at the headlight bullet increased from 9v to 11.5v (engine not running), and that despite my 'ring main' wiring of the brown circuit. So Something Should Be Done.

Relays are simple enough, but what to do about fuses? Two relays plus four fuses is going to take up quite a bit of space on the inner wing, all need mounting, and I don't like drilling holes. You can get sockets for plug-in relays so I looked for a socket for a pair of relays with a single mounting point without success. But along the way I found this dual relay with single mounting point from 12v Planet which is just the ticket - or so I thought. These are unfused and whilst I could get fused relays for individual sockets they take modern blade fuses which means carrying spares. In the end I decided to go with in-line holders that take standard fuses, 20 amp rated with spade terminals also from 12v Planet, and use just one per relay i.e. one for the dipped beams and one for the main, and expect to have the presence of mind to switch beams if the one should fail. I'm planning on having only about 6" of wire from the relay to an existing brown circuit connection. Four of these fuses could be used one per filament if you prefer but you would have to join two together to connect to the relay output, in which case the 'bare ended' type would probably be better for you to attach your own terminals.

Fabrication went well but with five headlight-grade wires going to the two relays I discovered the individual relays were getting dislodged in the dual case during installation. They are 'skeleton' relays, the only casing is the dual case, and they are only 'clicked' in. As well as the risk of mechanical damage I can't see anything stopping moisture getting in and causing problems, so I decided to super-glue them in ... and of course ran out of adhesive and had to order more. But the biggest headache by far was getting them working properly. You need to find the supply wire to the 4-way bullet connector at the right-hand headlight and pull that out, as that becomes the relay 'operate' wire, and the output wire from the relay goes back into the 4-way bullet connector to power both headlights. In theory one pulls one of the main harness wires out, and if both sides stop working you know you have pulled out the supply wire, so you put that into a new 2-way bullet connector with the relay 'operate' wire. But if only the left-hand headlight goes out you have the wrong wire, so put that one back and pull the other one out. Easy, no? No! I just couldn't get them to work right - one beam worked but not the other, sometimes one of the relays buzzed, if the dips were on and pulled the stalk back to flash the dips went out and all sorts. Thinking I had the wrong wires I juggled them about which just confused the issue. Resorted to a 12v jumper lead to operate the relays and power the lamps directly to try and work out what was wrong to no avail. Got a meter to measure the voltages and got some very strange readings. Eventually I used the jumper wire to connect an earth to the relays on top of the existing earth wire, and suddenly they started working. When I removed the front fog/spot lights for painting and decided not to put them back I left the relay in place with just the earth wire connected having removed the other three wires. Mounting the dual relay in place of the single I simply swapped the earth wire over to the new relays 'assuming' it was a good earth ... and of course it wasn't! Testing it with an ohmmeter it drifts about a bit, it comes out of additional wrap on the harness so where it

goes back to I have no idea. All I can say is that the old lights worked - probably because it was just one relay, but two sharing a poor earth get unwanted interactions. Anyway, I abandoned that wire and fabricated a new one to go under the relay fixing screw. Phew.

At the same time I've decided to uprate the H4 bulbs to Osram Night Breaker Silver which are claimed to be about 100% uprated (see below). Incidentally, one person reviewed these bulbs and complained about them giving an 'amber' light instead of 'silver' as on the tin. The word 'dipstick' comes to mind.

Main beam/flasher problems: *October 2021* Note that if your speedo contains the main-beam tell-tale as well as the panel light bulb the speedo must be properly earthed. Brian Wall on the MGOC forum reported a strange problem affecting the headlamp flasher after doing some work on his relays. It took a couple of goes to ascertain what was happening but I suspected speedo earthing affecting the main-beam tell-tale. The first symptom was that if the tell-tale was unplugged the headlights worked as they should, and if the tell-tale bulb holder was earthed with a separate wire that also worked as it should. Subsequently Brian wrote "when I turn on headlights it will show main beam and allow me to change to dip beam, but then will not change back to main or even flash the lights (unless I) turn lights off, then on again and same sequence all over again, until I disconnect the telltale and let it hang free and then the headlights and flasher work as normal". This confirmed speedo earthing as the problem to me, and connecting an earth to the speedo allowed everything to work as it should, The problem occurred for the following reasons:

- With the parking lights on, the lack of earth to the speedo means that the panel light is trying to earth backwards through the main-beam tell-tale bulb.
- Without relays the two bulbs in series would earth through the headlamp main beam filaments, but the current is so low you would not notice it at the headlights. Both panel and tell-tale bulbs would only glow dimly - unlikely to be noticed especially in daylight.
- With relays the relays only supply power to the headlamps themselves, the main-beam tell-tale is powered from the dip-switch/headlamp flasher switches as before, which are also powering the main-beam relay, hence there is a connection between the tell-tale and the relay winding.
- When the main beam is turned off there is enough current flowing from the parking light circuit through the panel light bulb and backwards through the tell-tale bulb in series to the relay winding to keep the relay operated ... unless the panel light dimmer is turned off!
- This keeps the main beam illuminated, but again you would have to look closely to realise it unless you were in the dark, especially if the dipped beam was illuminated.
- The headlamp flasher used on its own, i.e. with the main lighting switch off, would almost certainly work normally. Even the tell-tale would work almost normally as current from the headlamp flasher switch would flow through the tell-tale bulb and backwards through the panel light bulb to the parking light circuit, and from there to earth through all the parking light bulbs in parallel, again unless the panel light dimmer switch is turned off.
- LEDs used in panel lights and/or the tell-tale would change the symptoms because they will only pass current in one direction, not both like a filament bulb. LED headlamps were in use on this car but I don't think they would have an effect, and relays shouldn't be needed with LED headlamp bulbs anyway as the current is much lower.

Halogen: If you have sealed beams currently you will need an H4 conversion which includes the headlamp unit as well as bulbs, the connector should be the same. One would hope that these kits are correct for the MGB but some headlamp units are too deep to fit in the bowls.

Uprated halogen: There are H4 halogen bulbs available with claimed 20% to 200% more brightness for the same wattage as originally e.g. 60/55W, all road legal. There are also 100/80W and 130/100W versions for sale, but unless they were original equipment on your car they are not road-legal. The 'brighter for the same wattage' bulbs achieve that by a different design of filament which draws the original current, and hence are the same wattage (Watts being Volts multiplied by Amps), but as with anything else you don't get owt for nowt and the 'cost' (in additional to higher price) is a shorter life. For example the 150% is said to have half the life of the 130%, which itself will have a reduced life from the 110%, and so on comparing 110%, 50% and standard. When buying these make sure they are dual-filament for main and dipped beams, as there are single-filament variants which have the same H4 fitting. They are for cars with dual headlights such as the ZS which has main and dip in the outer headlight, and an additional main beam only in the inner headlight. As ever shop around, for example Halfords has a single 50% brighter at £17 (although you may get a BOGOF offer), whereas Euro Car Parts has pairs of Osram 115% at £15, Phillips 130% at £18, and Phillips 150% at £21 (although with these last two there is no written indication of whether they are single- or dual-filament). Standard halogen dual-filament are typically £3!

November 2020: As part of installing relays and fuses I also purchased a pair of '+100%' uprated bulbs but as the detailed text says 'up to' that can mean anything or nothing. After fitting just one it's true they are a bit brighter - but not as much improvement as from the relays, I doubt you would notice the difference with two in and on the road. But they were reduced from £17 to £12 so I can live with that.

But before considering a change such as this, it would be best to investigate your switches and wiring to see how much voltage is being lost before it gets to the bulb, if not fit relays and fuses. Clean bullets and connectors always help, and you should consider replacing the connectors at the front of the car, polishing the bullets with fine wet-and-dry or emery cloth, and reassembling with Vaseline. I did that on Vee as a matter of course towards the end of her restoration, as well as polishing all the bullets by the pedal box and in the boot, and found the indicator flashing rate afterwards was noticeably faster and more consistent even though the switches and wiring were as before. To measure the volt drop connect a meter between the brown at the fusebox, and the back of each of the bullets by the off-side headlight, for each beam when powered. No need to run the engine, although the voltages you will see will be higher the relative differences will be the same, and it is those we are interested in. There should be two wires from the harness, and one wire from the sub-harness going through the inner wing to the headlight. Any difference in voltage between the three bullets shows that voltage is being lost in that connector. And the difference between the highest of those and the brown at the fusebox is what is being lost in the main lighting switch, dip-switch, and their wiring. You can also unplug the alternator, and move the meter probe from the brown at the fusebox to the thick brown in the alternator plug, and the difference between that and the fusebox reading will tell you if any is being lost in the connections at the solenoid. Unless you have brand-new wiring and switches, and perfect connections, you are bound to see some voltage being lost, in which case your headlights would benefit from having relays and fuses installed. I fitted relays and fuses for someone with (illegal) 100w bulbs, he said before that as well as not being very bright before, when switching between dip and main the 'new' beam only gradually came up after the 'old' beam went out, leaving him momentarily in the dark. Afterwards he said they switched almost instantly, as well as being noticeably brighter. Checking Vee main beam lost volts is about 1.8v and dipped about 1.5v, with Bee (old bullet connectors at the front) a couple of tenths higher. There is only about 0.1v difference between the fusebox and the alt plug on both. Powered normally, then adding a thick jumper wire between the fusebox and the connectors (simulating a relay), there was a visible increase in brightness. Pondering.

LED:

March 2023: The wording changes again to remove the confusion caused by the use of the word 'halogen', now conversion to LED or HID of any type of headlamp on cars first used before 1st April 1986 is legal.

March 2021: Ink barely dry and they change the rules again. From 22nd March halogen to LED conversions on cars first used before 1st April 1986 will be legal. But then they go and mess it up by writing:

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Which surely implies that only if the **conversion** was done before 1st April 1986 will they pass the MOT, which is nonsense. Surely it should say 'Vehicles first used on or after 1st April 1986 ...' will be failed.

Also by specifying 'halogen' it's implying converted sealed beam installations will continue to be failed, surely 'halogen' should read 'incandescent' or 'filament' i.e. treat sealed beam and halogen the same. Even more complicated where sealed beam have already been converted to halogen!

Even more interesting is that HID conversions will also be legal, and having been disappointed with an LED conversion I'll be looking at HIDs.

1st January 2021: MOT rules have been changed to fail cars with LED headlamp conversions:

> 4. Lamps, reflectors and electrical equipment
> 4.1. Headlamps
> 4.1.4. Compliance with requirements
> "Existing halogen headlamp units should not be converted to be used with high intensity discharge (HID) or light emitting diode (LED) bulbs. If such a conversion has been done, you must fail the headlamp."

The irony is the phrase 'Existing halogen headlamp units'. Most MGBs came out of the factory with non-halogen headlamps, so even this has created another 'grey area', they probably should have used the term 'filament' instead.

October 2020: Information on legality or otherwise from Classic Car LEDs and the Federation of British Historic Vehicle Clubs here.

September 2020: Brian Wall on the MGOC forum asked about his club-supplied LED headlights and why the headlamp flasher wasn't working when the dipped beams were on. I wondered whether this was something to do with having LEDs and asked if the tell-tale was coming on. It is, so yet another undocumented feature of dual 'filament' LEDs. However Brian raised this again in November 2021 after having rewired the relays, and this time I suggested he double-check that the dip relay is remaining operated and the main relay operates as well when the control is pulled to flash. And he discovered that he had cross-connected the two some how, and correcting that they work as they should.

Intrigued by an advert in Enjoying MG I did some research and found some with the same manufacturers designation elsewhere at about half the price. They turned out to be slightly different physically as the driver module is integral with the lamp, which has a short cable terminating in a 3-pin plug which is compatible with the harness socket. There is quite a large 'lump' on the back of the 'bulb'

which made me wonder if it would all fit in the bowl, but it did. The MGOC items are shown with an external driver module, as well as having the lump on the back and cable with plug so even more to fit in.

One issue with installation is that you install the H4 adapter to the reflector/lens assembly, then slide the 'bulb' into the adapter, and twist it to get the correct beam pattern with a ball-bearing dropping into a hole to hold it in the selected position. This is so that one kit can be used for both RHD and LHD with the upsweep on the correct side ... but there are a whole series of holes all round the adapter meaning you can select any of about a dozen positions, including with the beam vertical instead of horizontal! The 'issue' was with the rubber seal that fits round the base of a halogen bulb and pushes up against the back of the reflector. With the LED items you fit the rubber seal to the back of the reflector after the H4 adapter, then push the LED 'bulb' through the hole in the seal into the adapter. However the seal is too deep to allow the 'bulb' to go in far enough for the ball-bearing to engage with one of the holes, meaning it (the seal) would have to be cut down. I didn't do this, pending further enquiries.

As far as adjusting the rotational position of the 'bulb' goes this has to be done with it powered, but before the lens/reflector is clamped into its carrier. The flat and angled cut-offs of the dipped beam can be clearly seen in the glass, and as my glass has similar moulded lines, it is a simple matter of turning the 'bulb' until the edges of the beam line up with the mouldings in the glass. Bear in mind that when looking at the glass, everything is reversed compared to how the light strikes the road, i.e. the light is at the top of the glass instead of the bottom, and the angled section is on the off-side instead of the near-side.

That gives rise to another 'issue', and that there is a distinctive 'dead' area in the light at the top of the glass, which means there will be a similar 'dead' area on the road right in front of you. This can be seen in YouTube demonstrations of other LED installations on other vehicles, and isn't apparent with halogen bulbs or sealed-beam units. The light is very white, and makes the filament pilot light in the rubber-bumper headlamp assembly look like an orange neon. A brief test at night in lit streets didn't seem to give that much better **actual** visibility, it was more the whiter reflection.

Yet another issue was flickering. A pal has had two sets of LED stop/tail but they failed the MOT being 'adversely affected by the operation of other lamps' i.e. flickering when the (filament) indicators were in operation. Some have said that is a factor of cheap bulbs, and if you pay more for better quality from other vendors it doesn't happen. One such vendor was named, and this is who I got my LED headlights from. Interested to see what happened when I cranked the engine with them on, I couldn't help laughing out loud when they cut out altogether apart from very brief flicks of light. There was also a visible flicker when the indicators were going - so much for 'better quality'.

However the biggest issue (at the time, clarified and simplified since) concerns legality. It wasn't until I got them that I saw on the box 'OFF-ROAD USE ONLY', despite the vendors description including words such as 'as used on our cars' and 'not dazzling other road-users'! So I did a search for 'off-road' in their ad and found buried in 2537 words of Terms and Conditions the statement "... Therefore all our external LED bulbs are sold as off-road use only." The MGOC ad makes no mention that I have been able to find, and speaking to them it is a grey-area. 1986 Regulations state that cars first used **from** 1st April 1986 must have filament lights with an approval mark, which is fair enough. But for cars used before that there are contradictions with the UN accord of 1958. The upshot is that pre-1/4/86 it's not clear (no pun intended). You are unlikely to get stopped by the Police, and the MOT only checks function and adjustment not legality, but that still leaves your insurance company. I consulted mine, and they were quite clear that they did not approve them, and it could compromise any insurance claim even if I had advised them beforehand. I'm pretty sure he knew what he was talking about as he was a Land Rover enthusiast and said there were LED conversions for Defenders with 7" lights which **were** legal. He gave me the details of two types (Nolden 7" Bi-LED and Lynx Eye) but these are so aesthetically different (and expensive!) compared to the MGB originals they are out of the question. The upshot is, these LEDs go back, and uprated (brighter but same wattage, higher wattage also being illegal) halogen are next to be tried.

The doubt over the legality of external LED lighting has cropped up before on MG fora, and many pooh-pooh it. But that's up to them and you. If you make an informed decision to fit them and it goes wrong, you have no-one to blame but yourself.

February 2024:

Pal Geoff had bought an MGB with complete LED headlight units (similar to Nolden and Lynx above) that have DRL and indicator functions as well but wanted to go back to standard headlights, which was where I got involved, and that made the LED units surplus to requirements. He offered them to me but I wasn't interested (at the time ...) having already fitted HID and then quite by chance not long after someone else contacted me seeking advice about improving headlights as he was getting less and less comfortable driving Yorkshire lanes in the dark. I mentioned these were available, sent him a link to *similar* lights (not knowing exactly where Geoff's had come from), he was interested, asked if Geoff had any comments about performance which he hadn't as he had done no night driving, so I offered to do some comparison tests. As well as the LED unit I have my previous 10% uprated halogen 'on the shelf' and the HIDs in the car. I'm not going to swap headlights round on the car, but can do 'hand-held' beside the car pointing down the road. Done from the garage as I'm not prepared to take all the gubbins out to a dark lane, so it is subject to local street lighting, which does include one immediately across the road. Set the camera recording, took the HIDs first, then each of the other two. The LED unit was quite impressive, although not as good as the link I had been sent indicated, but noticeably better than the LED 'bulbs' I had tried, the halogen 'live' was pretty dim in comparison. Using basic jumper wires to power them and hand-held I wasn't able to switch the other two between dip and main while keeping them steady, so did some editing of the video afterwards trimming and splicing to get the same effect. Recorded - subject to the street light immediately outside - and played back the halogen was so weak I didn't bother including it, and the LED was nothing like the link portrayed, and nothing like the HID (it's always annoyed me just how low headlight beams have to be to pass the MOT compared to OEM HID, which when on SUVs, 4x4s and the like are shining right in the eyes of an MGB driver ... even an RB MGB!). There is a wide range of LED units available, ranging in price from £25 to £500, so how you choose between them I don't know.

HID:

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Which surely implies that only if the **conversion** was done before 1st April 1986 will they pass the MOT, which is nonsense. Surely it should say 'Vehicles first used on or after 1st April 1986 ...' will be failed.

Also by specifying 'halogen' it's implying converted sealed beam installations will continue to be failed, surely 'halogen' should read 'incandescent' or 'filament' i.e. treat sealed beam and halogen the same. Even more complicated where sealed beam have already been converted to halogen! Nevertheless as Vee IS halogen and we do use her at night I decided to look into a conversion.

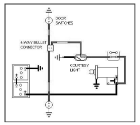
Switch Connections:

Only three wires but still several permutations even with only three spades as on rocker and the later 'toggle' switches on the column cowl. Early push-pull and toggle switches can have several unused spades and also work either way up, although there should be a flat which ensures they cannot turn in the dash as well as meaning they can only fit one way round. If the terminals are numbered then brown should go on 4, red on 7 and blue on 8. Rocker switches can fit in the dash either way round but forward-facing lamps have the logo pointing to the right. Later illuminated rockers fit with the illuminated panel at the top. You can derive the connections by using an ohmmeter as follows:

- When off all three spades should be isolated.
- In the first operated position two spades (pins on later toggle switches) will be connected together, brown and red can go on these either way round.
- In the second operated position a third spade/pin will be connected to the other two, blue goes on here.

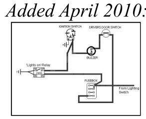
Prior to 1977 models the main lighting switches were always on the dash, after that they were on the steering column cowl. The cowl wiring has been known to get trapped and cause short-circuits, which can damage wiring as well as the switch. North American spec Mk2 prior to 1970 had the panel light on/off (not a dimmer) switch on the column cowl and those wires can also get trapped. None of the lighting wiring is fused at that point.

'Lights on' warning:



A simple 'lights on' warning buzzer when a door opens which avoids having to cut one of the courtesy-light switch wires, but operates from the passenger door and manual switch on the courtesy light as well. By cutting the purple-white to the drivers door switch a diode can be inserted so only the driver's door operates the buzzer. The polarities of the diode(s) and buzzer assume a negative-earth car, they should be reversed for a positive-earth car. Any 100v, 1 amp diode and 12v dc buzzer should suffice.

Added April 2010:



I've been asked by Frank Mooring if it's possible to use the existing North American spec seat-belt and 'key in' warning buzzer for a 'lights on' warning, rather than provide an additional buzzer. I suggest schematics (click the thumbnail) for each of the three types although I haven't been able to test them. This requires the use of a relay to convert the light-on signals so they can be used by the existing circuit. It may be easier just to provide and additional buzzer, but this will need a diode as shown in the schematics above.

Daytime Running Lights (DRLs):

Ubiquitous now, and getting so bright there has to be a risk that cars without could be missed (which is also why you see many motor bikes running with headlights on). There is enough chrome and bright-work twinkling on the front of your average MGB in sunny conditions, but in dappled sunlight under trees and going from sunny to shady and back again it would be easier to miss dark-coloured cars, such as Black Tulip!

Legally, there seems to be no information regarding after-market DRLs, and even that for later vehicles where they are original equipment is sketchy to say the least. The MOT Manual Section 4.2 (Updated: 14 October 2021) says they are only inspected on vehicles first used on or after 1st March 2018, and the only mandatory information for those is that they must go on and off with the engine. Other than that "Daytime running lamps (DRLs) or headlamps may function as front position lamps. If the DRLs function as front position lamps, they may or may not dim when rear position lamps are switched on and may dim or turn off when headlamps are switched on". They are not mentioned in the Categorisation of vehicle defects for passenger cars, and I can't find any mention of lighting at all in the Construction and Use document ... which is because it is covered under the separate Road Vehicles Lighting Regulations, which says even less than the MOT Manual.

LEDs are the obvious choice for longevity and low power consumption. I spent some time looking at these, but for after-market you are looking at spending £50 upwards without knowing anything about how they perform. Avoid cheaper 'styling' lights, they use much smaller and less bright LED elements. I even pondered OEM types as at least one can see those in use on our streets, but usually they are highly 'styled' for integration with existing bodywork on the car in question and not suitable for aftermarket use - round MINI types being an exception, but they are going to cost a fortune, maybe even at a scrapper.

Which led to the next question - circular or strip? I did find some cheap circular 9-element ones that fitted quite neatly to the honeycomb grille, but they were just not bright enough. Then after a long time with occasional searches of the internet I came across these Eagle Eye LEDs. Reputedly 9 watts (although I've never been able to get a clear explanation from any supplier of just what wattage means as far as LEDs go) and with a lens at 13mm diameter (overall housing diameter 22mm) much bigger than anything else I had seen before. At £2 (free P&P) for a pair on a slow-boat from China it was definitely worth a punt and when they sailed (OK, that's enough) through my letterbox a couple of weeks later the good news was that they were very bright indeed across the whole of the lens area, I couldn't look into them, definitely suitable. The bad news was that one of them didn't work. But an email to the vendor elicited a very polite apology and another pair sent. Take care when considering other suppliers, some of which supply in larger quantities with a lower unit cost, as there are smaller, and less powerful, versions around e.g. 3W types at 13mm overall diameter. Read the descriptions and look at the images carefully - compare the overall and nut/thread sizes, this supplier was the only one I could find at the time with this physical size and power that would ship to the UK. There were also more expensive suppliers, but for identical items, so simply paying more for the same thing. Some of these are probably based in the UK, so you would get them quicker, but for a new project I'm of the opinion that time is less important, unlike for something that has broken and needs fixing as quickly as possible.

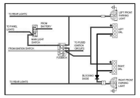
Next thing to ponder was quantity, mounting and positioning. Four each side should be enough, I know many OEMs go silly with a couple of dozen, but four each side is quite common and should be fine, so order three more pairs. These are individual LEDs, with an aluminium threaded body and nut, and the cable coming out of the back. The threaded part would fit through the holes in the honeycomb grille, so vertically at the outer edges is a possibility. But the grille is tipped forwards slightly, so each LED would need to be angled to point forwards (I had a similar problem with the round ones) individually, or a row of them on some kind of a strip held forward from the grille at the bottom. Then there is the question of weather. With the best will in the world even though intended for car and motorcycle use they are not going to be completely weather-proof. The (very thin) cables do go through a rubber grommet into the back of the threaded part, but who's to say that's enough to prevent water getting in? So I decided to mount them in a box. Given the size of a box needed to accommodate the threaded part, that precluded fitting them in front of the grille as they would project forwards far too much. So horizontally under the bumper it is, there is enough depth to the valance for the box, and it can be mounted to the bumper iron that is immediately below and behind the bumper in just the right area.

The box was the next thing - long enough for four across, high enough for the 23mm overall diameter of the LEDs, and deep enough to accept the 30mm threaded part and the cable that comes out of the end. After some searching Maplin has just the job at 112mm x 31mm x 62mm. I'll need two, but order just one to start with for proof of concept. Carefully marked up and drilled the holes (10mm) - pilot first, then stepped hole cutter step by step so I could make sure I was still correctly aligned and evenly spaced. Slotted in the LEDs, fitted the nuts - and a moment's panic as I realised I hadn't taken the internal pillars for the lid screws into account when setting the spacing! Fortunately there was ***just*** enough room to turn the nuts on the outer pair. I used silicone grease as a sealant between the LED flanges and the face of the box.

Internal wiring: Next job was to join the four cables together inside the box, and bring a single 2-wire cable out. As mentioned the cables are very thin, with the individual wires and conductors even thinner, so care needs to be taken when joining the four pairs of wires to the stouter external cable and to give mechanical support to the whole assembly. With the five wires in each connection soldered together, and heat shrunk, I turned the joins back against the sheaths of the four cables and slipped another piece of heat-shrink over the whole thing to remove any mechanical stresses from the joins. The external cable was two-wire black sheathed as used on many mains electrical appliances these days, in stock from having been chopped off various dead electrical appliances in the past. I have mounted the box with the lid on the bottom so lying water won't be able to run into the box, but this also allows me to get into the box without removing the box from the car should that be required. I also daubed silicone grease around the join between lid and box and in the screw recesses.

Mounting to the bumper iron was the next consideration, and I decided on a strip of black plastic cut from some square-section down-pipe, under the centre two LEDs, to go up between the iron and the bumper and hook over the top of the iron. If needs be a strip of double-sided foam tape (e.g. number-plate tape) could be used to stick the faces of the strip and the iron together. I've not taken the bumper off since the restoration 25 years ago, but the six nuts came undone easily (courtesy of always reassembling everything with Waxoyl or copper-grease) and I carefully lifted off the bumper, badge-bar and number plate complete. I'd previously measured how far it was from the top of the bumper iron to the bottom of the bumper, and that gave me where to bend the mounting strip to hook over the top of the iron. It only need bending into a right-angle, with a short overlap, as the bumper is close enough to stop it coming off again. Hooked the strips over the iron, and refitted the bumper. When fully tightened the back of the bumper is close enough to the top and front of the iron to grip the strip firmly, no sticky strips needed.

Connections to each other and existing wiring: There is a convenient space at the lower outer corners of the grille surround to fed the cable through, but not very big, so the connectors to join them together and whatever I use to connect them to the cars wiring need to be small. In the end I settle for standard bullets and connectors, even though they are less than ideal for behind the grille i.e. exposed to the weather. But Vaseline used to aid insertion will keep moisture out. I use four-way connectors, to join together the two cables from the DRLs, plus the wires to connect them to the cars wiring.



After-market DRLs seem to come with a box of electronics so that they only come on once the engine has started and is charging and the main lights are off, and go off when the main lights are turned on. If you were using 100 watt filament DRLs then I could see the point of not powering them until the engine has started, so taking a significant load off the battery during cranking, but these are LEDs with very low current consumption (30mA for eight). Also reckoned I wouldn't need any relays or electronics to switch them off when the main lights (parking or head lights) are turned on. Like any other light DRLs need positive and negative connections. Positive is easy - just connect to an ignition supply, but for the negative I used a bit of lateral thinking. I simply replaced the 2-way bullet connector for the right-hand front parking light with a 4-way connector and plugged the negative wire from both DRLs into that. How can that work? With the main lighting switch off, there are four parking lights, at least two number plate lights and at least four panel lights (depending on the setting of your rheostat) each going to earth i.e. all connected to earth in parallel, which with filament bulbs gives a relatively low resistance path to earth. Connecting the LEDs to the parking light wire the LEDs can 'see' the earth through the parking light bulbs, and you end up with a potential divider. With the relatively high resistance of the LEDs in series with the relatively low resistance of filament parking light bulbs, with a 12v supply you end up with 11.75v across the DRLs and only 0.25v across the filament. This means the DRLs effectively glow at full brightness and the parking light bulbs etc. do not glow at all. Note this is with filament, with LED parking and number-plate lights the DRLs would probably be a little dimmer and the parking lights might glow a little, as less voltage would be across the DRLs and more across the parking LEDs due to the changed resistance characteristics in the potential divider.

To extinguish the DRLs with parking or headlights on, when the main lighting switch is turned on with the ignition on, you now have a full 12v connected to the parking lights, which results in 12v both sides of the DRLs, which means they are extinguished (same principle as the ignition warning light when the engine is running).

That leaves the situation of having the main lights on with the ignition off, which would result in 12v being connected across the DRLs but with reverse polarity, which LEDs Do Not Like. So I included a blocking diode (1N4001 or 1N4002) in the wire that connects to the parking light connector, which prevents that reverse current flow.

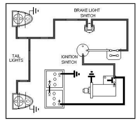
I also connected the DRLs to the green circuit i.e. fused ignition instead of the white, so if there is a short in that wire it would just blow that fuse. And if the DRL wire connected to the parking light connector should short to earth, the parking lights are fused so again preventing damage to any wiring. On early cars with unfused parking lights you might want to use an in-line fuse as well as a diode in the parking light wire.

The result is **very** visible, especially in low light, and anyone who misses these shouldn't be driving.

Brake Lights:

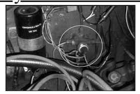
Schematic 
Switches
LED park/stop/tail lights
Supplementary brake lights

Schematic:



As factory wired.

Switches:
Switch failures
Switch relay
Hydraulic to mechanical conversion



All Mk1 cars, and all RHD chrome bumper cars, use a hydraulically operated switch in the junction on the inner wing near the fusebox. Early switches 13H2303 had screw terminals, later switches C16062/SMB422 use 'Lucar' or spade terminals. Replacement switches of this type seem to be problematic in that they cannot handle the load of the lights and premature failure is often reported, sometimes just after a few weeks, with subsequent replacement no better, meaning either a slave relay has to be installed or conversion to mechanically operated switch is needed. Note that these options are usually only needed if you have the hydraulic switch in the brake pipe manifold on the inner wing, not the mechanical switch fitted to the pedal cover or frame.

North American Mk2 cars in 1967 had a dual-circuit system - without a servo - with a mechanical switch (BHA4675) on the front of the pedal box. RHD Rubber bumper cars up to September 76 had the same arrangement. Also reported (but less common) are complaints that replacement switches of this type can spring apart because the crimping of the metal part onto the insulator isn't good enough.

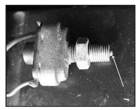
For the 1975 model year North American cars got a dual-circuit system with a combined master and servo, and the same mechanical switch was moved to the back of the pedal box. RHD cars got this system for the 77 model year on.

Note that in the 77 and later Leyland Parts Catalogue - Servo System - Dual Line Brakes item 22 is listed as 'BHA 4675 - Switch - stop lamp' but the drawing depicts the brake balance switch mounted under the servoed master.

The mechanical switch needed to change position when the combined master and servo was fitted as the brake master faces the other way. Originally the pedals were pivoted below the push-rod, which was mounted at the top of the pedal, and as the pedal was depressed the push-rod was effectively pushed towards the driver, so the switch could be mounted in front of the pedal in line with the push-rod. But with the combined master and servo the unit is so long it has to face into the engine compartment. This means the push rod has to be pushed away from the driver, so the pedal is now pivoted right at the top, and the push-rod is lower down. Consequently the switch now has to be behind the pedal, again to be near the push-rod. More info on the boosted dual line pedals and pedal box here.

The hydraulic switch only lights the brake lights when a certain amount of pressure has been developed in the hydraulic system i.e. the brakes are already being applied. But the mechanical switches light the brake lights almost as soon as the pedal starts moving, i.e. **before** the brakes start to be applied, and so give an early indication to following cars that one is about to brake. The hydraulic type are not adjustable, and the usual mode of failure is that they need more and more pressure before the light they lamps fully under light braking they may only illuminate dimly or not at all, but can also extinguish the lights under heavy braking. I've read one report that one of these has also stuck on.

The mechanical type are adjustable and it is critical to have them correctly adjusted. These switches are of the 'normally closed' type i.e. when the pedal moves away from the switch to release it its contacts close and the brake lights come on, and it is only when the pedal is released and operates the switch that the contacts open and the lights go off. If the switch isn't screwed in far enough the brake lights will be on all the time. But more importantly if the switch is screwed in **too far** it can stop the pedal returning all the way, which can block the bypass port in the master cylinder causing the brakes to stick on as the fluid heats up and expands. Adjust the switch to give about 1/8" free play at the pedal footpad. This free-play must occur at the pedal to master push-rod pivot - impossible to see with the cover on, and impossible to measure with the cover off for the pedal-cover mounted type! Maybe the answer is to screw the switch out until the lights stay on all the time, then screw it in counting the turns and being aware of the free play, until the switch starts moving the pedal down on its own, then unscrewing the switch half the number of turns you counted. I must try it one day ...



Updated November 2009: With the mechanically operated switch on the V8 I was surprised just how little movement of the actuator rod is possible - just 73 thou measured at the switch and one and a half turns between the light just going off and starting to reduce the free-play at the pedal. This shows just how careful you have to be, although setting it at three-quarters of a turn further in from the light just going off gives a good tolerance. I found mine at just one quarter of a turn, which is cutting it a bit fine. Out of interest when reset to three-quarters of a turn this gave nine and a quarter turns to remove the switch, but will vary greatly from car to car depending on the dimensional tolerances of pedal, pedal frame, pedal cover, master push-rod and all sorts.

Switch failures:
Protecting the switch with a relay
Hydraulic to mechanical conversion *October 2018:*
Earlier systems with the hydraulically operated switch worked well enough when new, although after many years they can require more and more pressure before they light the lamps and you may not be aware of that from the driving seat. One way is to look in your mirrors when stationary for the reflection from a car stopped behind you, particularly at night, or when backed up to garage doors, a wall etc. Alternatively you can probably tell simply from the indicators or heater fan slowing down slightly when you press on the brake pedal, especially at idle or with the engine switched off.

Electrical failure of the mechanical switches seems to be virtually unknown even though significantly more than 50% of MGBs used them. Plungers can apparently stick if the car is not used for a long time, but once they are replaced the current Lucas ones apparently have a habit of springing apart as the metal can is not crimped onto the plastic part that carries the terminals anywhere near as firmly as the originals.

There have been claims that using silicone fluid causes the hydraulic switches, even new ones, to fail within a very short time. Certainly from my telecom days, silicone grease was death to contacts, being a very good insulator even resisting the rubbing action as the contacts close. However it now seems that the real culprit is poor quality replacement switches failing in a very short time. If you cannot get an OE (original equipment) switch or NOS (new old stock) you may need to fit a relay to take the load of the lamps off the switch. The relay will need a quenching diode or varistor as even the back EMF generated by the switch releasing the relay seems to be enough to cause the switch to fail. The later mechanically operated type cannot suffer from the silicone fluid problem of course, but if they suffer from the same premature failures as the hydraulic type (and I've not heard of any so far) the same relay circuit can be used for these as well. Alternatively you could fit a generic switch such as this 'pull-on' type seen at Stoneleigh which can replace the pedal return spring and is screwed to the underside of the engine-compartment 'shelf' in an appropriate position, or use a suitable micro-switch with a normally-closed contact off the pedal as I have done here, as well as Herb Adler. Bear in mind generic switches must be capable of tolerating the inrush current of your lamps, which for conventional filament bulbs is significantly more than the current when they are fully lit, for the following reason:

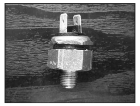
> **Inrush current:** filament filaments have a positive temperature coefficient, i.e. as voltage is applied and they start to glow, the filaments heat up which increases their resistance, which greatly reduces the current they draw (Amps equals Volts divided by Resistance) when fully lit as compared to when voltage is first applied. The wattage printed on the bulb represents the 'fully lit' current at the supply voltage, i.e. Amps equals Watts divided by Volts i.e. for brake lights 21w/12v = 1.75 amps. Per bulb, so 3.5 amps constant though the switch while you have your foot on the brake pedal. But the inrush current is based on the voltage divided by the cold resistance (as measured with an ohmmeter connected to an unpowered bulb), which for a typical 21w bulb is 0.5 ohms. 12v/0.5 ohms gives 24 amps per bulb at the instant of switch-on, i.e. 48 amps in total through the switch! That's a theoretical maximum, there will be various parasitic resistances in the switch, wiring and connections which will result in a volt drop before the lamps. The Lucas Fault Diagnosis Service Manual states that 1.25v volt-drop is acceptable for most circuits in the car (except for the starter which is 0.5v maximum). This is at the standing current when the lamps are fully lit, and Ohms Law says that a volt-drop of 1.2v at 3.5A implies a parasitic resistance of 0.35 ohms. That in series with the cold resistance of two bulbs in parallel (0.25 ohms) will give a practical maximum inrush current of 20 amps. This amount of current through the parasitic resistances will result in a volt-drop of about 7v i.e. more than half the system voltage, leaving only 5v for the bulbs (figures have been rounded and the system voltage taken as 12v even though it can be up to 14.5v when charging). However that 5v is enough to start the filament heating up, which reduces its resistance, which reduces the total current in the circuit, which reduces the volt-drop across the parasitic resistances, which leaves more voltage for the bulb. This heats it up even more, and you get an exponential rise in bulb resistance to its fully-lit maximum, and hence an exponential fall in total current to its fully-lit value, which results in a rapid shift of voltage from the parasitic resistances to the bulb filaments. Eventually you end up with the majority of the system voltage across the bulb, and relatively little (Lucas's 1.25v) lost in the parasitic resistances. However it takes a finite time for this to happen, which why filament lights take longer to light fully than LEDs. Even though the parasitic resistances are still present if LED brake lights are used there is no inrush current for LEDs, and the steady-state current is lower, so to all intents and purposes all the system voltage is present at the LED the instant it is powered. Also there is no element needing time to physically heat up and start to glow, and these are the reasons why LED brake lights illuminate faster than filament. Headlamp bulbs have an even lower cold resistance, typically 0.4 ohms at 55w and 0.3 ohms at 60w, which gives an even higher inrush current. The more powerful filament needs more voltage in order to output a given level of light, which means getting to full brightness takes longer. I fitted relays (and fuses) to the uprated headlamps on a pal's MGB, which takes a lot of the parasitic resistances out of the circuit, and the difference was remarkable. Before the relays, when switching from dip to main or back again, there was a finite period where there was effectively no light at all! After the relays the switch was near instant, and the lights were much brighter as well.

June 2011: Discovered Bee's brake lights not coming on just three days before the Ratae Run. Wary of going into the hydraulics so close to an event I found the switch was working but high-resistance - too high to work the lamps but not so high it wouldn't operate a relay to light the lamps, so installed a relay. However on the morning of the run I found that although the relay was clicking it was lighting the lamps under light pedal pressure and extinguishing them again under normal braking. I managed to wire in a switch to operate the relay manually, which got us through the day with no dramas,

and changed the switch (MGOC Intermotor) next day. Imagining all sorts of difficulties undoing a 40 year-old switch it moved fairly easily gripping the multi-port adapter with channel-lock pliers and a correctly fitting spanner on the switch. Some polyethylene under the master cap to reduce leakage, had the new switch in my right hand while I removed the old switch with my left, then popped in the new one, and just a tiny dribble of fluid. Originally I was going to reuse the relay, but that wouldn't have told me anything about the quality of the switch, so I've left it in-situ but not connected. I've also connected the switch output to the overdrive lockout LED (via a couple of diodes) as a 'tell-tale' so I can see the switch operating, at least then I stand a chance of spotting it if the switch fails during a run.

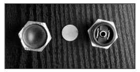
July 2013: Two years on I'm noticing quite a bit of retardation before the tell-tale comes on, and even then it is only coming on dimly until I press the pedal more firmly - not good. After our return from the Surrey Run I connect the relay that I made up two years previously, and I find that the lights are now coming on cleanly, and with the pedal about an inch higher than before, so significantly less pressure, and much lighter braking. Contact the MGOC describing the problem and asking if they are aware of problems with this switch and get the reply: "Thanks for your enquiry, unfortunately this is charactertic (sic) of this brake light design and why it was redesigned on the later cars to a mechanical system. The hydraulic switch does require extra pressure to ensure operation, assuring no air is trapped within the hydraulic system." Inaccurate as well as missing the point. So I write back re-emphasising that they seem to be coming on late, as well as dimly unless I press the pedal quite hard, and this time the reply is: "If the brake lights are coming on dimly this is normally associated with an earthing problem." i.e. still missing the point. So I write back again, keeping it as simple and as clear as possible, and this time I get a phone call saying they will send me a replacement switch, but show no interest in the 'old' one.

It arrives in a couple of days, and it occurred to me that it would be interesting to compare contact resistance against pressure of the two switches. After a bit of fiddling around I find the conical adapter for football and air-bed inflation that comes with my foot-pump fits nicely in the hole in the end of the new switch. What's more it expands as I apply pressure, which keeps the air in. I connect my analogue multi-meter on it's ohms scale, and start pumping. I'm quite surprised to find that I go past 20, 30, 40, and 50psi before the meter moves, in fact initially it takes nearly 60psi, but at least it swings from infinity all the way across to zero, so making a good connection. Over a few operations the pressure required drifts a bit lower, and stabilises at 50psi. I repeat the operation to swap the switches on the car, again with virtually no fluid loss. Reconnect the relay straight away (I won't be running **this** switch without!), check the brake pedal, and they come on at full brightness with very light operation. I then connect the old switch to the foot-pump, but even though I get it up to 90psi (max for the pump is 100psi) I get no movement on the meter.



What lies inside the first replacement switch. I cut this one open (a bit more neatly than last time). No fluid on the contact side of the diaphragm, but a different internal construction to before. However the principle is similar i.e. fluid presses against a diaphragm, which presses against a metal disc, which pushes against a spring or springs. Where this one differs is that instead of the disc moving a contact finger to make the electrical contact, with a rubbing action, the disc bridges two fixed contacts directly. I.e. no rubbing action, and even though there is only slight burning on one part of the disc and one of the fixed contacts it is obviously enough to start affecting the quality of the connection.

September 2017: Andy Tilney posted on the MG Enthusiasts MGB Technical forum that he had found NOS Lucas brake light switches at LMS Lichfield who have tons of ex-MOD spares and other parts. However on external inspection they don't have the riveted spades like the originals, but have them going through the plastic moulding as on the poor copies. Rather dashed his initial euphoria, although when they checked their stock they found one with riveted spades, so he bought that one as well.

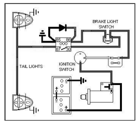


I went over and purchased one and sectioned it as before, with interesting results. Whilst basically operating on the same principle as the cheap copies i.e. a disc pressed against the internal parts of the spades, they do differ in detail and also probably in the materials used which may well be enough to make the difference. However their current price is the same as the usual suspects so I'd imagine the quality is the same. Coming in a green Lucas box counts for nothing, see this warning about indicator flasher units that have hazard flasher internals!. Only red/orange Lucas boxes - ideally saying 'Lucas' in full rather than the 'L' in a stripe - are truly NOS or OE.

If the materials in these Lucas switch is harder that may well resist burning better, so I decided to test that theory. Couldn't find the earlier failure that I sectioned, so went to try the second one from the MGOC that has been in Bee for four years ... only to find it has riveted spades! And no, I'm not going to section that one as well!!

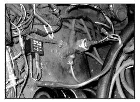
Relay:
Made to order

If you can't get hold of an NOS switch then given the reputation of current-stock switches the only solution seems to be to fit a relay, so that the brake light switch only handles the very small current of the relay, it is the relay that switches the much higher current of the lights. See this modified schematic and information on how to obtain a ready-made relay or



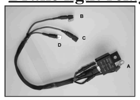
make your own up. Note that this relay should only be needed with the hydraulic brake light switch, not the mechanical switch mounted on the pedal box.

June 2011:



As mentioned above, just before a run I found the switch wouldn't light the lamps but would still operate a relay, so installed one as a quick-fix until I replace the switch. However given the reputation of current (ho ho) switches I decide to do a 'proper job' on installing a relay, so it can be used permanently i.e. with the new switch. Piggy-back a green off the hydraulic switch (rather than the purple, or a fused brown) to the relay terminal 30 (one of the contacts). Use a male to female extender for the green purple taken off the hydraulic switch to terminal 87 of the relay (the other contact). A female to female to connect the output side of the switch to one side of the relay winding (85), and take the other winding terminal (86) to earth. As it will almost certainly be used with a new switch, and as I don't know how the old switch will react to the back emf when releasing the relay, I fit a diode (A Lucas diode, no less!) between the two spades which go to the relay winding terminals to protect the brake light switch contacts. **Note:** This is now a varistor which means that positive earth cars with this relay can be converted to negative earth without changing the circuit. There is a very handy unused earthing point on the inner wing close to the hydraulic switch complete with screw and washer, for both mounting and earthing the relay, and I have brake lights again. The only issue is that with the dicky switch the relay is often giving a double-click when it operates and when it releases, which won't be doing the bulbs any good, so I'll be changing the switch sooner than later. Sooner, as it happened as just a couple of days later about to set out for the start I discovered that although the relay was still clicking it was clicking on at light pedal pressure and off again under normal braking! However I had a little-used switch under the dash wired into the engine compartment which reached the relay, so I had manual brake lights. Fortunately hardly had to use the switch until approaching the A42 for the journey home and in traffic, the Navigator was not best pleased when she asked why I kept reaching under the dash. Once on the A42 and M42 I didn't need them until the exit slip-road, and didn't need them travelling through Solihull to home. Next day I replaced the switch. I was intending to use the relay with the new switch from the start, but that would have told me nothing about the quality or otherwise of the new switch, and if they **are** poor quality then suppliers need to be made aware of it. So the relay has been left in-situ but not connected, and I will be checking the brake lights before and after each run for a while. Sure enough in a couple of years I was noticing from a tell-tale I had installed that the pedal was needing more and more pressure before the lights came on, so nagged MGOC until they replaced it, and connected the relay. No more problems, but five years later decided to add a mechanical switch so they come on as soon as the pedal starts to move.

Brake light relays made to order for the MGB as well as other makes and models.



Uses existing connection points i.e. no cutting of wires, and can be restored to original in moments if required. Suitable for both positive and negative earth systems, just specify length of wiring from relay mounting point to switch position, and switch terminal type if they are other than conventional spades. Click the thumbnail for details. Usually despatched within 24 hours of receipt of payment.

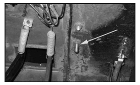
March 2021: If you find your brake pedal needs more and more pressure to light the brake lights then you will need to replace the hydraulic switch at the same time as you fit the relay. If you just fit a relay then the situation **may** improve, and the switch won't get any worse, but it is already damaged so must be replaced. Mike Robertson has just purchased one saying he replaced his switch about a year ago and it's got progressively worse so the switches obviously haven't got any better! He has another new one to fit with the relay.

However there is another option and that is to convert from a hydraulically operated switch to a mechanically operated.

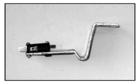
Hydraulic to mechanical conversion - or 'seeing the light'. *October 2018* Rubber bumper cars used a pedal-operated switch from the outset, which is standard practice on probably all cars these days. The main feature of these is that the brake lights come on as soon as you start moving the pedal, before there is any braking effect. For example it takes about 35mm of foot-pad movement before Bee's hydraulic switch turns on the lights, but only 7mm for Vee. Out of interest the ZS has 15mm but that switch has a much longer plunger. The MGB mechanical switches don't seem to suffer from the same problem that the replacement hydraulic switches do - I've not come across a single report of electrical failure of these *(one in 2024)*, either original or replacement (however there have been some reports of plungers sticking on cars not used for a long time, and the insulated terminal plate on current stock popping out of the metal housing due to inadequate crimping). Why this should be I don't know as I haven't had the opportunity to open one up. They use the same 'soft-close' rather than 'snap-action' as the hydraulic switches, but maybe the physical design better allows for a wiping action such as the OE hydraulic switches had. There has been more chatter lately on various fora about the hydraulic switches, and people coming up with options to fit a pedal-operated switch to cars with the hydraulic switch, some using various bits of wood or drilling holes which doesn't appeal to me, but it spurred me on to see what I could do.

To fit the factory switch either needs you to replace the pedal cover - they are NLA but may be available from one of the breakers. Or you could modify the existing cover by drilling and welding a suitable boss or nut, but the positioning is fairly critical. Another option is to fit a switch in the cabin under the bulkhead shelf, resting against the front of the upper part of the pedal, and that is eminently feasible.

There is stiffener right beside the brake pedal, and a bracket for a switch could be attached directly to that. Not only would it be difficult to drill in that location, but I don't like drilling holes anyway. However there is a convenient welded nut for a pedal-box screw just the other side of the bracket, in a convenient position to mount a bracket, and that is what I opt to do. It just needs a longer screw, then a nut with washers to tighten the bracket against the welded nut. Oddly although this screw is one of six holding the pedal-box to the shelf it is a different size to the other five - 5/16" UNF as opposed to 1/4" UNF - possibly because it is the closest one to the brake pedal which has the greatest force applied to it during driving.

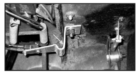


The standard screw is 5/8" long, replacing it with 1 1/4" allows a few threads to remain exposed after a plain washer, lock washer and standard nut have been fitted. You must use a plain washer even with a stiff- or Nyloc nut or as you tighten the nut it tends to move the bracket out of adjustment.

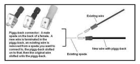


I chose to wrap the bracket round the flange at the bottom of the stiffener slightly to resist any attempt for the bracket to twist back from the pedal, which would compromise the adjustment and could leave the brake lights on. It does make for a tricky bending operation though, and if the part that goes across the pedal is too high it can foul the spring and make a noise as the pedal is operated and released. Subsequent thought is that a simple bend of 90 degrees under the stiffener would be more than adequate. For the second bend to make the part that bears against the welded nut, if this is slightly less than 90 degrees then as the nut is tightened it will tend to push the vertical part of the bracket firmly against the side of the stiffener to achieve the same positively located result, and be a lot easier to produce.

I used this switch from eBay. It's rated at 15A and 120v AC, and snap-action, so hopefully OK. Switches are rated higher on AC than DC as the alternating current passing through zero 100 times per second (50 Hz has one positive and one negative pulse per second, hence passing through zero twice for a full cycle) will tend to extinguish any arc created when the switch opens. However it's not the opening current that is the problem with hydraulic switches as that is only 3.5A and non-inductive, but the inrush current on closing which is a lot higher. But as these switches are snap-action and it is the 'slow-closing' of the hydraulic switches that causes the problem, we shall see. This switch has spade terminals to which standard spade females make a good firm connection. Note that the switch needs a normally-closed contact as the switch is released when the brake pedal is pushed, and mine has three terminals to give a normally-open (not used) as well as the normally closed. Switches with only two terminals may be of the normally-open type and not suitable for this application without additional components.



Bracket with switch and wiring fitted - pedal foot-pad travel down from 35mm to 8mm, and 5mm of that is taking up the free play in the linkage between pedal and master push-rod.



You have a couple of options for connecting the switch to the existing wiring - I fed 2-wire sheathed cable though the main harness grommet - and there is also the question of what to do about the existing hydraulic switch i.e. leave it connected as a 'second string' or take the wiring off that and extend it to the new switch. I decided on the latter option, and if you don't have a relay already fitted then the easiest way to attach the new wires is with piggy-back spade connectors, and it is completely reversible. However I already have a relay fitted using piggy-backs on the hydraulic switch and I want to retain that, as well as my tell-tale so I can continue to keep an eye on power going to the brake lights. I didn't want 'nested' piggy-backs i.e. one on top of the other, so I decided to utilise the bullet connectors which are close by where the main, rear and gearbox harnesses join together, and bullets on the new wires. You need a green wire to pick up the fused ignition supply for one side of the switch, as well as the green/purple going to the brake lights from the other side of the switch. The latter is easy as by substituting a 4-way bullet connector for the existing 2-way between the main and rear harnesses you can connect to the green/purple. And the green wire is just as easy as there is one of those going from the main harness to the gearbox harness on all MGBs from March/April 1967 for the reversing light switch. If you don't have that then you will have to pick it up from the brake light switch.

Supplementary brake lights: *June 2021*

Third brake lights have been around a long time and while relatively easy to install to a GT behind the hatch they need to be slim to avoid obstructing the rear-view mirror. However roadsters are another matter needing some protuberance above the panel behind the boot lid, unlike OEM convertibles where it can be fared in to some part of the structure. Also possible on an MGB of course, but not as a simple add-on. But an MGOC forum post gave a link to something that combined high-intensity red lights with the white reversing light, which was worth investigating.

Easier on the GT as it can sit behind the glass, and 'ready-made' are more likely to be suitable.

Instrument Lights:

 Schematics: Up to 1969

1970 and later

Bulb Holders
Rheostat
Uprating

These are powered from the 'parking' or first position of the main lighting switch, and were never fused. Originally all cars had a rheostat between the speedo and the tach to progressively dim the lights including being able to turn them off altogether. Then North American MkII cars up to the 1970 model year had a simple on-off switch on the column shroud whilst other markets continued with the rheostat. In 1971 North American cars got the rheostat again and all cars continued with this until the end of production. This change for North America may have been due to lack of space on the first version of the padded dash. Until the 77 model year RHD cars always had the rheostat between the speedo and tach. LHD 'padded dash with glovebox' cars regained the rheostat on the right of the instruments between the choke and heater switch until the 77 model year. From 77 onwards RHD cars had it on the lower edge of the dash under the speedo. From 77 on LHD cars had the rheostat on the extreme left-hand side. 1977 and later models had the switches and heater controls illuminated at night as well as the instruments.

From the rheostat or switch to the gauge lamps the wire colour was always red/white, picking up an earth from the instrument case. On two-fuse fusebox cars the wire from the main lighting switch to the rheostat or on/off switch is red, on 4-fuse fusebox cars it is red/green. My V8 rheostat exhibits a smooth change in resistance from almost zero ohms at the 'bright' end increasing to about 10 ohms just short of the 'dim' end, then goes fully open-circuit for the last bit of travel to fully extinguish the lamps. The roadster has the 'off' section at the bright end. Both were faulty when the cars came to me, I remember paying top-whack for the roadster one, but gibbed at that when I had to replace the V8 one as well so bought a cheaper version off eBay, which probably explains the 'reverse' operation.

North American spec Mk2 prior to 1970 had the panel light on/off (not a dimmer) switch on the column cowl and those wires can get trapped causing short-circuits and damaged wiring and switches - none of the lighting wiring is fused at that point.

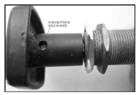
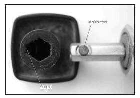
Bulb Holders:

The original 4" speedo and tach use claw-type holders with a single wire for the 12v supply as they pick up an earth from the gauge body. The smaller 80mm speedo used on all V8s, and RHD RBs, and North American spec Mk2 (prior to 1977 at least) use a holder that pushes into a tube on the back of the gauge, and also only have one wire. The smaller fuel and dual gauges use the same tube-type fitting. My 73 and 75, and a 1980 that I rewired, all use MES E10 screw-fitting bulbs and holders. However a replacement harness for the 1980 came with T10 capless/wedge-type bulb holders. The problem with those in pre-77 gauges is that the bulbs can get dislodged and fall inside the gauge. The original tube-type holders for MES E10 bulbs don't seem to be available any more. T10 capless are available but have two terminals as the body is plastic and you have to make your own arrangements for earthing, as well as the problem of the bulbs falling in the gauges. A better alternative that is also available is the BA9 bayonet holder which picks up its earth from the tube the same as the original holder so only has a single terminal. These, and single-wire claw-type MES E10 holders are available from the likes of AES.

Rheostat/panel switch:
North American spec Mk2 to 1970 cars had an on/off panel light switch on the steering column, the wiring can get trapped causing short-circuits and damaged wiring and switches. A dash-mounted rheostat (variable resistor) was fitted to all other models, and on both Bee and Vee (both replaced I might add) they vary the resistance between 0 ohms (brightest) and 8 ohms (dimmed).

Clausager writes: "Another innovation on the V8 model was the introduction of a new rheostat switch for the panel lights". Hardly an innovation as the rheostat was used on all models apart from North American spec Mk2 to 1970 which had a switch on the steering column. Whilst it may have been to a different design it can hardly be called 'innovative'.

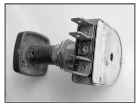
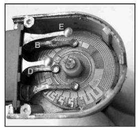
The Parts Catalogue doesn't show a rheostat until BHA5047 for 361001 on i.e. the start of RB production but MGBs always had one. The knob isn't listed separately but suppliers have it as AHH5369 with a 'P' symbol. V8s are shown as having the same rheostat, again no knob, but it seems to have been 37H7995 with a speedometer symbol. Specified LHD markets such as North America, Sweden and Germany are showing as having the same rheostat (no knob listed) from 219001 for the 1971 model year, then BHA5198 from 294251 on for the 1973 model year changing to 37H7994 both with knob 37H7995. The September 76 catalogue shows RHD having rheostat AAU4944 and North America showing a manuscript amendment to 37H4994, no knob listed separately in either case.

The rheostat knob is retained on the shaft by a push-button in the shaft which fits in a hole in the knob. The push-button must be depressed as the knob is withdrawn. The push-button is on a strong spring, and even when depressed the knob can be seized onto the shaft. The rheostat is usually retained in the dash by two nuts. The inner nut is

to allow the threaded portion of the rheostat body only to protrude through the dash far enough to get the outer nut on for a neat appearance with no free threads showing. This picture shows a chrome nut, on the MGB it is usually a slotted ring which strictly needs a 'ring-driver' to remove and refit, but if used carefully long-nosed pliers or a screwdriver and light hammer used as a drift will suffice. When replacing the knob you should notice that one face of the hexagonal hole is spaced back more than the others, this must be placed over the push-button on the shaft, and depresses the push-button as you push the knob onto the shaft, until it clicks into place.

On CB cars (except V8) there is a dashboard bracing panel behind the rheostat and between the main dials which means one of the main dials has to be taken out first in order to remove, or even access the terminals, of the rheostat. V8s and RB cars don't have that bracing panel and the main dials are smaller so the rheostat can be reached from behind more easily. Maybe tricky to juggle connections while fitted, but it's relatively easy to remove the knob, locking ring and wavy washer and pull the rheostat back and down for better access.

All the rheostats I've had (several cars - each coming to me with the rheostat faulty) have been of the printed circuit variety where the changing resistance is obtained by having printed circuit tracks of various thickness and lengths switched in and out as required. If all the instrument lights fail the rheostat is a likely cause. They are quite expensive for a) what they are and b) the use they are, even with uprated instrument lighting. Nevertheless I have always replaced mine as I hate things that don't work properly, and haven't had a subsequent failure, even on cars used as daily drivers with a lot of 'lights on' use particularly in the winter. As these lights are unfused it has occurred to me that maybe one of the lamps was shorted out at some time in each cars life, which would destroy a printed-circuit rheostat very quickly. Current supply of rheostats in the UK (for all years) seems to be 37H7994 or BHA4278 ("knobs not included ...") which are wire-wound so should not burn out as readily at typically £22 to £27 (October 2019, although some sources are higher), which is a lot cheaper than the £50-60 I was seeing just a couple of years ago. I jibbed at paying the higher price to replace Vee's from the usual suspects many years ago and got one elsewhere, but discovered it functions the other way round i.e. anti-clockwise for bright then off instead of how I remembered it before. No big deal, it's not something I ever use anyway, I just don't like things not to work.

If your panel lights are dimmer than you think they should be, or don't work at all, the first thing to do is try bypassing the rheostat to see what happens. Although the rheostat only has two connections (it is just a variable resistor) you will actually see four spades in a row. Each connection has two spades, bent into a 'U' shape and riveted to the body in the bottom of the 'U', and the two 'U's are side-by-side, with a bigger gap between the 'U's than between the two spades of one connection. All years of MGB have one red or red/green wire on the one connection leaving a spare spade. Some years only have one red/white (to the instruments etc.) on the other connection also leaving a spare spade, so it is a simple matter to move one wire from its connection to the spare spade of the other connection to bypass the rheostat. It doesn't matter which wire goes on which connection. Other years have two red/whites going to the rheostat, in some cases in one spade connector so you can bypass the rheostat in the same way, but it seems that some may have two separate wiring connectors which occupy both spades on the rheostat output connection, meaning you can't get both on the input connection (which would require three spades), but you can still transfer one of them over to bypass the rheostat for some of the lamps to see if that makes them brighter. If you want to bypass the rheostat permanently for all lamps on these cars then you will need a branching spades like these. You could use a Scotchlok but it would mean cutting the connector off one of the wires and they aren't the most reliable of devices.

If you have changed the instrument and control bulbs from the original filament-type to LEDs, the rheostat will no longer work as originally, as described here.

Uprating Instrument Lights:

That leaves us with the normal situation of dim lights when everything is working as it should! It has often been said that the provision of a rheostat must have been a joke by someone in the factory, as with the best will in the world they are never going to be too bright with the standard bulbs. Filament bulbs do blacken on the inside as they age, failure seems very rare so most of them are probably very old, and replacement might help. Cleaning the inside of the cans and the back of the glass can help, as can repainting the inside of the cans with gloss white or silver, but is a bit of a fiddle and you could end up damaging the instrument. But is it even an issue, I ask myself? The beauty of analogue instruments is that you don't **have** to read the numbers anyway when you are familiar with the gauges, just be able to see the angle of the pointer. You don't read the numbers when you look at a clock or watch do you? You just look at the angle of the hands, and how many watches and clocks these days have numbers on them anyway? Over several years I tried a number of options, and whilst some were better than others, none were really worth the effort and/or cost.

February 2013:
But as time goes by and the years mount (mine), as well driving other cars and infrequent driving of either of the MGBs at night blunting familiarity with what the needle angles mean in particular the relationship between speedo needle angle and

speed, improved brightness is probably becoming more necessary. Whilst investigating DRLs I had come across a 5-element LED which was worth trying in the gauges. It had a T10/wedge fitting for the rubber bumper pilot light in the headlights so not a direct replacement in the instruments on either car. But I had a wedge holder lying around and tried just holding it in position for the chrome bumper speedo and tach and it gave by far the best improvement of anything I had tried before. This is almost certainly due to the four radial elements being inside the case as well as the one forward facing. At the time I couldn't find any bulbs of this type with an MES (medium Edison screw, which is what all eight of my instrument bulbs are) fitting, but did find some bayonet types, so fiddled about quite a bit with wedge and bayonet holders and ended up with the speedo and tach on both cars much improved.

The ancillary gauges (and the smaller V8 and rubber bumper tach and speedo) have 12mm tubes on the backs for cylindrical bulb holders. Two of the previously obtained screw-in LEDs worked well in the dual gauge, but in the fuel gauge whilst they changed the hue to a blue/white the same as the other gauges they were not really any brighter, and even these new 5-element bulbs (wedge and bayonet) held in place seemed no better. This is largely because the fuel gauge has a completely different light path to the other gauges.

I was convinced there must be an MES i.e. standard screw fitting version of these bulbs, so kept looking from time to time. And while Googling '12v MES LED' I realised that an alternative description for the fitting was 'E10'. Googling that instead of MES got a couple of hits for the correct type of bulb, but it was factories touting for bulk purchases and wholesalers with bundles of 100 units. But then I noticed they all had the same description 'E10 5 5050 SMD LED' and Googling that led me to a pair for £2 and free shipping from China! A pal ordered a set, supposedly delivery in 30 days, but they actually took more like six weeks, with no response to emails, and while we were waiting there was a flurry of bad feedback complaining of non-delivery and no response to emails! Eventually they turned up after about six weeks. In the meantime I had found another source, also in China, just under £4 for a pair so nearly double the price but still very cheap. They only took a couple of weeks to arrive, so the extra cost is obviously to pay for a faster type of snail. And trying those with the standard holders does give a noticeable improvement in the fuel gauge on both cars! So both cars now have four legible instruments.

The upshot is that these are a direct replacement for the standard filament bulbs and give a real improvement, so no fiddling around with alternative holders. And whilst they are a plug-in replacement for the 4" speedo and tach, the 80mm tach and the matching dual and fuel gauges, there may be a clearance issue with the 80mm speedo on the V8 and rubber bumper cars needing the holder to be spaced back a bit as I had to do with the BA9 versions. And I haven't tried these in any of the 77 and later plastic gauges. These have a green plastic bowl over the end of the standard bulb which will limit how far an alternative bulb will project into the instrument. It's also why you have to be careful with halogen bulbs, as being much hotter they can melt this green bowl.

October 2021:

The fuel gauge has seen the least improvement, but then in an MGOC forum post someone posted a link to a 'flat faced' unit with eight small elements (E10 SMD 8 x 3020) all facing forwards instead of only one facing forwards and the rest distributed round the sides. That does give a small improvement to the fuel gauge to make it about the same as the dual gauge, and it also overcomes the problem of the 8 x 5050 fouling the speedo innards. The equivalent for the wedge-type bulbholders are T10 SMD 8 x 3020.

December 2021:

Finally (?) I spot an alternative COB type that are shorter than the 5 x 5050 and only slightly longer than a standard bulb and these prove to be slightly brighter than the 8 x 3020 type and a noticeable improvement in the fuel gauge. Not worth replacing 8 x 3020 type in the other gauges, but definitely better than the 5 x 5050 type, and miles better than filament bulbs.

However with LEDs you will find the rheostat no longer works as it did. If you have all LED bulbs then really it won't dim them at all, if you have some filament bulbs left - i.e. in the cigar lighter or a clock or auxiliary instrument, then they will all dim slightly, the filament bulbs more than the LEDs. However the rheostat should still turn them off altogether as before. The lack of dimming is because the LEDs draw so little current, which means virtually no (no filament bulbs left) or very little (a couple of filament bulbs left) voltage is now being diverted to the rheostat so all or nearly all the voltage is still at the LEDs at the maximum dimming position. The 5 x 5050 SMDs take 30mA each (8 x 3020 35mA, first COB 60mA and 2nd COB 52mA) whereas the original 2.2w filament bulbs take almost 200mA each i.e. nearly six times the current. With the rheostat at full dimming there is only 7v left for four filament bulbs which are almost fully dimmed, whereas there is 11v for four LEDS, i.e. very nearly full voltage and very little dimming.

I know of a couple of cases where someone has gone to quite a bit of trouble to attach a conventional potentiometer of a higher resistance value to the back of the rheostat control to retain originality on the dashboard (in tests with four of the above LEDs 100 ohms was enough for significant dimming) but this isn't really necessary. By adding a load equivalent to the replaced filament lamps you will restore the function of the rheostat to a large extent. For example if you have replaced four 2.2w filament bulbs with 5050 SMD LEDs you need to generate 8.8w of load for the rheostat to work something like normally. 5050 SMDs take 30mA each or 1.5w for four, so you would need 7.3w of load from a parallel resistor, which at 12v represents 20 ohms. 8w minimum dissipation, 10W and 20w are available from the likes of RS Components and Farnell. However due to the different voltage/illumination characteristics of LEDs and filament the dimming may still not

be exactly the same. A more sophisticated alternative would be to use the standard rheostat to control a transistor to give the required range of voltage output, or a pulse-width modulation circuit, maybe a future project.

Herb Adler has done a similar thing.

December 2024: As an example of how different LEDs react to the rheostat, I've only just discovered (because I never use it!) that a single-element COB type I had fitted in Bee's dual gauge dims right down to nothing like an incandescent while the other LEDs barely dim at all, but it wasn't advertised as such when I bought it. It isn't as bright as the 5050 or 3020 types when used in the other gauges, and in the fuel gauge it barely gives any illumination at all, it's the construction of the dual gauge that makes it so effective here (by contrast the fuel gauge has a tortuous light path):

What's even more remarkable is that because the current drawn by LEDs is so low compared to filament bulbs the voltage at the bulbs only drops from 12v to 11v over the full range of the rheostat, yet that is enough to dim this one LED to nothing.

1st April 2024: No - not April Foolery. Just come across these dimmable LEDs for instruments so you can use the standard dimmer - if you want. More expensive, and I've never felt the need to dim even the brighter LEDs. The dimmer does have an 'off' function which turns them off altogether, but I've needed to do that either, and in the early days when one failed in the dual oil/temp gauge in the V8 at the start of a long night-time journey it made me feel very uncomfortable.

September 2020: While browsing the Classic Car LEDs website I came across the following statement:

> "Do LEDs work with Dimmers?
>
> "A very common Classic Car owner question. Briefly, ours do with the old style internal variable resistor in the dimmer. This reduces the voltage available to the LED which in turn reduces the brightness. LEDs are far more sensitive than filament bulbs though which means a small change in the dimmer will have a bigger effect."

That's absolute nonsense as anyone who has converted to LEDs will know, even over the full range of the dimmer LEDs will hardly alter their brightness at all compared to filament bulbs, so a much bigger change in dimmer resistance is needed. The standard rheostat has about an 8 ohm range whereas my tests with LED instrument lamps indicates at least 10 times that is needed i.e. 80-100 ohms. I politely advised them of mine and others experiences, and they wrote back:

> "Regarding dimming of the dash LEDs, whilst ours will dim, it will depend on the condition and voltage range of the rheostat. The LEDs will dim faster than a filament and have a working voltage range of 9-15 volts. Below 9 volts they nearly extinguish so a lot will depend on the range of your rheostat."

More nonsense. Rheostats don't have a 'voltage range' they have a resistance range and it's the current drawn by the lamps that determines the voltage that is present in the 'fully dimmed' position. Because the current for LEDs is far less than for filament bulbs this 'fully dimmed' voltage for LEDs is much higher and can be as much as 11v i.e. near full voltage, hence the negligible dimming. So LEDs dim 'slower' than filament bulbs in that significantly bigger resistance range from fully bright to fully dim is needed. I pointed out that vendors of LEDs for indicators often say you have to fit load resistors to take more current and make the flasher unit work properly for the same reason, and they wrote back "11 volts is near full brightness with the LEDs so a resistor would help." Yes it would, making their previous statements incorrect! At which point I left it there as we had gone full-circle. I'm increasingly finding these days that more and more people are incapable of holding more than one stage of a discussion at a time in their brains. Step forwards twice in the discussion and they have forgotten the original point that was being discussed. Even when it is written down in a forum thread. Bloody annoying, as is when they blame an incomprehensible post on the 'spell checker', when it's predictive text and not a spell checker, and it's because they didn't read what that had 'written' before they clicked Send! Rant over.

Fusing: *October 2019*

- Headlights and instrument/switch lighting were never fused from the factory.
- Factory or dealer-fitted optional front fog and spot lights or rear fog (1980) were never fused from the factory.
- The headlamp flasher circuit (optional and factory) was initially unfused and powered from the brown circuit, changing to the purple fused (always live) circuit for North American on Mk2 cars, but not until 1970 for other models.
- Brake lights and indicators were always powered from the green circuit (fused, ignition powered) in the fusebox until 1978, then from an auxiliary green circuit fed by an in-line fuse under the fusebox.
- Parking and number-plate lights were unfused on Mk1 cars, on Mk2 cars prior to 1970 with the two-fuse fusebox there were two in-line fuses by the fusebox one feeding the front and the other the rear, and from 1970-on there was a four-fuse fusebox with the top two fuses feeding the corners of the car, one for each side.
- The map light was powered from the unfused parking light circuit except in 1971 on non-North American cars with door switches acting as a courtesy light when it was powered from the purple (fused, always live) circuit.
- Factory-fitted reversing lights (March/April 67-on) were fused from the green circuit (fused, ignition powered in the fusebox.
- Courtesy and boot/load space lights - optional and standard - were always powered from the purple fused circuit.
- North American side-marker lights powered from the headlight circuit prior to the seat-belt warning system fitted during 1972 were unfused. After that when powered from the parking light circuit they were fused with the parking lights.

Any unfused circuit can cause severe damage if the wiring should short out. **Note that on cars with the main lighting switch in the steering column shroud it is easy to trap the switch wires against the column when refitting the shroud. Eventually the plastic insulation will fail and cause a short circuit, which will cause considerable local damage. And if it is the brown wire that is affected while the car is unattended it could result in a fire such as this.** Care also needs to be taken on Mk2 North American spec prior to 1971 that have a simple on/off switch for the panel lights on the column shroud, in place of a rheostat on the dash.

Particularly when fitting relays to the headlight circuit consideration should be given to adding fuses as the greater current that relays will allow to flow will cause more damage and faster. It is advisable to add one fuse per filament if you are not to be plunged completely into darkness from a fault at one headlight, more information here.

Parking light circuits on Mk1 cars can be fused as per early Mk2 cars i.e. one fuse for the front and another for the rear, inserted where the two red wires in the main harness (12v supply and feed to front lights) and the red in the rear harness come together. Part the three wires and determine which from the main harness carries 12v with the lights turned on, and connect that to a 4-way bullet connector. Connect two in-line fuses to the other side of that, one going to the other main harness wire via a 2-way bullet connector, and the other going to the rear harness via another 2-way bullet connector.

Instrument/switch lighting circuits have been known to cause wiring damage, and on every car that has come to me with rheostat lighting the rheostat has been burnt out, possibly from previous shorts by the instruments, and fusing these depends on the year of the car. To add a fuse ideally it should be as close to the main lighting switch as possible, where the red (prior to 1970) or red/green (1970 and later) wires have two branches one to the parking lights and the other to the instruments. On 1977 and later this will be where the lighting switch sub-harness plugs into the main harness with a multi-way plug. However this does mean guessing which one of the two wires to cut, and you have a 50% chance of getting it wrong.

On Mk1 cars the parking lights weren't fused either, so an in-line fuse with a female spade one side and a male the other between the two red wires and the lighting switch will protect all of them ... with the proviso that a fault at the instruments will extinguish all the rear lights. Mk2 cars prior to 1970 still had the two-fuse fusebox, but had two in-lines in the parking light circuits one feeding the rear (which again would extinguish all lights at the rear if it blew) and the other the front, where at least you have headlights.

The alternative is to insert it in the red/green at the rheostat using an in-line fuse with a female spade one side and a male the other, but even that is complicated prior to 1971 because as well as the red/green feed at the rheostat there is a second wire daisy-chained on to the map light. In that case inserting an in-line between the two red/greens and the rheostat would protect the instrument lights, but not the map light.

Factory/dealer/PO-fitted fog and spot lights should be easy to fuse where the switch supplies are picked up from existing parking and headlight circuits.

For unfused headlamp flasher circuits it should be possible to add an in-line fuse at a bullet connector behind the dash where the tail from the indicator/flasher switch connects to the main harness. However the diagram for 62 to 64 cars shows the brown wire going all the way back to the fusebox. If this is a single wire in a spade connector it can simply by moved to the other end of the same fuse i.e. the purple circuit to fuse it.

For North American side marker lights powered from the headlights there are three blue wires joined together by the fusebox - two from the main harness one of which is the 12v supply the other going to the front markers, and one to the rear harness for the rear markers. Identifying which of the two blues from the main harness is the supply, and inserting an in-line between that and the other two blue wires will protect both front and rear marker lights.

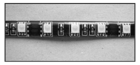
The factory-fitted rear fog light circuit almost certainly uses multi-way plugs and sockets to connect the manual switch to the headlamp circuit i.e. no bullets or spades, so a blue wire would have to be cut to insert a fuse. As there are two blue wires at the main lighting switch and you have a 50% chance of getting it wrong, it makes more sense to cut the single blue at the manual switch.

Seat-belt and Brake Warning Lights:

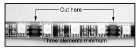
Brake system warning lights were fitted to North American spec (and subsequently all LHD) with the Mk2, but not to RHD until 1977. Reminders to fasten the seat-belt were fitted to North American spec from 1972, but RHD only gained them 1977.

Switch Illumination: *June 2013*

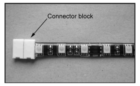
For the 77 model year on the factory supplied night-time illumination in the switches (and in some case a tell-tale function) and heater controls from an internal bulb in each, but on earlier cars you have to grope in the dark to some extent.



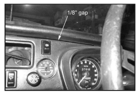
About the same time Michael and I were fiddling with the instrument lighting we had the idea of using LED strip to illuminate the dash, particularly the switches. 77 and later MGB have illuminated switches and heater controls so are already catered for. Available in a variety of colours, we decided to be relatively sober and act our age choosing warm white over other offerings such as blue, green, red and yellow.



The strips can be cut to the required number of LED elements, where there are typically four short copper strips between each group of three LED elements, three elements being the minimum that can be powered off 12v without an external resistor (but see below). Unless you are going to daisy-chain two or more strips, cut to the end of the strips rather than in the middle, and that gives you more copper strip to make a connection at one end, and none at the other.



There are connector blocks available but they are relatively big, the type to connect two strips are relatively cheap but the end ones with wires are four times the price. You can use the first type with wires, inserting the strip into one half and the wires into the other, but it's just as easy and makes a perfectly good connection by soldering direct to the copper strips, then using heat-shrink to cover the connections, and a blob of silicone sealant in the open end to stabilise the wires. The copper strips are very close to one of the elements so it's preferable to use enough heat-sink to cover the nearest one and so get a stronger joint.



Mounting them under the dash crash pad makes them unobtrusive if not invisible from the driving seat, and the wires can be fed through the gap between the top of the dash proper and the dash top under the crash rail. Depending on how the dash and crash pad have been fitted there will either be a clearly visible gap to feed the wires through, or you may need to wiggle a small screwdriver through to open this up.

Although the LED strips are self-adhesive and have a peel-off strip the textured surface of the crash pad will limit its effectiveness so you will probably need to use an additional adhesive, such as Copydex, or silicone sealant.

The LED elements are quite bright and so you may need to use a series resistor to bring this down to an acceptable level.

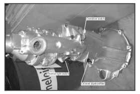
Michael used 330 ohms in series with nine (one concealed) 5050 elements, I used 1.5k although anything from 1k to 1.5k gave very similar results. Herb Adler used 1.8k ohms in series with six although I don't know whether his are 5050 elements or not. Each group of three are effectively in parallel with all the other groups of three across the voltage supply, so the more groups of three you use the more current they will draw. This means theoretically the resistor to achieve a given brightness will vary according to how many groups of three you have used, i.e. a lower value for more groups, but in practice they take such a small current that choice of resistor is going to be down to personal preference of resultant brightness rather than how long the strip is. A resistor, if fitted at the end of the wire where it joins the white/red instrument lighting feed elsewhere, also means that the current will always be at a safe value even if the wiring or LED strip should happen to short out. For example even 330 ohms will limit the current to 42 milli-amps, whereas a single 2.2w instrument bulb takes 160mA.

A shorter strip can be fitted below the dash to illuminate the centre console. Join the wires from the two strips together, via a single resistor, to the instrument lighting feed.

Reversing Lights:

Schematic
Uprating
Reversing lights with auxiliary brake light function

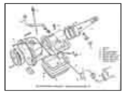
Factory equipment from April/May 1967, may have been a factory fitted option before then. The lens screws through the body of the light unit into captive nuts behind the rear panel, and unusually there is a 2-'pin' plug on the harness that connects to two small spades under the light unit. The bulb is a festoon-type GLB270 (18W, North America) or GLB273 (21W, elsewhere) although these days some describe the GLB270 as '18/21W'. There are several different lengths of festoon and these are 44mm. The lens (37H1760 with gasket 37H1759 and two screws 37H3751) seems to have a silvered coating on the back round the edge as a pseudo chrome bezel. The light unit complete with lens is BHA5167 and also uses gasket 37H1759 to the body.



The reverse light switch is screwed into the upper half of the gearbox and can be seen on the right-hand side looking directly up into the narrower part of the tunnel. Access to this switch is not easy, but disconnecting the rear cross-member at the chassis rails allows the gearbox to swing down a little for better access. You can also remove the centre arm-rest/cubby (where fitted) and pull back the tunnel carpet for some access from above. On 3-synch cars there is a large access panel on top of the tunnel that can be removed, but even on 4-synch cars there is a small panel in front of the gear lever which can help. Note that OD gearboxes prior to September 66 may not have provision for a switch, unlike early non-OD gearboxes.

The only 'adjustment' on these switches is provided by spacers, and a loose or worn switch can prevent the light coming on or make it erratic. In the case of wear causing non or erratic operation removing a spacer may be all that is required. OTOH a missing spacer can cause it to be on when it shouldn't be. It's always been said that these spacers are fibre, and there were originally two of them. However on Vee the OD switch spacer is copper and the Parts Catalogue only shows one per switch. Various suppliers only indicate one (1B 3664), and fibre, but Brown & Gammons shows a fibre washer for the reverse switch and a copper for the OD (3H 550), which is the same as for the brake banjo! Incidentally the OD and reverse light switches are the same part number. Vee's reverse light switch has one thin fibre spacer so exactly as per Brown & Gammons, and this is noticeably thinner than the OD copper spacer.

Automatic Gearbox:

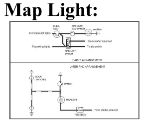


The automatic gearbox uses a completely different switch that combines the reversing lights and inhibitor functions. It screws into the side of the gearbox and there is a calibration process to ensure it is screwed in to the correct position.

Map/Interior Lights:

Door switches

Map Light:

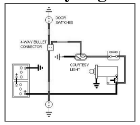


Originally the MGB had a map light for the passenger, controlled by an on/off switch close by when the main lighting switch was in either of its 'on' positions. On Mk2 North American cars the map light moved to a centre console, replaced by a courtesy light in 1971. For 1971 only non-North American cars had the map light available at any time with the on/off switch, as well as being lit from both driver and passenger door switches, in 1972 it was replaced by a central courtesy light. Map lights were never fused.

This light (when fitted to the dash i.e. excluding North American centrally mounted lights) is a little confusing as many parts sources indicate it is the same as the number plate light that attaches to the overrider, but this is only partly the case: It uses the chrome cover (37H5426), glass dome (606078) and seal (17H5302, this should be a round seal but some suppliers have it as a diamond-shaped seal which can be cut down) from the number plate light. However it doesn't use the bulb holder, and it is a little cheaper to get the individual parts. For the bulb holder it uses a claw-type holder with a 2.2w bulb the same type as for the speedo and tach. Well I say the same type, and whilst the UK diagrams do show what would appear to be a one-wire bulb holder which picks up an earth from being clipped into the dash (confirmed by Bob Gibbons with his 1964 LHD), a replacement harness has a red/green and a black wire going to a 2-wire claw-type bulb holder, so has a wired earth. This is preferable as a freshly painted dash may not supply a decent earth without scraping some of your precious paint off, but does not appear to be listed separately in the Parts Catalogue. Indeed it doesn't appear to be listed by any of the usual suspects, although I did find a 2-wire claw-type holder listed under part number AEU1313 from a number of non-MG sources. North American spec schematics for Mk2 cars do show a wired earth.

The red/green from the bulb holder goes into the harness and back out again with a red wire from the main lighting switch. These wires have spades on a replacement harness (as does Bob Gibbons' 1964 LHD), but current stock from UK suppliers shows the switch as having screw terminals.

Courtesy Light:



From the Leyland circuit diagrams North American Mk2 cars seem to have had a central console with a map light controlled by a separate rocker switch, **and** an optional courtesy light with a manual switch as well as being operated by both doors. However Clausager indicates they had the map light until 1970, then from 1971 the courtesy light. The following year i.e. 1972 non-North American cars had the map light replaced by a central courtesy light, lit from an integral manual switch as well as from driver and passenger door switches at any time. But again the Leyland circuit diagrams are confusing in that they show an optional interior light controlled by two door switches in addition to the map light, from 1968 to 1970. Again Clausager indicates a simple change from one to the other for the 1972 model year, when non-North American cars gained the centre console.

Note: Haynes issue dated 2010 with coloured schematics has an error in the drawing of the courtesy light for 1973 cars, and later. As shown it wouldn't work at all from either the door switches or the manual switch, but if both are operated at the same it will blow the purple circuit fuse. Earlier versions e.g. my 1989 copy are drawn correctly.

Getting to the bullet connectors behind the console for the courtesy light, lighter socket etc. is a real pain as there is not enough slack in the harness, so I made an extender.

October 2017: Since getting Vee back on the road I'd noticed that unless the passenger door was fully shut the courtesy light wouldn't go off. I didn't do anything about it as if anything it acted as a safety feature warning that the door wasn't fully shut, like modern cars where the switch is on the B-post. But I wasn't totally happy with the alignment of the passenger door, so slackened the door to hinge screws, lifted the door very slightly and retightened. That put the door right, but also means the light now goes off when the door is only half latched, as it always used to before. I mentioned this in connection with an MGOC thread on door hinges, and John Holland said he had to add a packing piece before his would go off at all. Given the amount of travel of the switch plunger after the contacts open I'm amazed they are so marginal.

LED upgrade:

On a trip away I must have caught Vee's load-space light switch and knocked it on when getting bags out, but wasn't made aware of it until some 30 hours later. Fortunately she still started, but it got me thinking about LED replacements for the interior lights in case it happened again, as well as for their increased brightness. LED replacements for the GLB254 6w festoon are commonly available, but I came across two types. The one with three 5050 SMD elements and a resistor seem to be the most common at around £2.50, but I also found one with two tiny elements and additional electronics (Cree), and an alloy heat-sink at £1.50. Now one would expect the first type to be better, but I was intrigued enough (and the cost was low enough) to buy one of each.

Testing them the Cree-type was obviously much brighter, but how to compare them in a photograph without a lot of fiddling around with wires and holders? I put them in the reversing lights! One thing to note is that the 3-element type are polarity sensitive so if they don't work one way round try them the other. The other type are not polarity sensitive so work either way round. The 5050-type are really not much brighter that the originals, only whiter, which seems to be the case for stop/tail LEDs at least. It will be good enough for the V8 load space, and I'll use the Cree-type for the interior light. The supplier had one remaining Cree-type so I ordered that as well for Bee's interior light. She already has an 'eagle-eye' LED boot light which is a great improvement over the standard light.

The Cree-type are so bright that I was tempted to buy more for the reversing lights. The supplier had no more, and whilst they are available elsewhere they are typically £6 each or two for £8, or I could settle for the less bright type. But there is also the issue of legality and acceptability to insurance companies, and having read of someone with LED number plate lights having an insurance claim refused I decided to leave them as they are.

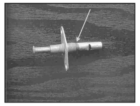
That leaves the current drawn by each type:

- The original 6W festoon takes 350mA
- The 5050-type LED takes 28mA
- The Cree-type LED takes 225mA
- And out of interest the single Eagle Eye in Bee's boot takes 50mA

So whilst the 5050 type takes less than 10% of the current of the originals giving a big reduction in load, the Cree takes about 70% of the original. So a small reduction in current but a huge boost in output - horses for courses.

I've used 'Eagle Eye' LEDs for DRLs and they are very effective. I've also used one in a trial of a vastly improved boot light, and it occurs to me that they could be used as 'puddle lights' when mounted in the bottom of the door, and red versions as rear-facing marker lights as the doors are opened. However these last two would require the drilling of holes in the door case.

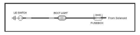
Door switches *Added October 2011:*



BL door switches (always BHA4593 for the courtesy light) were always subject to water ingress and corrosion as they are effectively outside the cabin, giving flickering of the courtesy light or failing to operate at all. Two of mine were like that so I replaced them, but at the time the original style were not available and the replacements were not only different in appearance but also needed the hole in the A-post opening up a little bit. By 2012 Brown & Gammons and others have the correct switches (albeit with complaints of the plunger buckling), but dodgy switches may be recoverable, particularly if they are only intermittent and not so badly corroded they don't work at all or have crumbled away, click on the thumbnail. This should only be a problem for the main doors, the roadster boot lid and GT hatch seals should be protecting those switches completely.

Note that North American spec cars from 1970 had a 'key in, door open' warning buzzer that involved a second switch BHA4984 on the driver's door. This switch has two wires and both contacts are insulated from the body i.e. is totally different to the courtesy light switch, so problems and possible fixes are probably different as well.

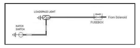
Boot Light:



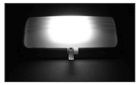
Both UK and North American roadsters had a boot light (BHA5040) from the 1971 model year onwards, fused from the purple circuit, operated by a switch (13H391) activated by opening the boot lid. These switches are inside the boot so protected from weather.

However whilst the light gives a reasonable light when there is not much in the boot, if it is fully loaded it gives virtually no light at all. A pal had the idea of using one of the 'Eagle Eye' LEDs I had used for the DRLs, and it works very well. Tucked up into the recess of the boot lid reinforcing frame where the latch release button is, but positioned to one side so it doesn't interfere with the mechanism in either the locked or the unlocked positions, it is at the perfect angle to illuminate the whole of the boot with a bright white light.

GT load-space light:



Both UK and North American GTs had a load-space light (EAM1651) from the 1971 model year onwards, fused from the purple circuit, with the switch (13H2018) operated by the hatch being opened as well as a manual switch, and again the switches are inside the cabin so protected from weather. Not sure why it needs a manual switch ... unless someone is sitting (never 'sat'!) in the back ... reading a magazine ... in the dark.



While updating the courtesy lights with LEDs I took the opportunity to do the same with the load space, and replace the melted cover.

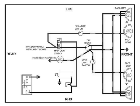
North American side marker lights:

Side marker lights appeared in the 1970 model year and were powered from the unfused (it is easy to fuse them) blue circuit to come on with the headlights - dip or main. In 1972 cars with the sequential seat belt system and later, each unit is wired to the nearest side/tail light assembly and hence comes on and is fused with them from the top two fuses in the four-way fuse block. Side-marker lights always had a wired earth, shared with the headlights at the front and the reversing lights at the rear.

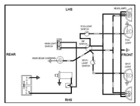
Fog & Spot lights:

Auxiliary switches

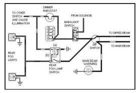
Factory-fitted:



The optional factory-fitted front spot/driving lights were always wired to be available with the main beam if required. From inception until 1970 optional factory-fitted front fog lights were wired, via a switch, to be available with the side lights if required. Factory or dealer wired fog and spot lights were powered from unfused circuits, but it should be easy to add fuses.



From the 1970 model year the front fog lights were wired to be available with the dipped beam if required, maybe a regulation change, but this renders them pretty useless as dipped beams throw back a lot of glare in fog. By the time my 2004 ZS was built regulations allowed front fogs to be available with the parking/position lights on only.

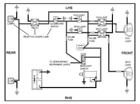


A pair of square Lucas rear fog lights were factory-fitted to all home-market cars for the 1980 model year, wired to be available when the headlights were on dipped or main beam. Again, if driving in thick fog with front fogs on without dipped headlights this means rear fogs wouldn't be available. This time my ZS is the same - if only the rears are turned on, but if one turns the front fogs on with parking lights then the rear fogs become available - sensible. However if you use drive-on wheel ramps these can catch on the ramps before the car has been raised high enough to clear them, they can also skid on concrete when trying to drive up them. Pre-ramps, or ramp extenders, solve both problems as described here. A similar problem occurs at the front with after-market valances such as the ST air-dam.

After-market:

You have a number of options as to how to wire them - available all the time; available when the side lights are on; or available when the appropriate headlights are on. In all cases except the first a relay should be employed to reduce the load of the extra lamps on existing wiring and switches to a minimum. All additional lamps should employ an in-line fuse, which if standard-gauge wiring, switches and relays are used, can be a standard 17-amp rated, 35-amp blow fuse. A lower-rated fuse could be used, but why complicate matters with a proliferation of fuses with different ratings? And if an auxiliary lamp fuse **does** blow it can be replaced with one of the spares from the main fuse block - once the fault has been cleared of course. I suggest that a single fuse for all lights is adequate except for night rallying when separate fusing of each front light, including each headlight filament, would be more robust.

Personally, I have my front and rear fog lights wired so that they are available when the side lights are on as I can't see much point in having front fog lights if you can't use them without being dazzled by the glare thrown back by normal dipped lights. The following schematic has all three types of lamp wired in this way:



My 2004 ZS is wired this way from the factory, although I'm told by people from North America that this is illegal there and they can only be used with headlights. I have a vague recollection that the UK might have been the same some time ago, if so common sense has obviously prevailed since then. The MOT requirement is: "Front and rear fog lamps are permitted to operate independently of any other lamps or ignition systems." (MOT Manual Section 4.5.1). A 'tell-tale' indicator is required but only for mandatory rear fog lights i.e. on vehicles first used after 1980. At one time the manual said it could just be a coloured tag visible when the switch is operated as well as a light, but now it mentions neither (MOT Manual Section 4.9). I.e. it could be either, but it will only be checked for mandatory lights which from the factory did have a light.

Rectangular fog (kerb-side) and spot lights as fitted to my V8. However as the glass on the spot got broken many years ago, and I haven't needed to use the fog light for even longer, after the restoration in 2017 I didn't bother refitting them.

People sometimes suggest using the off-side reversing light as a rear fog light with either a red LED or red lens fitted. The Road Vehicles Lighting Regulations 1989 Schedule 11 2.(d) says that optional rear fog lamps must have a minimum separation distance of 100mm between a rear fog lamp and a stop lamp. On an MGB there is only 45mm between the illuminated reversing light and stop/tail lenses at their closest point which appears to preclude that. But Dave Birkby wrote on the MGOC MGB Technical Forum in April 2019:

> Before you go too far this modification would require informing the insurance company. Take the lenses of both the offside reverse and rear position/brake/indicator light unit off (the light emitting surfaces). Measure the distance between the reverse bulb and the brake light bulb to ensure there is 100mm separation, if there isn't 100mm they would not approve as it contravenes the Road Vehicles lighting Regulations.

And in a subsequent post emphasising:

> But, it is the bulbs and not the lenses, and the glass section of a festoon at that. That is how moderns get through type approval if they are combined in a lamp.

More recently (November 2020) the question was asked again, I posted the above, and Richard Massey quoted the IVA which shows the distance as being measured between the lenses. But Dave also wrote in April 2019 about when fog lights are permitted to be shown:

> That is the law for cars that have been type approved or had to go through IVA. Our cars have not had that process so they do not need to comply. IVA is much stricter than MOT, but they are different tests.

The upshot is that the MOT checks neither distance not light source, but an external LED may cause problems in an insurance claim. Staying with filament is probably not an option as they are 21W and get pretty hot. OK for the short period of use a 21W reversing light gets, but it would almost certainly damage the lens if used as a rear fog light.

Front or rear fog lights can only be used in poor visibility e.g. fog, falling snow or heavy spray. If someone is travelling behind you in convoy, turn your rear fogs off, so they can better see your brake lights and not be dazzled. Never use them as a matter of course at night, particularly in built-up areas in the rain, the resulting dazzle for following drivers even travelling at a safe distance behind you severely limits their ability to see anything other than your fog lights - including your own stop-lights. In the UK it is an offence (Highway Code Rule 236) to use fog or spot lights inappropriately, you risk a £1000 fine - per light! Day-time running lights are different - they should come on when the engine is started, but must go off (or be dimmed) as soon as sidelights or headlights are turned on.

Auxiliary switches:

Fitted where you will, but on the V8 a PO had butchered the dash panel below the air vents to fit a mish-mash of switches for cooling fan override, front fogs, and maybe something else, which looked a mess. I was fortunate to get a set of three illuminated rockers comprising one with a fan symbol (which shows me when the thermo switch has come on as well as being able to turn the fans on manually), a red one (rear fogs) and a green one (front fogs) at Stoneleigh one year. Slightly bigger than standard, but with a fascia cover-panel cut from a piece of textured black plastic they cover the bodging pretty well. These illuminated switches have probably every logo variation you are likely to need, and whilst they are a more modern design of rocker they are said to be the same size as the MGB pre-77 rockers.

Number Plate lights: *April 2009*

Schematics

Number plate illumination lamps were originally mounted on the rear bumper overriders (amazingly **front** overriders on UK cars were optional to begin with!). For the 1970 model year North American cars had two 'quarter' bumpers instead of a full-width and the lights were tucked inside the ends of these. They moved to the bumper itself for 1974 non-North American cars, to the number-plate backing-plate for North American 1974 model year cars with the 'Sabrina' overriders, and for all rubber-bumper models. When mounted on the backing-plate they had 12v and earth wires, but for the overrider and bumper-mounted types there is only a single wire to provide 12v for illumination and a very tortuous path for the earth return relying on the physical contacts between bulb, bulb holder, light unit, light unit plinth, overrider and overrider bolt (or bumper), bumper irons and body plus various nuts, screws, washers and bolts! Mine didn't work after restoration so I provided an earth wire from the light units back to one of the existing earth wires. lights.

It was only when I received an email from Felix Weschitz in Austria saying he had the same problem, and couldn't find my own well-hidden comment on the problem, that I decided to add this specific paragraph, and a link to Felix's information. Reversing lights have an earth but that goes directly back to a number plate bolt on RHD cars so you will still have to do as Felix did, but cars for North America with side markers use bullet connectors for both those and the reversing lights so you can tap into those. Number plate lights mounted on the number plate backing plate (North American split bumper and all rubber bumper) were provided with earth wires from the factory.

May 2017: Neil Harrison on the MGOC forum raised this problem, and a couple of us suggested the earthing. I mentioned I had run an earth wire in from a light-unit stud where it is inside the overrider. However he tried that, and it made no difference. So he dismantled the light unit and found it had been assembled such that the rubber gasket was completely insulating the bulb holder from the remainder of the fitting. Assembled correctly it worked and didn't need the earth wire. So if you have the same problem before going to the trouble of making up and installing an earth wire, clip a temporary earth to the light-unit stud inside the overrider, and see if that makes it work. If it does, then it does need an earth wire.

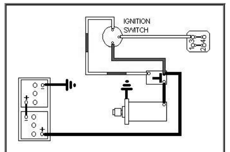
Sheared stud repair: *October 2016* When removing the light units from Vee's number-plate backing as part of her restoration I was annoyed to shear a stud on one of the units as otherwise they are both in as-new condition. Looking at the studs they have a shallow round head, then a short square shank, which is pressed into a square hole in the base-plate. "I can make one of those", I thought.

I pressed out the sheared stud in a vice using a socket over the head. I found a cheese-head screw that fitted the other nut, and a nut that fitted the screw. I then filed the lower half of the head down into a square using a needle file. On the base-plate I used the square tang of a file in the square hole to bow it downwards a little, opening it out so the screw just fitted. Then using the 1/4" drive end of a socket, which just fitted over the square shank on the new 'stud', and a vice, pressed the base-plate round the screw flat again, so reducing the size of the hole, and pinching-up the screw. About an hour's work, and £20 saved.

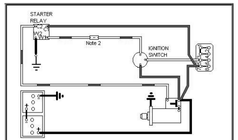
Starters

Help! My starter is cranking all the time! On 76 and later models this can be caused by the 'brake test' diode having gone short-circuit. On all models it can also be caused by failure of the ignition switch, a sticking starter relay (1970-on), sticking solenoid, or chafed wiring.

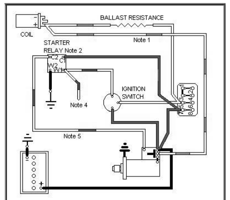
Schematics Note: Automatic cars have the White/Red wired via the combined reverse light switch and automatic transmission safety switch on the gearbox. While the automatic gearbox was an option, **all** MK2 CB cars had a bullet connector in the white/red starter wire to the solenoid (68 and 69 models) or starter relay relay (70 and later) in the tail leading down to the starter.



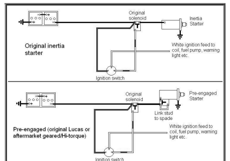
Inertia Starter (remote solenoid to 67)



Pre-engaged starter (attached solenoid) 12v Coil (chrome bumper 68-74, not V8)

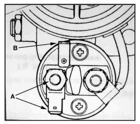


Pre-engaged starter (attached solenoid) 6v Coil (rubber bumper and all V8s)

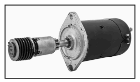


Pre-engaged Starter Replaces Inertia

Model Variations:



An M418G inertia starter 13H4561 and a remote solenoid on the inner wing was fitted to MkI cars. MkII and later had a 2M100 pre-engaged starter with attached solenoid 13H6130. Originally the ignition switch operated the solenoid directly on both types, but probably because of the higher current requirement of the pre-engaged starter a starter relay was eventually (1970 models) fitted which has the effect of reducing the load on the switch and its connections. 18V engines had the later 2M100 starter 13H7844. The solenoid on this starter has a 'boost' contact for ballasted ignition systems to aid starting (it connects full battery voltage to the 6v coil) but this wasn't used on 4-cylinder CB cars, only RB. All V8s had the 2M100 starter with the coil boost system - albeit to a different part number BHA5223. V8s also have an additional connection under the right-hand toe-board where the battery cable joins a short tail from the starter.



December 2023: The inertia starter is significantly longer and heavier than the later pre-engaged starter, even more so than the modern replacements which are also 1/3rd the price of a rebuilt exchange original. Simon Sjenitzer needed to remove his and was having trouble getting it out, asked on the forum how it should be done but didn't get any useful response. The Workshop Manual makes no reference to it as they advise removing the engine and gearbox together. Haynes does cover removing engine only and says "... Undo the two bolts which hold the starter motor in place. It will not be possible to remove the starter **until the engine has been drawn forwards a few inches** *my emphasis*, unless the distributor is removed. They say 'all models', but show a circular gear lever gaiter so that must be a 4-synch with the pre-engaged starter, and I removed mine just by removing the distributor i.e. without pulling the engine forwards. Not having done an inertia starter (on an MGB, I have on a Mini) I did advise that once he did get it off to replace it with a modern - smaller and lighter - type even if there was nothing actually wrong with the starter. He had to puzzle it out for himself and came back with (paraphrased) the following:

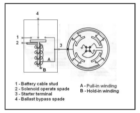
"The only way to remove the original inertia jobbie is to (1) remove the distributor, (2) remove alternator (to be able to get at the off-side engine mount), (3) disconnect the engine mounts. Then lift the engine just enough to allow the old unit to be taken out. What a palaver!!!"

He did replace it with a modern type.

The 1977 LHD Workshop Manual AKM3524 gives the 'lock torque' current (stalled?) as 463 amps, the current at 1000rpm (cranking?) as 300 amps, and the 'light running' (spinning not cranking?) as 40 amps.

Clausager and the Parts Catalogue say that a rubber boot BHH790 was fitted over the 4-cylinder (but not V8) starter, solenoid and connections from chassis number 284721-on in May 72. It is no longer shown in the 77 and later catalogue, but some say their 77 and later models have it. It's said to be a right pain to remove and refit, my 73 hasn't had one in my 30-year ownership and hasn't suffered as a result.

Pre-engaged solenoid: *August 2013*



The Workshop Manual including early models makes no mention of it but the pre-engaged solenoid has two windings - a pull-in of 0.25 to 0.27 ohms as well as a hold-in of 0.76 to 0.8 ohms. Current flows through both windings in parallel initially - the hold-in direct to earth and the pull-in in series with the motor to earth. This additional current turns the motor as the solenoid is moving the pinion towards the flywheel which aids engagement with the flywheel. As soon as the solenoid has moved far enough a copper bar bridges two large contacts and that connects full battery power to the motor for cranking. That effectively short-circuits the pull-in winding i.e. connects battery voltage to both sides, so pull-in current no longer flows, only hold-in current.

Haynes lists both windings in the sectioned drawing of the pre-engaged M418G starter, but doesn't mention it for the later 2M100 for 18V engines, however it will be the same. This results in an initial current of about 30 amps when power is first applied to the solenoid, dropping to about 10 amps when it has operated. In fact it is closer to 8 amps once the cranking load has been applied to the battery when its voltage has fallen to the normal cranking level of about 10v. Brian Shaw reported that the solenoid plunger didn't move when he applied 12v to the larger operate spade and earth to the starter body, even though he could see it was sparking, and he measured 11 amps on it. It was only when he connected 12v to the battery cable stud as well as the operate spade that the solenoid operated (and the motor spun). Bob Davis pointed out these two windings and posted a Bosch circuit diagram of a typical starter and ignition system, click the thumbnail for a simplified diagram of the solenoid and motor and an explanation how the system works. However that doesn't explain Brian Shaw's problem. Regardless of whether 12v is connected to the battery cable stud or not, current will still flow from the solenoid operate spade to the starter body through both hold-in winding **and** the pull-in winding and the motor - as long as the solenoid is connected to the motor. By not having 12v on the battery cable stud the opposite problem occurs, i.e. the pull-in current isn't reduced to the hold-in value when the solenoid operates, so it could overheat. Brian's problem is more an indication that insufficient current was flowing to pull the solenoid in. The solenoid only operating when 12v was applied to the battery cable stud as well is not logical as until the solenoid operates the battery cable stud isn't connected to anything.

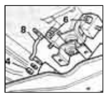
Fixing bolts: *August 2016*

Incidentally the two starter bolts are different on engines attached to 4-synch gearboxes. The upper one goes through the engine back-plate and into the bell-housing, so is longer. The lower goes into the back-plate only so is shorter. If a long bolt is fitted here it can foul the flywheel. However there is confusion over the thread type. The Parts Catalogue indicates they are both UNC thread; Brown & Gammons indicates they are both UNF; Moss Europe indicates the longer upper is UNC and the shorter lower is UNF. Moss makes the most sense - bolts that go into alloy castings are usually UNC, and those that go into steel are UNF.

Earth Straps: *January 2020*

Earth straps should be braided to cope with engine/gearbox movement, stranded cable (as used at the battery) will eventually fracture if used at the engine or gearbox.

Chrome bumper cars have the earth strap round the right-hand (as you look into the engine compartment from the front) engine mount with one end under an engine front-plate nut (one of two) and the other under a chassis bracket nut.



Rubber bumper cars have it at the gearbox end as the engine mounting arrangement is completely different. One end under a bolt through the rubber mount plate into the gearbox casting, and the other end under the nut that secures the mount stud to the crossmember, and as such much less accessible.

Very late models got a new engine earth strap from the heater shelf to the engine back-plate, it would be easy to add that to any RB and forget about the inaccessible gearbox strap.

See below for how to check the condition of battery and earth connections. A bad engine/gearbox strap can result in smoking/damaged accelerator, heater and choke cables as well as slow cranking and difficult starting, and I have heard of one case where a braided clutch hose (why?) burst.

Mechanical Problems:

The original inertia starter relies on the pinion being 'thrown' into engagement with the flywheel as the motor starts to spin, and it can stick and fail to engage, also only just engage where it can 'jump out' again just as it starts to take the load of the engine, resulting in a whining motor and no cranking. The books say the spiral gear and fine spring should be scrupulously clean and not oiled, but in my experience this causes them to stick as much as over-oiling. Just a drop of light oil on the spiral gear, distributed by working the gear, and any excess wiped off, seems best. The pinion can also jam in mesh with the flywheel after a failed start, and this can prevent any further cranking. This can usually be cleared by putting the car into 4th gear (not 1st!) and rocking it back and fore until it 'clonks' out of engagement. Sometimes the motor has a square shaft sticking out of the back-plate and this can be turned with a spanner to 'wind it out of engagement' and clear the jam.

By contrast the pre-engaged starter uses the solenoid to move the pinion into engagement with the flywheel before full power is applied to the motor (see here

Electrical Problems:

Probably the most common is slow cranking, or there is a chattering noise when you turn the key, but there can be others where the starter doesn't turn at all. With Mk1 cars you turn the key which operates a solenoid on the inner wing and that connects power to the inertia starter motor. For about three years of the Mk2 the ignition key switch operates the solenoid on the pre-engaged starter directly, but 1970 models on had a starter relay on the inner wing by the fusebox operated by the key and that powers the solenoid on the motor which powers the motor proper.

On Mk1 cars if you hear a 'click' when turning the key that is probably the solenoid on the inner wing operating, so if the motor doesn't turn either the solenoid is failing to extend power to the motor or the motor is not responding to it.

On Mk2 if you hear a 'clonk' when turning the key that is probably the solenoid on the starter you can hear, so if the motor doesn't turn either the solenoid is failing to extend power to the motor or the motor is not responding to it.

From 1970 if you only hear a 'click' that is probably the starter relay you can hear, so if you don't hear a 'clonk' or the motor either the relay is failing to extend power to the solenoid or the solenoid is failing to respond.

If you don't hear anything at all when you turn the key either the key switch is failing to extend power to the solenoid (up to 1970), or to the relay (1970 on), or the solenoid/relay is failing to respond.

July 2024: Filled up a couple of days prior to a trip to Norfolk I went to start the engine and just got a 'clonk' - odd, but I'd already put it in gear and was starting to lift the clutch so it could have been something to do with that. 2nd turn was fine. Morning of the journey the same thing happened, but again the 2nd turn was fine - slightly concerning at the start of a 3-day 360 mile trip! Lunch stop was fine, as was starting the engine twice when we were there. Could be the solenoid failing to power the motor, or the motor not responding. Unlikely to be a dead segment on the motor as the armature would need to be turned to another segment before it would work. Could also be a bad connection feeding the solenoid, so far I hadn't looked at the ignition warning light to see if that went out, but having got the clonk and again when I released I doubt it is that. Could also be a bad engine earth strap, but that would make the accelerator, choke and heater cables smoke, and I should be able to use my lithium jump pack connected to the remote starter terminal on the inner wing and the engine block to get round that. Looking at pictures of Bee's solenoid and motor there is a bolted connection both sides of the solenoid, with the 2nd one being the connection to the motor, so if it is the solenoid contact I would be able to bridge the two to power the motor independently - once I had got the car high enough ... and safe enough! But if it is the motor itself then no chance. The hotel car park was down a slight slope and had a hardcore surface so bump-starting it there was out, as was pushing Bee out onto the road, she would have to be towed out. Start of the journey home the same thing happened, but fortunately again the 2nd try was fine, as was a restart at a filling station and our lunch stop then home with no further problems.

Pondering next day if I can connect two voltmeters one to the battery cable stud on the solenoid and the other to the link between the solenoid and the motor I should be able to see exactly where voltage is and isn't getting to. Jacked up with axle stands under the spring pans that's easy enough, but Sod's Law dictates that she fires up first time and several times immediately after! Can't leave her like that as she is just forward enough to prevent the garage door closing, so really I need something a bit more 'permanent' that I can see in the cabin, like a bulb connected to the solenoid output, with the ignition warning light being used for the input. The wiring needs to be fairly robust to cope with engine movement, and connected firmly enough so it doesn't fall off, so I opt for length of twin-core sheathed mains cable with a through-hole terminal on the end as the connection between the solenoid and the motor is also a threaded stud and nut just like the input. I go to undo that nut ... and whilst not loose as such it needed very little pressure to start moving it, and many years ago I did have a bad connection develop where the battery cable attached to the solenoid input stud! In the normal run of events that nut shouldn't have been moved since the starter was built, and it is quite likely to be the original as it came with the car to me in 1990, so no complaints about quality of the starter as a whole!

For the bulb I root through the old harness I kept from a 1980 and find a holder one with a small bulb with long enough wiring tails both sides which is perfect. Connect the tail to my solenoid output wire which has been fed though the harness grommet, the earth goes to the fuel gauge clamp bracket under the knurled nut. Bulb taped to the top of the steering column just down from the cowl. Turn the key and it lights up and the starter turns the engine - several times, so worth the effort as it's may take a few start attempts over a week or more ... and I may have fixed it anyway by tightening that solenoid output nut more than it was before. Next morning still working, and again in the afternoon, plus twice next day and succeeding days. After a few weeks and several starts no further occurrence so took the test bulb off, and nothing in the remainder of the year.

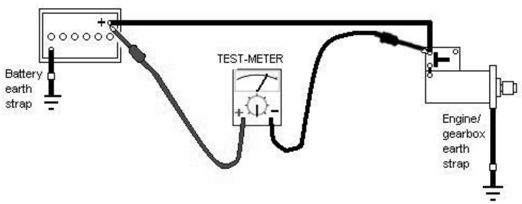
Electrical Problems - slow cranking:

As well as a weak battery this can be caused by bad connections in the cranking circuit. The Lucas Fault Diagnosis Service Manual states:

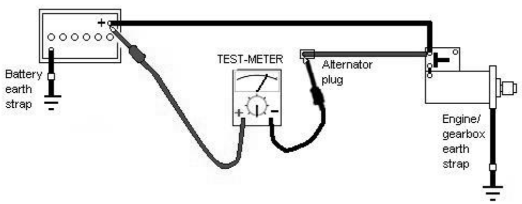
> "The acceptable volt-drop figure for most circuits is 10% of system voltage (1-2v on a 12v system) but there are exceptions to this rule as in the case of the starter circuit where the maximum voltage drop is 0.5v."

The first thing to do is measure the voltage on the battery **posts** (not the clamps or connectors) while cranking - each battery in turn and adding them together for twin 6v batteries. If you see much below 10v then the batteries are weak, otherwise check for bad connections as follows (assumes negative earth, for positive earth cars change each reference of positive to negative and vice-versa). What you are going to do here is measure how much voltage is being 'lost' at bad connections in a circuit, which reduces cranking speed but more importantly reduces voltage to the ignition system, rather than measure the absolute voltage between a terminal and earth.

Note that V8s have an additional connection under the right-hand toe-board where the battery cable attaches to a short tail coming from the motor.

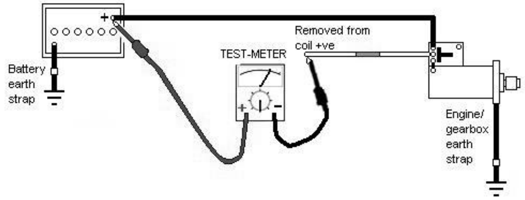


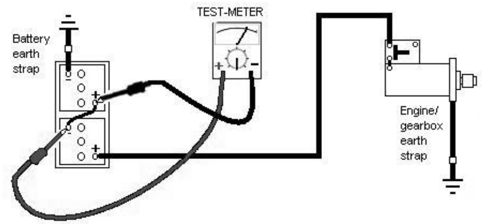
Ideally we want to test the 12v circuit between the battery post and the and the solenoid stud - meter positive on the 12v post and negative on the solenoid stud for negative earth cars, reverse for positive earth cars. Again these voltage measurements are taken while cranking, but instead of a meter with manual range selection being set to its 12v scale, it should be switched to a low voltage scale.



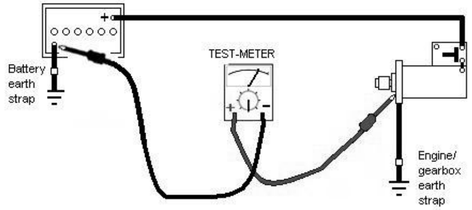
However the solenoid stud is not easy to get to, particularly on the V8 where it is covered with a heat-shield. But by unplugging the alternator plug and using the brown wire in that, you are effectively measuring the voltage at the solenoid stud. Except on the V8 - where the browns go to a battery cable stud under the toe-board, and a short length of battery cable goes from there to the starter. This will give the true voltage at the toe-board stud, which still leaves the potential (ho ho) for losses between there and the solenoid stud.

But! There is another dodge, and that is that when V8 and rubber-bumper 4-cylinder solenoids are operated and powering the starter, they are also connecting solenoid stud voltage to the ignition ballast bypass wire that goes up to the coil +ve. So removing this from the coil and connecting your meter to that tests the voltage **inside** the solenoid, and includes any voltage being lost in the battery stud half of the solenoid contact. There could be more voltage lost in the starter half of the solenoid contact, but unless you can get at the link that goes between the solenoid and the starter motor itself you won't be able to test that.





For twin 6v batteries also measure between the two link cable posts and add that to the losses measured in the 12v and earth circuits to get the total losses. Note that the meter polarity shown is correct for the negative earth system depicted.



The earth circuit is tested with the positive probe on the starter body and the negative on the battery earth post (for negative earth cars, reverse for positive earth), and checks the engine/gearbox strap as well as the battery earth strap. You will obviously need a long wire for one of these connections on an MGB.

The individual readings will tell you which of the two (or three) parts of the circuit are giving you the greatest losses. An analogue voltmeter is preferable for these tests as a digital meter may give wildly fluctuating readings while cranking. Disconnect the coil to prevent the engine from starting.

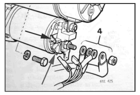
In a perfect world you would see 0v while cranking on both tests. But even with cables and straps of this size and good connections there will be some resistance, and hence some volt drop, but ideally it should not exceed 0.5v in either path. With freshly cleaned connections you should be able to get it down to a couple of tenths of a volt in each direction. If you get significantly more than 0.5v you have one or more bad connections, and by using the same technique of looking for lost voltage at various connections in a circuit you will be able to determine those that are causing the biggest volt-drops. These can typically be the battery post connectors, with the older cup-style battery connectors in particular, the earth strap where it bolts to the battery box, and either end of the engine/gearbox earthing strap. In any of them you could also get bad connections where the cables and straps attach to their connectors. Incidentally make sure you do have an earthing strap either around the left-hand front engine mount (CB cars) or round the gearbox mounts (RB cars) or your starter current will be returning to earth via the heater and accelerator cables, heating them up and possibly damaging them in the process.

Also test the link cable between twin-6v batteries in the same way, i.e. between the two posts, and the cable from the remote solenoid on the inner wing and the starter motor for the earlier inertia starters. You can also test the remote solenoid by putting the meter between the two studs. However this will show 12v immediately, dropping to the 'lost' voltage in the contacts when you turn the key to crank. If your pre-engaged starter with the attached solenoid has an exposed link between the solenoid and the motor as some do, you can check that solenoid as well.

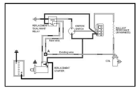
Rubber Bumper 'Coil Boost' System: *August 2014*

Rubber bumper cars and all V8s have a 6v ignition system for running, but the coil voltage is boosted to full battery voltage during starting. This makes starting easier and can make the difference between starting and not starting under certain conditions.

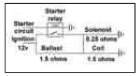
The system works in normal running by feeding ignition voltage to the coil through a ballast resistance concealed in the wiring harness, such that half the voltage is dropped across the ballast resistance and half across the coil. The coils on this system have half the primary resistance of 12v ignition systems - about 1.5 ohms as opposed to about 3 ohms, and are known as 6v coils.



For starting there is an additional contact on the starter solenoid which is connected direct to the coil +ve. When the solenoid operates as well as powering the starter, it also feeds battery voltage out on this additional contact. With a decent battery you should get 10v while cranking, which boost the coil voltage from the normal 6v running level to 10v during cranking, which gives a much fatter spark. This boost voltage is disconnected as soon as you release the key and stop cranking, if you ran with this voltage on a 6v coil you would overheat it and rapidly burn out the points.



It seems many geared and 'hi-torque' starters supplied for the MGB still don't have the extra contact on the solenoid which boosts coil voltage during cranking, meaning you either have to dispense with the coil boost feature or replicate it with an alternative or additional relay, or possible a diode if you know what you are doing! Click the thumbnail for three options.

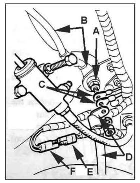


A couple of people have asked why the bypass circuit doesn't come from the existing contact on the starter relay and the answer is that Messers Ohm, Volt and Amp won't allow it! With the coil +ve wired to the solenoid contact on the relay you create a network of resistances instead of two simple series circuits and they interact with each other to affect the voltage that is available to the coil, reducing it from 6v to about 1.5v which isn't enough for ignition. A secondary effect is that the current through the ballast resistance would increase from about 4 amps to 7 amps almost doubling the heat that it would have to dissipate, and a tertiary effect is that the solenoid would have some current passing through it all the time.

I recently started getting hot-starting problems on the V8, first wondering if it was a batch of dodgy fuel, but when it happened again two or three tankfuls later I wondered whether the coil boost circuit was operating. I connected an earth to the coil -ve effectively shorting out the points, and connected a volt-meter between the coil +ve and earth. When turning on the ignition I saw 6v which was what I expected. However when turning the key to crank, instead of seeing about 10v, the voltage dropped to 5v i.e. half the cranking voltage, so the coil boost circuit wasn't working.

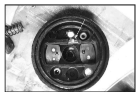
I got under the car and found the coil boost wire was broken between where it came out of the harness and where it went to the spade on the solenoid. This wiring was damaged when I got the car, there is supposed to be a short sub-harness on the starter and a 2-way connector joining it to the main harness, but this was missing and a dodgy join made instead. I'm not sure why it needs this as both solenoid spades are accessible even with the heat-shield in place. When I replaced the starter in 1999 I repaired it as best I could - I had to change the spade as originally it was a small spade to distinguish it from the standardised solenoid operate spade, but it seems that rebuilt starters have two standard spades. However since then the insulation had hardened and cracked in a couple of places and allowed engine movement to flex the conductors which fractured them.

I made a better repair, removing the heat-shield and convoluted sheathing that covered the battery cable plus the two wires. I sleeved all the wire that came out of the harness with two layers of heat-shrink for strength, and soldering the end of that to the tail from the starter, putting two layers of heat-shrink over the join as well. Tested before refitting the convoluted sheathing ... and still no boost! This time I put the meter right on the solenoid spade with the wiring removed, and still no boost, so there is a problem with the solenoid. The question then was, whether to remove the starter and investigate it, or use one of my alternatives until the engine comes out for a replacement clutch or whatever. Having replaced the starter previously I know I could get at everything relatively easily, so opted to take the starter out, which only took a few minutes.



The V8 has a curious arrangement of a stud under the toe-board with the battery cable attached on the top, then a few inches of battery cable from the bottom of the stud to the starter. This together with the sub-harness containing the solenoid operate and boost wires means the starter can be removed and refitted with these three still attached to it - why, I don't know. Maybe it is so you can fit the heat-shield before the starter, which **is** a bit of a fiddle, although I have been able to remove and replace it with the starter in-situ.

With the starter on the bench a couple of Allen screws removed and a nut terminating the starter feed to the second stud slackened the solenoid comes away. There are two Phillips screws holding the 'plastic' end-cap that carries the two studs and the two spades to the end of the solenoid, but there are wires from the solenoid that come through the cap and have to be unsoldered from the operate terminal and the starter stud, and fortunately my iron is up to the job. Flicking molten solder off, then levering up the ends of the wires, allows the end-cap to be removed.



I can immediately see what the problem is! There is a large copper bar that bridges the two studs when the solenoid operates, and the boost terminal has a small copper contact that sits between the two studs and should be contacted by the copper bar at the same time. However, the contact is bent back, so the copper bar will never touch it. This lies under the copper bar, so it is impossible that my dismantling has damaged it in any way, it must have been like that from the beginning. It obviously was never tested, and although I tested the starter before fitting I only checked that the pinion moved forward and spun. I didn't check the boost contact - "Of course that will work ..." yeah right.

So I straightened the boost contact, and adjusted it such that the copper bar touched that before it reached the two studs. Refitted the end-cap but didn't solder the wires yet, and with a continuity meter checked that when the copper bar was moved manually by pushing a bar down the middle of the solenoid the boost contact and the two studs were all connected together. Re-soldered the wires, and fitted the solenoid to the motor. Another test this time with 12v between the battery cable stud and the solenoid body, then bridge the battery cable stud to the operate spade, first to check the pinion comes forward and spins, and secondly to check that voltage appears at the boost contact - all good.

Refit the starter to the engine, attach the battery cable and the two wires but leave the sheathing and the heat-shield for the time being, and redo the original test i.e. monitoring the coil voltage before and during cranking - success! Refit the sheathing and the heat-shield, test again - still good.

So the question is, will this overcome the hot-starting problem, which in any case is still down to unknown causes, as there obviously has been no coil boost function for 14 years. But the hot starting has only been an issue for two or three months, and seems to be associated with hot weather.

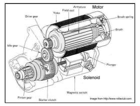
October 2018: It seems to have gone as suddenly as it came, nothing since the summer of 2014, including in the very hot weather we have experienced this year. There have been several complaints of 'vaporisation' or 'vapour lock' in various fora and Enjoying MG, with those reporting it claiming it is common. Not only has it not happened to me, but on various runs in hot weather this year I've not come across any stranded MGBs - including organised runs with dozens of MGBs and Midgets taking part! If you get the problem, then there is a fault on your car that can be fixed without resorting to modifications. The one possibility I will acknowledge is that excessive fuel height in float chambers can expand when turning off a hot engine, and rise enough to run out of the jet into the inlet manifold, resulting in a rich mixture which DOES affect hot starts. That can be caused by incorrect float height, and for those that experience it during a long idle it may even be the float valves are not fully closing off when they should, and letting in more fuel that is being used at idle (see this test). That will gradually raise the fuel level in the jet, with liquid fuel eventually running in to the inlet.

'Hi-Torque' Starters:

Be careful with these! I've seen some and they sit between the original and the geared starters. They have a different internal construction that gives more torque in a smaller and lighter unit than the original starters, but they are not as efficient as the geared starters. However these days geared starters are also described as 'high torque', so you need to be careful what you are buying. In general non-geared starters seem to have the motor in line with the pinion, and the solenoid attached to the side. Most geared starters have the solenoid in line with the pinion and the motor to one side (but not always, see the 'Powerlite Micro-Starter' below), and the solenoid is about the same size as the motor. Price should be the most obvious difference.

Modern Geared Starters:

Coil-boost considerations on rubber bumper cars



Within the last few years 'geared' starters have become available for the MGB as an aftermarket item. These simultaneously reduce the current drain on the engine **and** spin the engine faster - I've seen claims of double the cranking torque for nearly half the current drain - which both aid starting and increase battery life, they are also smaller, lighter and quieter! In fact the solenoids on these are usually larger than the actual motor, and it is the solenoid that is inline with the pinion and not the motor. There are a number of basic types of starter from different manufacturers, with a variety of different adapter plates to mate them to the MGB bell-housing. Some come with a captive bolt ready to go into the bell-housing as one of them is shrouded by the motor. Others are assembled differently and both bolt holes are accessible. Some have a slotted top hole which makes it easier fit the motor - you start the bolt first hook the motor onto it, then while that takes the weight of the motor you can start the second bolt. Others require you to support the weight of the motor whilst trying to get one of the bolts started. They are available to replace both inertia and pre-engaged starters, because although the inertia starter pulls the pinion into engagement with the **back** of the flywheel and the pre-engaged (including these geared starters) push it into engagement from the front, the earlier flywheel has the teeth cut properly on both faces of the flywheel so will accept either type.

September 2021: A New Kid in Town (to me) is an 'epicyclic' starter which is like a conventional starter in that the motor is in line with the pinion and the solenoid is on the side unlike other geared starters which are the other way round. But that is because there is an epicylic gearbox between the motor and the pinion, like the overdrive, whereas the other geared starters only have a single idler gear between the two shafts. Very light at 5.2lb, but also very expensive at over £400 i.e. about six-times more than a modern 'lightweight' conventional starter. 'Lightweight' is by comparison to the original MGB starter which are still available but at twice the price of the modern lightweight they can only be of interest to 'purists'. Very confusing information in the MGOC ad for the Powerlite starter as well as on the Powerlite site itself:

- The difference between inertia and pre-engaged starters for the 4-cylinder MGB is that the former have 9 teeth on the pinion and the latter 10 teeth (V8 pre-engaged have 9 teeth).
- With the change from Mk1 to Mk2 the starter changed from inertia to pre-engaged, the electrics changed from positive earth to negative earth, and the gearbox, flywheel and engine back-plate changed which impacts the starter.
- MGOC states 'dual polarity' but MGB starters have always been 'dual polarity'.
- MGOC states they are for 1968 and later.
- Powerlite's RAC531 says "to replace the original 5" inertia type ... will fit ... MGB (early inertia type only) ... Negative earth applications only ... 9 teeth." The implication being that this can only be used on converted Mk1 cars, and probably only those with the original style of engine back-plate and gearbox. Which is odd as the picture shows a flying lead for the coil boost wire which is only on RB cars.
- Using Powerlite's model selector they say they have nothing for the MK2 and later MGB, but if you search on 'microstart' they list the RAC530 for 1968 to 1980 which has the correct 10 teeth, but apparently no coil boost wire for RBs.
- Powerlite don't appear to have a version for the MGB GT V8.

You **must** get the correct type of geared starter - there are different models for 3-synch and 4-synch - as the pinions have different numbers of teeth:

- Inertia starters (MGB to 67 and all MGC) have 9 teeth - note that the geared starter replacement for this is a pre-engaged starter, not an inertia starter.
- Pre-engaged starters on the MGB have 10 teeth.
- The factory V8, even though it is a pre-engaged starter, also has 9 teeth.

However there may be other differences such as mounting between the two types.

An early example I tried on the V8 was very poorly manufactured in that the adapter plate was only held to the motor by three self-tapping screws and some super-glue! Needless to say it broke free within a few days, so look for some substantial bolts connecting the plate to the motor. While it was on though it was remarkably quiet, so much so that the first time I turned the starter I though the motor was just spinning without being engaged with the flywheel.

Price: Geared starters are the most efficient but whether it is worth paying the very large premium on them is debatable. At the time of updating (July 2024):

- MGOC have a reconditioned OE at £135 outright, a light-weight GXE4441 at £70, a geared at £225, and a Powerlite micro-starter at £375.
- Motaclan/Leacy seem to have a rebuilt OE at £101 plus surcharge on the old unit and a light-weight at £82.
- Brown & Gammons don't seem to do the OE any more, have a 'pre-engaged' at £90 (presumably a light-weight), and what they describe as a 'competition' (which in the photo is identical to the light-weight but the technical document describes as geared and hi-torque) at £222 which is slightly heavier than the only alternative.
- Moss Europe have reduced their prices with a higher-efficiency, lighter-weight alternative at £113 which appears to have the coil boost contact for rubber bumper cars, an OE at £170 plus surcharge of £48 pending return of the old unit, and a geared (described as hi torque) at £258 reduced to £232.
- Powerlite seem only to have a geared at £273, not the previously listed inertia or micro-starter types.

The light-weight varies in price from £70 from the MGOC to £113 from Moss so it pays to shop around, similar variations but in other directions for OE and geared. Brown and Gammons and Motaclan/Leacy seem to depict the same light-weight unit as Moss, so hopefully have the coil boost contact for rubber bumper cars as well. This isn't always the case, geared types don't seem to have it, but Moss US seems to include a sub-harness with the solenoid operate wire plus a second dioded wire going to the same solenoid terminal to provide the coil ballast bypass function when starting. A diode is one of three ways of providing the coil boost function if your new starter doesn't have it, as described here

September 2021:

Mark Robinson shopped around for a geared starter in America and got one for the same price in dollars as we would pay in pounds, so a bargain. However when mounted using the slotted hole at the bottom which aids fitting, that puts the motor below the solenoid and its connections for the battery cable and operate wire are above the motor and can only be accessed from above. Moss Europe shows the slotted hole on the other side of the solenoid to the motor, which puts the motor above the solenoid, and makes the connections more accessible from below. Another issue is that the battery cable connector is bent at a right-angle originally, but will have to be straightened to fit this starter. So with that and the positioning Mark has made up a short stub between the car's battery cable and brown wires, and the solenoid stud.

February 2017: I've just had occasion to replace the starter motor on my ZS 180. It's immediately apparent that the new one is much quieter and cranks noticeably faster than the old one. When I first had the car I felt that cranking it sounded much like my MGBs, i.e. significantly noisier than other 'modern' cars heard round and about. It's almost as

quiet as a geared starter, but not quite. The motor is externally identical to the modern light-weight versions from the likes of Moss etc., so I'd have no problems about using this type on my MGBs in place of an OE.

Changing an inertia starter to a pre-engaged: *Updated April 2012*

Positive-earth, Mk1 cars used an inertia starter with a remote solenoid operated direct from the ignition switch. For one year negative earth/ground cars used a pre-engaged starter (with the solenoid mounted on the starter) again operated directly from the ignition switch. After that MGBs got a starter relay operated from the ignition switch, which operated the solenoid, which operated the motor. This was done to reduce the load on the ignition switch as the current drawn by the later, attached, starter solenoids is significantly more than the remote type, as it has to push the pinion into mesh with the flywheel as well as close an electrical contact.

When fitting a later engine to a Mk1 car, or fitting a pre-engaged (any type) starter to a Mk1 engine, there are several possible ways of integrating the new pre-engaged starter with the original wiring:

- Remove the original solenoid, reroute the original battery cable to the battery cable stud on the new starter, and extend the brown wires down to the new starter. This will work, but requires joints in the wires which is not a good thing, and the original ignition switch will be carrying the current of the new solenoid, which is quite a bit higher than the original, and may burn out the ignition switch.
- Leave the original solenoid in place, move the starter motor cable onto the battery cable stud of the original solenoid, connect the other end of that onto the battery cable stud of the new starter, and remove the white/red wire from the original solenoid and extend it down to the operate spade of the new solenoid. Leaves the original solenoid but it isn't doing anything other than acting as a connector block, and you still have the problem of joints in the white/red and the full current of the new solenoid going through the original ignition switch.
- You can add a starter relay to either of the above, which solves the problem of excessive current through the original ignition switch, but you have to find somewhere to mount the new relay and provide three new wires to battery, earth and the new solenoid. The original white/red transfers from the original solenoid to the appropriate terminal on the new relay.
- In response to someone having starter problems (first continual cranking then no ignition) after fitting a hi-torque starter, Matt Dabney suggested using the existing solenoid as the starter relay, which only involves moving the original motor cable from it's stud on the original solenoid to the same stud as the battery cable (the other end of which goes to what would normally be the battery cable stud on the new starter), then running a new wire down from the now empty motor stud on the original solenoid to the operate spade on the new starter.
- However the simplest method is to use the original solenoid as a starter relay as above, but leave all the wiring on the original solenoid as it is. The original motor cable goes to what would normally be the battery cable stud on the new starter, and the only other change is to simply connect a wire from that stud to the operate spade of the new solenoid - a distance of about an inch or so. Now the ignition switch operates the original solenoid, that extends 12v down to the new solenoid, which operates and extends the 12v on to the new motor. The only difference to how the factory wired the pre-engaged starter on the later engines is that you won't have 12v on what would normally be the battery cable stud on the new solenoid, but then you don't need there to be as the brown wires are still with the battery cable on the new solenoid.

Jump-Starting: *Updated December 2011*

Jump Leads
Starter Pack
Battery Cable Post in the Engine Compartment

Never, ever, follow the advice given by a certain contributor to the MGOC magazine and 'clip the ends of the leads together'. It's true there was a drawing showing one lead clipped to the **insulation** of the other, but the following month it was obvious someone had taken the advice literally and connected the two clips together, destroying a battery. The person involved was very lucky the battery didn't blow up in her face. The contributor than had the unbelievable arrogance to imply that at least she will have learned a lesson!

Quite apart from the extreme hazard if the advice is misunderstood as in this case, even clipping one end to the insulation of the other is bad advice. The clips have teeth which will bite into the insulation and quite possibly damage it, and why have to cope with two leads at a time instead of just one? You only have two hands, but three ends. So if you clip the two free ends onto one battery or the other, the clipped-together ends will be dangling somewhere, and one of them at least will be live at some point. Far safer to separate the leads if possible and deal with one at a time as below. All the leads I have looked at appear to have two separate cables. If yours have the two cables tied together in some way, such that you can't completely separate the cables, then you should still deal with one polarity of cable at a time, then deal with the other. You will have to watch where the two free ends are dangling, as well as what you are doing with the ends you are dealing with, but at least the dangling bits should be short and they won't be live at any time.

Jump-starting, or 'boosting' is the act of using another battery - a donor - temporarily hooked up to a car - the recipient - to start it typically when its own battery is flat, the donor battery often being in another vehicle. **Great care must be taken when connecting the donor battery, if it is connected incorrectly explosions can occur at worst or electronic components like the alternator destroyed.** That said there are a number of myths and legends surrounding jump-starting to be ignored. One is that the arc generated when connecting jump-leads will destroy the diodes in the alternator of the recipient. It won't as long as you connect the two the right way round! The second is that having the donor engine running while cranking the recipient will burn-out the donor alternator. It shouldn't, all alternators have over-current protection built in.

You can get expensive heavy copper professional leads and cheaper aluminium home-use leads. The former are much more robust, can carry much higher currents and have safety-insulated clips, but the results of connecting them the wrong way round will be much more spectacular! The hobbyists leads have a certain amount of 'fail-safe' in that they cannot carry such high currents so are less likely to result in battery damage if connected incorrectly, but the connections between cables and croc-clips are a bit iffy (they will get quite warm in use) and the clips are usually uninsulated. You will not get as much cranking voltage with the hobbyists leads as with the professional but in my experience it should be more than enough to get the recipient started (6-cylinder BMWs excepted ...).

Either vehicle can be of either polarity (i.e. either positive or negative earth), but no matter what the polarity of either vehicle the connections are **always** positive to positive and negative to negative. You **must** confirm the polarity of both cars before you start. **Never** assume that colour-coded cables or plastic covers on the battery terminals are a reliable indication of polarity, look for '+' and '-' symbols on the battery case, or coloured rings round the posts. If you cannot see them check with a voltmeter. A voltmeter can also confirm which is the live terminal and which is the earth/body terminal, and even a newly flat battery should have enough voltage in it to indicate polarity. The MGB changed from positive earth to negative earth in 1967, other classic cars may be different, probably all modern cars are negative earth. If the recipient has not run for a long time and the battery has been out of the car in the mean time make sure the battery has been reconnected correctly. The positive and negative battery posts and clamps are of different sizes, but it is possible to force bolt-up clamps (not the 'helmet' variety) onto the wrong terminals given enough brute force and ignorance.

When connecting different polarity cars together **never** let metal parts of the cars come into contact with each other or this will short out one of the batteries and cause a very high current to flow, but then we wouldn't let out cars come into contact with anything else anyway, would we? And even on same-polarity cars the potential difference between them can be enough to cause damage to the surfaces in contact. Because MGB starter motor and battery cable are pretty well hidden the usual way of jumping to or from is direct to the batteries even though they are also relatively inaccessible. Note that on a V8 you might be able to use the toe-board stud but I have never done this, and with uninsulated clips the risk of the clip coming into contact with the chassis rail is quite high. If either car has twin 6v batteries you must take careful note of which are the +ve and -ve terminals of the two batteries taken as a single unit and not connect anything to the interconnecting cable that goes between the two.

Connect both ends of one cable first, then connect the second cable. If you connect both cables to one battery first you might inadvertently bring the free ends of the jump-leads together which will generate a big spark off a fully charged battery.

You can connect the two batteries together using the jump-leads direct on all four battery terminals, but the risk with this is that if you **have** got the connections the wrong way round one of the batteries may explode as you are leaning over it. For that reason it may be better to make the last connection to some sturdy chunk of earthed metal like the block. Easy enough on most cars other than an MGB as the battery is usually in the engine compartment, but a bit more difficult when two MGBs are involved. Personally I always tap the last croc-clip on very briefly first to see how much of a spark I get. Connecting a fully charged battery to a flat one will always generate a small spark but the spark from having the batteries the wrong way round is much bigger!

I've just come across these Kangaroo Safety Jump Leads from Airflow which should help guard against sparks and incorrect connection. They are in two halves, with an interconnecting plug. To use them you part the plug, put the two clips of one half on one battery, then the two clips of the other half on the other battery. Then you look at the LEDs in each half of the interconnecting plug which will indicate whether you have the clips on correctly. If you do, push the two halves of the interconnecting plug together. Could be useful on MGs with two black leads at the battery/ies and no polarity marking symbols or colours.

I always leave the engine of the donor vehicle running while cranking the other car. This ensures the donor battery is at its maximum voltage beforehand, recharges it during the brief pauses in cranking the recipient, and if one persists in cranking a car that just won't start it avoids flattening the donor battery as well.

Rather than cranking the recipient you can leave the jump-leads connected for some minutes allowing the alternator of the donor to charge the recipients battery, disconnect the jump-leads then try starting as normal.

Equal care needs to be taken when disconnecting leads, that they don't hit earthed or painted parts, or short together. Some advice says if a modern car is involved at one end or the other when the jumped engine is running the

headlights, heated rear window and heater fan should be turned on full to minimise any voltage surges that might damage electronic units. Additionally some suppliers of electronic ignition systems for classic cars say they should not be jump-started at all or it may damage the module.

Starter Packs *Added February 2014*
There are various types of these containing a full-size battery, with mains-powered charger, and often a compressor, from £50 upwards. However these are pretty bulky and one wouldn't normally carry them round.

July 2019: I've had my jump leads for probably getting-on for 50 years and having been bought in my impecunious youth they were cheap ones with aluminium conductors and the clamps crimped on. Never terribly effective, and the last time I used them five years ago I had to wiggle the conductors in the clamps to get them to work. Now one of Bee's batteries suddenly failed and all the wiggling and additional crimping couldn't get enough power out of another battery, so Something Has To Be Done. In any event jump leads need a donor car next door, but we do a lot of touring on our own in some pretty remote locations. Capacitor packs need a donor close enough by to charge it up, which leaves lithium jump packs as the only way to be truly self-sufficient. True they have to be topped up every year or so, but that's not difficult. Looking around there are several different capacities but with three cars I need one capable of powering the biggest - Vee, so 3.5 litres minimum, and if you have a diesel in your fleet that reduces the maximum engine size a given pack will power. Halfords do a Noco GB20 for 4 litres (which is the minimum size from that manufacturer although the instructions say not suitable for diesel) at £79 click and collect. I could get it for a bit less mail-order, or alternative products cheaper still, but as it is an unknown quantity to me I want to be able to get a refund with no hassle. It comes half-powered, and took about four hours with a USB connector plugged into my desktop computer front panel to get fully charged. USB sources less than 2.1A will limit the current and so extend the charging time. No direct mains connection but USB mains plugs are available for a few pounds, as are car accessory socket adapters, although note that something described as '5W' is only a 1A source. I then note that the information says 'only suitable for single batteries', but two 6v batteries in series are exactly the same as a single 12v - as long as you connect the jump pack correctly, but that applies to any boost starting and charging method.

Although by now the replacement batteries had arrived I left the old ones in Bee so I could test the jump pack. Followed the instructions and all seemed when I connected it and switched it on, so went for a start. It cranked well enough and started OK but I must say I was expecting faster cranking with 400Amps, as it was it was slower than the batteries used to be before they croaked. As this was 1800cc I wondered what it would be like on the 2.5 V6, and the 3.5 V8. So I took the earth cables off Vee's battery, and put both of my old jump leads in series between the earth cable and the earth post to simulate a flat battery. Tried to start (without the jump pack!) and barely a groan from the starter. Connected the jump pack (to the CABLES, not the battery!), switched on, and cranked again (cold engine parked overnight) and it spun the engine like billy-oh - noticeable faster than Bee. So that's OK. Did the same with the ZS with the same result, so for some reason it finds Bee harder to turn than the other two. Vee is low compression compared to Bee, but the ZS is higher at 10.25:1 Could be the starter circuit of course - poor connections, but with the new batteries in they whizzed the engine round - also cold and no choke. It's high summer of course so thinner oil even when 'cold', may be slower in the deep mid-winter, and I have to remember to take it with me whichever car we are using. Subsequently towards the end of the summer when the ZS battery had gone down through lack of use it only took moments to get it going. Needless to say I carry it in whichever car I'm in at the time!

March 2019: When I first wrote this section I had just been made aware of this 'Startmonkey 400' from British Motor Heritage. Claiming to start any car or van and delivering up to 400 amps, with enough capacity for 15 to 20 starts of 6 to 8 seconds each. Small enough to keep in the car, and rechargeable from either the cars electrics or mains. Expensive at £200 though. Now there are many different brands all significantly cheaper, some of them at a quarter of the price at around £50. You do need to charge them periodically to make sure they are ready for use - not much point in spending that much, and carrying it around, only to discover it hadn't got enough oomph when you needed it away from a mains socket. Several of them are capable of being charged from the car's accessories socket as well as the mains, so I don't see why you couldn't keep it connected all the time in the car i.e. fully charged at all times. However if your accessories socket is 'live' all the time as on MGBs from 1972 and some earlier you would need to be sure that the jump pack wouldn't discharge back into the cars electrics and flatten itself. If it is only live when the ignition switch is in the accessories or run position as it seems modern cars generally are you should be fine. Personally ~~I shall stick with my jump leads~~ (replaced with a jump-pack) and mobile phone. Some of the jump packs include a phone recharger, but the first thing I get on the rare occasions I change my phone is a charger that plugs into the lighter socket, and these are usually just a few pounds. Your battery would have to be completely dead, and your phone battery flat, to strand you then.

There are also loads of capacitor-based jump packs around, see this Google search. These are not intended to hold a charge long-term and be ready for use immediately, but if you have a 'donor' car nearby they charge in a minute or so then can be transferred to the car with the flat battery. A sort-of half-way house between a battery pack and jump leads - doesn't need regular charging like a battery pack, but doesn't need to be right next to a donor car like jump leads and doesn't have the hazards of incorrect connection either. But it does need a donor to be nearby and accessible, so even by that the self-contained battery type are better, and some of them are cheaper too.

There are gizmos around that plug into both cars cigar lighters and transfer a charge between them without using jump-leads at all, a LED indicating when the recipient has enough charge to try starting it. I don't know whether these can cope with either polarity or can only be used when both cars are negative earth. I also don't know how long they would take to put sufficient charge back into the recipient to allow it to start. When collecting my son's BMW with a near completely flat battery I couldn't even get that to start with jump leads and a donor vehicle, even with the donor engine running, and having left it charging like that for half an hour. In the end I had to call out the AA for their starter pack.

Finally, if a normally easy starter suddenly refuses to start one day there is little point in cranking it until you flatten the battery. If it doesn't start given double the normal cranking time then you should be checking the ignition and fuel supply. If it is a hard starter anyway, well, if it is an MGB there is something wrong that you should have seen to a long time ago, you are knackering your batteries out of laziness.

References:

Typical conventional jump-leads
Lighter-socket jump-leads
AA recommendations.
Halfords recommendations.
UK Health and Safety Executive recommendations (pages 5 and 6, begins at para 24).

Battery Cable Post in the Engine Compartment *June 2020:* Given the faff of getting to the batteries in an MGB I've long pondered having a battery cable post in the engine compartment, for connecting a jump pack should it be required. I know some marques have this as standard, and it's 'just' a matter of getting a suitable post somewhere in the engine compartment and a cable down to the starter (or the connection point under the floor on the V8). After coming to the end of working for a month or so painting at a pal's place and the prospect of not having enough to do in the Covid lockdown, I started looking seriously.

First question is where to mount the post - not much point in buying the makings until that is decided, not least without knowing how much cable will be needed. I don't like drilling holes in bodywork, but on Bee there is a convenient space just aft of the coil, and the clamp bolt can be used to mount a bracket for the post.

Next what post to use. I Googled various terms looking for one with a cap that would insulate the terminal when not in use, then flip back to connect the jump pack, but the only ones I could find were through-panel and hugely expensive. Eventually I settled for a surface-mount 8mm post with small base as taking up the least space but big enough for starting current - 8mm is close to the battery cable post on the starter. I need something to insulate the post when not being used, and they have various 'boots' that slide onto the cable and fit over the termination. An enquiry comes back with red push-on cover 35mm cable size max, so order both at the very reasonable price of £5 plus £4 P&P, and they arrive in a few days.

Next a bracket - I used a bit of 5mm aluminium off-cut and made a stepped T-shaped bracket to fit the base of the post, and go under the coil clamp bolt. The step holds the nuts that attach the post to the bracket away from the wing. Measuring from there down to the starter with enough slack to make a couple of right-angle bends comes to about 450mm.

Unfortunately 12v Planet only have battery cable by the metre i.e. unterminated, so more searching comes up with SplitCharge who have no less than 19 combinations of colour, current capacity, terminal sizes and lengths. 110 amp should be fine for such a short distance, 8mm terminals each end, at £4.41 including P&P, which also arrives in a few days.

My initial thought was to route the cable down with the others against the firewall then go forwards to the starter along with the brown wires. But that brought it very close to sundry pipes and the clutch slave, unless it had been quite a bit longer. At the starter end it was better if the cable went straight down to the terminal, and I could have got away with a shorter cable. So I end up with six of one and half a dozen of the other where the cable goes back towards the firewall, then angles forwards and down to the solenoid terminal. Engine rocking has to be considered and proximity to the chassis rail and solenoid, but I have some split corrugated sheathing which slides over the cable to protect it at that end.

Subsequently I fit one to Vee as well, piggy-backing the post bracket on the alarm siren bracket.

V8 Starter

Replacements
Conversions
Heat Shield

I have had two separate bouts of solenoid chattering on the V8 a couple of years apart. Both initially were only when the engine was hot, although eventually it was doing it on cold starts as well. In both cases improving bad connections in the brown - starter relay - solenoid circuit cured the problems (for two years in the first case) but eventually I did have to go for starter replacement. I suspect the starter was on the way out all along, the bad connections were just making it worse.

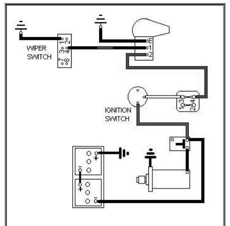
To my surprise I was able to replace the starter **without** removing either the tubular manifold or down pipe on the right-hand side, but I did have to remove the rack in order to get sufficient movement with a spanner on the top nut. Subsequently (I tried an alternative starter for a while but went back to the OE item) I used a pair of 3/8" extensions and a universal joint to get to the top bolt between two of the pipes on the manifold, meaning I didn't even have to remove the rack. The situation with the original cast-iron manifolds may be different.

Replacements: The alternative I mention was one of the 'gear reduction' starters beginning to crop up all over the place. They are much smaller and lighter, in fact the solenoid is bigger than the motor, and bigger than the on the original starter so should be more robust, it being the solenoid that usually fails on V8 starters. The first time I tried it I thought it was just spinning and not turning the engine over as there was no rocking of the engine and no grinding, just a steady hum, but then it fired up. Because of the gear reduction the motor has a lot more torque, hence the smaller size, and spins faster and so take a lot less current which should take a lot less out of the battery at each start. However the connections were in a different place meaning I had to connect the cables **before** I could fit it which meant lying on my back under the car holding the motor up in the air with one hand, while I attached the cables with the other. There is also no boost contact for the coil on rubber bumper cars and all V8s on the ones I have seen. This last could be simulated with a relay, but with the lower drain on the battery it may not need it. They are about 50% dearer in price though. The problem with mine was that the motor assembly was attached to the adapted plate with just a couple of self-tappers, and needless to say these came loose after just a few days. On another occasion, and with beefier mountings, I could well be tempted to fit one. Be aware that there are after-market starters available described as 'hi-torque' - not all of these are geared, Caveat Emptor. *May 2019:* It seems only two types of replacement are available for the factory V8 - the original style and geared. Prices are very variable, Clive Wheatley has the original 3M100 type at £120 exchange and the geared type at £252. SC Parts has the original at £230 plus a £264 core charge until you return the original, and the geared at £264.

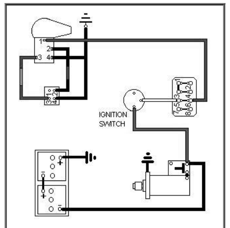
Conversions: I've seen a couple of comments now about the starter motor fouling things when a Rover V8 from another application is used for a conversion. On at least one of these the solenoid is on the side of the motor when installed which will definitely foul the chassis rail. It needs to be below as per the original, but to get an original you are faced with finding one from somewhere, maybe to use as an exchange, or fork out nearly £500 as above. In which case it would be preferable for several reasons to get a geared for half that. These geared starters are basically a standard motor on an adapter plate orientated to suit the application, and SC Parts has just such an adapter plate meaning you have the potential of getting a motor elsewhere and modifying it accordingly.

Windscreen Wipers

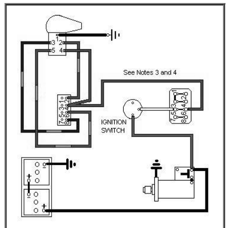
Schematics



MkI Roadster Single-speed



MkI GT Single-speed



MkII and later two-speed

Note 1: From 1971 for the remainder of chrome bumper production and all V8s the wipers (and heater fan and electric washers where fitted) were powered from the accessories position of the ignition switch via a white/green to an in-line fuse under the fusebox, and then via a green/pink.

Note 2: In 1970 (North America), 1974 (V8), and from the start of rubber-bumper production for remaining cars the wiper switch moved from the dash-board to a column stalk. Some time later possibly for the 1977 model year on the wiper stalk incorporated a flick-wipe feature. The wire colours remained the same through all these changes, Note 1 excepted.

The 1977 LHD Workshop Manual AKM3524 gives the 'normal' speed current as 1.5 amps, the high speed current as 2 amps, the normal speed wiping as '4.6 to 52 rev/min' (presumably 46 to 52 sweeps per minute), and the high speed as 60 to 70 rev/min, both after 60 seconds, and presumably a wet screen.

One speed or two? *Rewritten February 2012*

There were three different wiper systems - MkI roadsters, MkI GTs, and MkII-on.

The MkI roadster used a square, single-speed motor 17H2013/57H5599/GEU714 with a basic internal parking circuit, three wires, and a simple on/off switch with just two wires.

The MkI GT had a round single-speed motor 27H6409 with a more complex parking circuit that involved the manual switch, with four wires at the motor and three at the switch. There was an adapter harness that allowed its different motor to use the roadster harness for three of the wires, the fourth wire running direct from the motor to a different manual switch (13H 1909) with an extra terminal. The Leyland Parts Catalogue for the Mk1 GT says to use GEU708 as an alternative to 27H6409 - GEU708 is the Mk2 two-speed motor but it is 'plug compatible' with the Mk1 GT albeit only giving the 'standard' speed unless a wiring and switch modification is made.

In May 67 the MkI GT switch was also fitted to the MkI roadster for standardisation, with the extra 'park' terminal left unused.

In Nov 67 all MkII cars got a new round two-speed motor 37H2732/GEU708 with a similar parking system to the MkI GT, with five wires at the motor. The switch was changed again to give two 'on' positions and a park contact, making four wires at the switch.

Upgrading Mk1 roadster to two-speed
Two aspects - motor mounting and electrical. As the 2-speed 14W motor and its mounting arrangements differ to those of the original have a look at this document from Colyn Firth regarding this job on his MGA. For the electrical side Colyn chose to provide relays so he could continue to use an original MGA pull-switch (albeit the three-position lighting switch) instead of mounting an MGB toggle switch elsewhere. For the MGB you will need the Mk2 toggle wiper switch (BHA4786, Lucas 35927 57SA) with six spades giving two 'on' positions as well as the 'park' function. Ideally you would have the wiring connector to fit the connector block on the motor, but could get away with **insulated** spade connectors on each wire. You need to add two more wires from the motor to the switch - for the second speed and the park function. Strictly speaking you should correct the polarity by providing a 12v supply to the switch in place of the earth, and use the motor connections to 12v and earth as for the later cars. It will work without but in that case you **must** reverse the 12v and earth connections at the motor from those shown in the schematics for MkII cars or it will blow the fuse. Also with an earth from the switch and 12v at the motor the two-speed motor will run backwards, being permanent magnet stator rather than wound. But that will happen on the many MkI cars that have had their battery polarity reversed, and I've never heard of any problems with the wipers subsequently.

Upgrading Mk1 GT to two-speed
Much easier as the motor mounting is the same and the motor is 'plug compatible' with the existing wiring, you only need to provide one additional wire for the second speed, plus the switch as above. But Keith Evans contacted me with the following:

> "I have just replaced the wiper motor on my early GT fitted with a single speed round motor type 12W, now sadly NLA. My local stockists told me the later 2 speed round type 14W was interchangeable. It is except for one problem, you need to also change the Gear Wheel, as the later housing is smaller, and will not allow the original to fit. I replaced with the later type of Gear Wheel and now all is well. This has a dimple on the Gear Wheel for parking, which moves a plunger type switch to park, as opposed to the original interrupted 3 contacts type. The power plug is the same, however the high speed contact and the additional wire for the fast speed is not there, so the wipers only run at standard speed, as the original wiper motor did. My next job is to fit a 2 speed switch, and another spade into the Wiper motor plug. although then not original, I think in modern conditions, Safety will be improved. The circuitry corresponds to the 1967 GT schematic, and the later 2 speed schematic. And the difference is the latter has the Blue and Green wire from Pin 8 of the switch to the missing spade in the plug."

The appropriate gear wheel needs to be obtained as well because they differ between roadster and GT as well as with other marques and models, and motors are usually supplied without.

Switches

Mk1 roadster systems had a basic normally-open 'on-off' toggle switch to connect an earth to the motor to cause it to run, and a simple parking system that when switched off allows a park wiper contact and arc on the motor to keep an earth connected to the motor until it reaches the park position.

Mk1 GTs had a later system with a more consistent parking method that used a more complex switch and an extra wire - the 'park' wire. It's possible this was found necessary on the GT with its longer wiper blades and arms as at speed they could interfere with the driver's view.

Two-speed systems use a similar parking system to the GT but with a three-position manual switch with a power wire, 'standard' and 'fast' wires, and a 'park' wire. that connects 12v to the standard and fast speed windings as required, but when switched off an additional wire on the switch - the park wire - is connected to the standard-speed wire. With the wipers not parked the motor park switch connects 12v to this park wire, which with the manual switch in the 'off' position is connected to the standard speed wire and causes the motor to continue to run. When the wipers reach the park position the motor park switch disconnects 12v from the park wire (and hence from the standard speed winding) and connects an earth to it instead. This parking system ensures that the motor stops dead which stops the blades in a more consistent position, the earlier system was affected by whether the screen was wet or dry. Originally a toggle switch, from 1972 it was a rocker switch, then rubber bumper 4-cylinder cars and all V8s had a column switch.

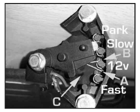
1977 and later models use basically the same system but with an additional 'flick-wipe' feature.

Stalk Switch:

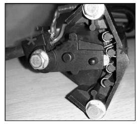
V8s and rubber bumper had a column stalk switch for the two-speed wipers, overdrive and screen washer of two different types, for 77 and later it incorporated a flick-wipe function.

Flick-wipe:

1977 and later models came with a flick-wipe feature by moving the stalk down (on RHD cars, LHD used the same switch mechanism but on the other side of the car so flick is up and the continuous speeds down). The manual switch

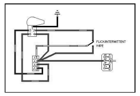


was basically the same but with an additional non-latching contact to connect 12v to the standard-speed winding while the stalk is held down, then parks as normal when released, click the thumbnail for details.



Be aware that replacement switches from some suppliers have been incorrectly assembled so the flick-wipe function does not work, click the thumbnail for details. Simon Holland received two incorrect switches from one supplier before receiving the correct item from Moss UK. Most of the Google images I have been able to find show the incorrect assembly, Moss, Brown & Gammons and Midland Sports and Classics are correct (at the time of writing, in September 2019 of those three only MSC shows the correct orientation), but it is relatively easy to tell the difference from suppliers photos.

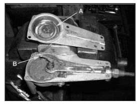
To add flick-wipe to MkI roadsters you simply need a non-latching normally-open contact (SPST) to connect a momentary earth to the black/green wire for the wipers to complete a single sweep and then park.



The MkI GT and all MkII two-speed wipers need a more complicated circuit because of the different parking system, suggested wiring is shown here.

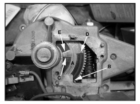
Parking systems

Which side do you park?



The square MkI roadster motors have a earth supplied from the manual switch and 12v at the motor. The parking circuit consists of a moving contact on the large gear wheel running on an arc which has a break where the wipers are required to stop. The contact is connected to earth and the arc is connected to the motor, bypassing the manual switch. Thus when the wipers are away from their park position the motor has an alternative earth supply to keep it running until the park position is reached. This parking mechanism is fairly crude in that the inertia of the motor and wipers allows them to 'over-shoot' a little meaning the actual stopping position varies with conditions, i.e. a dry screen will stop them sooner compared to when the screen is fully wet. The wire colours and functions are as follows:

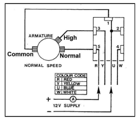
- Green - 12v supply to motor
- Black - earth to motor for parking circuit
- Black/Green - standard speed connection to motor earthed by manual switch



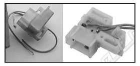
The round MkI GT motor parking system differs in that it stops in a much more predictable and controlled fashion. The parking circuit consists of a normally-closed contact at the manual switch and a change-over switch at the motor which consists of a segmented disc with three sections that rotates with the large gear wheel, and three fixed brushes that are part of the connector plug. With the manual switch on an earth is connected to the red/light-green 'run' wire that goes to the motor to operate the motor. When the manual switch is turned off the red/light-green is disconnected from earth and connected instead to the black/green 'park' wire that goes to one contact on the parking disc. With the wipers not parked this part of the disc is connected to an earth on another part of the disc to keep the motor running. Just before the park position is reached the earth is disconnected from the segmented disc to remove power from the motor, but inertia allows the motor to continue to turn as it slows down, then shortly afterwards 12v is connected to the third section of the segmented cam, which is picked up by the black/green wire, which goes back to the manual switch (off) then comes back to the motor on the red/light-green wire, which effectively short-circuits the winding. The motor now has 12v both sides which effectively stops it instantly. The theory behind this is that when power is disconnected from a motor it has inertia and continues to spin as it is slowing down and in the case of the wiper motor this means that the blades can stop in different positions according to how wet the screen is and vehicle speed. While it is spinning down it becomes a dynamo generating a voltage at its windings, and by shorting out the winding the dynamo is effectively being asked to supply a very high current which puts a heavy load on it, which is why it stops very quickly, and this gives it a consistent park position. The wire colours and functions from the Workshop Manuals are as follows:

- Green - 12v supply to motor
- Black - earth to motor for parking circuit and manual switch for running
- Red/Light-green - running connection to motor earthed by manual switch in the 'on' position, connected to the park circuit in the 'off' position
- Black/Green - motor to manual switch for park circuit
  Note the adapter harness has the first three as short wires between the main harness and the motor, and the last is a long wire from the motor to the manual switch.

February 2014: Click the thumbnail for how to test this motor with the five-pin (but only four wires) connector .



MkII and later: The round two-speed motor on these cars has a similar park principle to the MkI GT, but now the motor is backed by earth and the manual switch puts out 12v instead of earth to run the motor. The manual switch again has the normally-closed contact which connects the standard-speed wire to the park wire when the manual switch is in the off position. But now there is second changeover switch on the motor, that supplies 12v to run the motor when the manual switch is off and while the wipers are not parked, and an earth in the park position to short-out the motor and stop it rapidly as before. The wire colours and functions are shown here.



However this motor is not without its own confusions as although there was only one part number for the complete motor assembly there were at least two different types of park switch. The motors could be suffixed A, B etc. up to F or maybe higher. A and B have a screw-on park switch (originally 37H 2734, later 517645A but probably NLA), examples of D and F have the more common clip-on park switch (originally 37H 6784 now 520160A and available from the usual suspects). The brush plates also differ.

Which side do you dress I mean park? *Added October 2008*
This question seems to crop up from time to time, particularly in North America. Parking in front of the driver seems the most logical, as they will clear the driver's view first which is safer when first turning them on in the event of sudden spray being thrown across the screen. However that needs the arms to be angled such that the blades lie flat across the bottom of the screen, straight arms would be across part of the drivers view, and indeed some photos of early cars do show the blades like this, particularly the 64 car on the front of Clausager which looks like it could have straight arms. FWIW modern cars seem to park on the passenger side, but with their much deeper screens they can have much longer arms and blades which move about 90 degrees i.e. from the horizontal parked position against the bottom edge to the vertical position against the right-hand edge as compared to the 106 degrees of roadsters and 115 degrees of GTs. This gives a far greater proportion of swept area, leaving little more than a small arc at the top corner on the passenger side.

It seems quite clear that RHD cars always parked in front of the driver i.e. on the right-hand side. Many North Americans say theirs also park on the right, some say they park on the left, and some say that when ordering new arms they get the 'wrong' ones i.e. angled for parking on one side when they need the other. **All** the photos of LHD cars in Clausager show them parking on the right, but interestingly the Coune Berlinette on page 107 is parked on the left even though it is an RHD! It's not difficult to get them parked on the 'other' side - on the earlier round motors with the park switch on the domed cover over the main gear you can slacken the cover screws and rotate the domed part by 180 degrees.

On the later round 14W motors with the plastic park switch and connector block combined you can dig the plastic cam out of the back of the main gear and reposition it. The intermediate GT system is significantly different to either the earlier single-speed or the later two-speed. *May 2009:* Bob Muenchausen has contacted me to say that 20 years ago all he did to change sides was to simply rotate the wheel boxes 180 degrees so that the rack drives them from the top instead of the bottom, and reset the arms - brilliantly simple! You have to remove the rack and tubes from the wheelboxes to do this, so obviously easier with the dashboard out for example during a rebuild as Bob did. It is possible to get motor, tubes and wheelboxes out and back in as an assembly (a pal has done that for other reasons) in order to do that.

November 2021: A really strange thing happened to the MGC of Geoff Thirlby in that the blades suddenly started parking on the other side! I listed a number of things to check, even though Geoff said there had been no changes made to the car, and I couldn't see how any of them could happen by themselves. Then Geoff removed the large gear from the motor to look at the parking cam.

His is quite different to the other one I had seen, and with Geoff's I can imagine that if the plastic gear started sliding down the shaft of the cam plate the location pegs could become disengaged, which would stop the blades while the gear carried on turning. Then the pegs could re-engage 180 degrees out and the blades carry on but would park at the other end of the sweep. It seems unlikely, but what else could it have been apart from the garage pixies, as Geoff said? He was able to slide it down and turn it through 180 degrees to correct the problem. On the other type of gear its probably impossible for the cam to move round the gear and re-engage, but depending on how the gear is attached to the cam plate that could still move as Geoff's seems to have done. However

that's not the whole story, you have to consider any angle in the arms which tilts the blades one way or the other. Whether the blades park in front of the driver or the passenger, you would always want them to sweep right down parallel to the bottom edge of the screen in front of the driver or he will have quite a large unswept arc in front. This means that when they park in front of the passenger, they will be angled up across their view, and partially across the drivers when they look across - see the photos of my V8 and roadster temporarily stopped in this position. Bob tells me that when he changed his parking position he replaced the arms which is fair enough, but he used generic arms which could be angled either way, something I haven't come across before.

Going back to Clausager's photos, these all appear to be triple wipers, and that raises an interesting point. North America changed to triple wipers in November 68 as the authorities required a greater proportion of the glass to be swept (the relatively short screens necessitating short blades to avoid going off the top of the screen, which left large areas either side and between the swept arcs). As this moved the left-hand arm closer to the left-hand side of the car, more of the glass would have been swept that side, so the blades could park in front of the passenger but still sweep an 'acceptable' area in front of the driver. This changes the unswept area from being an arc at the top corner of the screen to a triangle at the bottom corner. The latter may be smaller, but to me having a clear screen to see people and objects at street level is preferable to being able to see things up in the sky (traffic lights excepted)! Whereas previously - for some of the time at any rate - LHD cars seem to have parked in front of the driver, it looks like cars with triple wipers changed to park on the right-hand side i.e. same as RHD cars. This **must** have been the case from April 71 as RHD cars got the same arms as LHD cars, and as the arms have a bend at the top to allow the blades to park against the bottom edge of the screen, they must have both parked on the same side, i.e. the right. From the Parts catalogues it would also seem likely that LHD GTs **always** parked in front of the driver, as the gears and arms were always different between LHD and RHD, LHD were common to all markets, and they never had triple wipers.

Before triple wipers the situation is less clear. Up to February 63 the complete wiper system was the same for both left and right-hand drive. If the change of parking side on the early motor was very easy i.e. just turning the park switch dome over the main gear through 180 degrees, then possibly the factory made the change themselves. And if the arms were straight it wouldn't have made much difference either way. In February 63 the arms changed to have stronger springs, and also changed to be different between RHD and LHD. In November 67 motors, gears (which now controlled the park position) and arms were all different, and if the parking side wasn't different before it almost certainly was now. That takes us up to November 68 when North American cars triple wipers, and got different arms to other LHD cars. The difference in arms continued up to April 71 when the North American arms were fitted to RHD cars. It wasn't until September 74 when **all** LHD cars were produced to North American spec that other LHD cars got the North American arms.

The MG Enthusiasts bulletin board has a pretty comprehensive series of photos of cars from 1962 to 1981 and these roadsters make interesting viewing:

Year	USA	Park side	Europe	Park side
1962	not available		Denmark	Driver
1963	Originally Californian, exported to Norway	Passenger	Germany	Driver
1964	USA	Driver	Sweden	Driver
1965	USA	Driver	Sweden	Driver
1966	not available		Holland	Driver
1967	USA	Driver	not available	
1968	USA	Driver	not available	
1969	USA	Passenger (triple)	Sweden	Passenger (triple)
1972	LHD V8 (Switzerland, Holland, Germany)	Driver	UK	Driver

This indicates - when examples are available from both locations, that all LHD cars with two wipers i.e. up to and including 1968 parked in front of the driver. Also that for the 1969 year again **all** LHD cars got triple wipers that parked in front of the passenger.

The confusing thing is that even when North American cars got triple wipers, and changed over to park on the right when they weren't before, they kept the same motor and gear as before - according to the Parts Catalogue, that is. Other LHD cars had the same motor and gear as North American spec cars. Where the Parts Catalogue gives the North American items a different part number to other LHD items and with a 'Safety' marking this is more likely to indicates a difference in material or construction methods and not function. The other thing to be aware of when comparing part numbers is that roadster wiper motors from November 67 to June 76 had suffix letters A, B and D. The motors were less the gear, the gears did **not** have suffix letters i.e. were just RHD or LHD, but the park switch (and brushes) had one part number with an A and B suffix and another with the D suffix or no suffix. The Catalogue has a note saying reference must always be made to the suffix letter to ensure the correct part is received, so it is probably the suffix letter that determines which side parking takes place. Unfortunately it doesn't say which suffix letter applies to which situation, i.e. RHD, LHD North America or LHD elsewhere. RHD cars had the same motor as LHD, but their own gear, from November 67 until the end of production. Other part number changes will be due to the change from bright arms and blades to matt-black, and there also seems to have been a change in position of roadster wiper spindles which required a change in arm and/or blade length.

Looking at GT pictures on the MG Enthusiasts bulletin board only one LHD (undated but between a 75 and a 77, the cars all being in date order) has the wipers on the right i.e. in front of the passenger, at least one LHD from each year having them in front of the driver.

The full (as near as I can judge) list of part number changes:

Roadster									
Change-point				Motor	Comments	Gear	Arms	Comments	Blades
HN3-101	May-62	HN3-6916	RHD/LHD	17H 2013	Use GEU 714	57H 5589	BHA 4321	10.25" arms, 10" blades	GWB 202
HN3-6917	Feb-63	HN3-138400	RHD	57H 5599	Use GEU 714	47H 5307	37H 4952	Heavier (13 oz) wiper arms	GWB 202
HN3-6917	Feb-63	HN3-138400	LHD	57H 5599	Use GEU 714	47H 5307	BHA 4396	Heavier (13 oz) wiper arms	GWB 202
HN4-138401	Nov-67	HN4-158230	LHD NA	37H 2732	Use GEU 708	37H 3046	BHA 4816		GWB 202
HN4-138401	Nov-67	HN4-167576	RHD	37H 2732	Use GEU 708	37H 3045	BHA 4814		GWB 202
HN4-138401	Nov-67	HN4-167576	LHD not NA	37H 2732	Use GEU 708	37H 3046	BHA 4816		GWB 202
HN4-158231	Nov-68	HN4-164063	LHD NA	37H 2732	Use GEU 708	37H 3046	13H 5460	Triple wipers	GWB 202
HN4-164064	Dec-68	HN5-294250	LHD NA	37H 2732	Use GEU 708	37H 3046	BHA 4913	Magnatex arms instead of Lucas	GWB 141
HN4-167577	Feb-69	HN5-246076	RHD	37H 2732	Use GEU 708	37H 3045	BHA 4914	Magnatex arms instead of Lucas	GWB 141
HN4-167577	Feb-69	HN5-294250	LHD not NA	37H 2732	Use GEU 708	37H 3046	BHA 4915	Magnatex arms instead of Lucas	GWB 141
HN5-246077	Apr-71	HN5-294250	RHD	37H 2732	Use GEU 708	37H 3045	BHA 4913	LHD NA arms fitted	GWB 141
HN5-294251	Aug-72	HN5-410000	RHD	37H 2732	Use GEU 708	37H 3045	BHA 5201	Matt black arms and blades	GWB 216
HN5-294251	Aug-72	HN5-360300	LHD not NA	37H 2732	Use GEU 708	37H 3046	BHA 5203	Matt black arms and blades	GWB 216
HN5-294251	Aug-72	HN5-410000	LHD NA	37H 2732	Use GEU 708	37H 3046	BHA 5201	Matt black arms and blades (3)	GWB 216
HN5-360301	Sep-74	HN5-410000	LHD not NA	37H 2732	Use GEU 708	37H 3046	BHA 5201	NA arms fitted	GWB 216
HN5-410001	Jun-76	on	RHD	37H 8221		37H 3045	BHA 5201		GWB 184
HN5-410001	Jun-76	on	LHD	37H 8221		37H 3046	BHA 5201		GWB 184
GT									
Change-point				Motor	Comments	Gear	Arms	Comments	Blades
HD3			RHD	27H 6409	Use GEU 708 (see note)	27H 6420	BHA 4546	12" arms, 11" blades	GWB 142
HD3			LHD	27H 6429		27H 6424	BHA 4548	12" arms, 11" blades	GWB 142
HD4-138401	Nov-67	HD4-158230	RHD	37H 2732	Use GEU 708	37H 3047 115°	BHA 4817	13" blades	GWB 143
HD4-138401	Nov-67	HD4-158230	LHD	37H 2732	Use GEU 708	37H 3048 115°	BHA 4819	13" blades	GWB 143
HD4-158231	Nov-68	HD5-296000	RHD	37H 2732	Use GEU 708	37H 4308 125°	BHA 4881	13" blades	GWB 144

HD4-158231	Nov-68	HD5-296000	LHD	37H 2732	Use GEU 708	37H 4309	BHA 4880	13" blades	GWB 144
HD5-296001	Aug-72	on	RHD	37H 2732	Use GEU 708	37H 4308 125°	BHA 5205	Matt-black 12" arms and 13" blades	GWB 217
HD5-296001	Aug-72	on	LHD	37H 2732	Use GEU 708	37H 4309 125°	BHA 5204	Matt-black 12" arms and 13" blades	GWB 217
V8									
All			RHD	37H 2732	Use GEU 708	37H 4308 125°	BHA 5205	Matt-black 12" arms and 13" blades	GWB 217

Notes:

- GEU 708 is a two-speed motor but is 'plug compatible' with the Mk1 GT wiring albeit giving only the 'standard' speed without modifying the wiring and switch.
- Info on gear part numbers May 2024 varies somewhat:

	Chassis No.		Leyland PC	Moss Europe	B&G	MGOC	Rimmer
Mk1 Roadster	101 – 6916		57h5559	511007			511007
	6917 – 138400		47h4307	520939 nca	520939 nca		
Mk1 GT		rhd	27h6420	27H6420 nca			27H6420 nca
		lhd	27h6424				
Mk2 roadster		rhd	37h3045	37H3045	37h3045 105°	37h3045 105°	37h3045 105
		lhd	37h3046				
Mk2 GT	138400 – 158230	rhd	37h3047		37h3048 115°	37h3048 115°	517622
	138400 – 158230	lhd	37h3048				
	158231 – on	rhd	37h4308	37H3048		37h4309 125° oos	
V8			37h4308				
	158231 – on	lhd	37h4309				

Wheelboxes have their own variations, these are the original numbers, several NLA. Early versions are shown as 'assemblies' so may have come with bush kits:

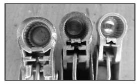
Roadster	Wheelbox	Bush kit	Use
101-6916	BHA4324		
6917-138400	BHA4392		
Replaced by	37H6824	519988	520275
Mk2	BHH4763		37H7738
Replaced by	37H6314	37H6875	37H7738
368223-41000	37H7738	519988	
41000 on	37H7738	37H6875	
GT	Wheelbox	Bush kit	Use
101-369228	BHA4529		AAU1073
369229-410350	AAU1073	37H6879	
V8	Wheelbox	Bush kit	Use
101-2185	BHA4529		AAU1073
2186-2903	AAU1073	37H6879	

The original bush kits have an angled spacer under the panel (roadster are longer than GT) as well as the angled chrome bezel with gasket (roadster ADC560 GT 27H6428) above the panel, to clamp the wheelbox to the panel and seal against water ingress. Suppliers only seem to have the upper kit (gasket, bezel and nut) and not the lower spacer, without that the wheelbox will be loose on the panel and leak. Moss Europe does picture the lower spacer for Mk1 cars but without a part number so not available. B&G does have what looks like the roadster item although it is not pictured at the top of their main 'wipers' pages, at £8.34 plus P&P. However Andy Jennings has new 3D printed at £7 a pair with free postage!

GT wipers have a wider sweep angle than roadsters and this is set by the position of the crank pin on the main gear - that for the GT will be further out from the spindle than the roadster. Roadsters were 106 degrees, GTs were 115 degrees originally then 125 degrees for 1969 models on according to the Parts Catalogue, but suppliers indicate this change was much earlier. It looks like the main gear is stamped with the applicable sweep angle.

Arm fitting:

From what I can tell wiper arms always attached to the spindles with a spring-clip, never a screw. A very simple arrangement but seemingly effective, so far in over 30 yrs and 200k with two cars none of mine have gone flying off into a hedge or the middle of the road. As the spring pushes the blade against the glass the 'cup' tilts on the spindle and the clip lodges behind it. To release them pull the blade back, angle the hinge side of the cup towards the glass instead of away, and wiggle and pull. To replace just push back onto the splines with the blade in your preferred position relative to the screen glazing seal.



T Aczel in Australia has had problems with TEX arms flying off, losing about four of them. He posted pictures of two different types of TEX fitting which as well as being different to the originals are different to each other.

December 2011:

That leaves the angle the parked blades make to the screen. Clausager shows a 1964 Tartan Red on page 17 with the right-hand wiper at an angle to the screen, but the inner end on the screen surround so it can't go down any more. However the left-hand wiper is cocked way up, and is clear of the surround, so I'd be looking if that arm could be moved on the spindle by one spline. The 68 MGC on the facing page has them lower, with the right-hand pretty-well flat, and the left-hand angled but much lower. Most other images in the book have them flat to the surround, and both my cars are like that. I'm pretty sure I have never altered the V8, but following a comment on a BBS I do recall increasing the angle at the blade-end of the roadster arms to make the blades lie flat before repainting them. There have also been reference to 10 or 12 degree arms, and 20 degree arms, the difference being the larger angle makes them lie flat where the smaller angle doesn't. GT arms and blades are longer and the spindles are positioned differently to the roadster partly because of the deeper glass, the overall effect being that the arms need less of an angle for the blades to lie flat to the lower edge of the glass. Where they park in front of the driver, parking flat is desirable, and I adjusted my roadster arms as follows: With the edges of the blade-end of the arm clamped lightly between the jaws of a vice, I gripped the flat sides just above the jaws with a pair of large pliers so stop the arm turning over and buckling, then pulled the splined-socket end of the arm towards me. I didn't bother about the angle, just did each until the blade lay flat, only took a couple of goes. This may chip the paint on painted, but that can be touched-up if you aren't repainting them anyway. For bright arms probably best to use plastic vice jaw inserts and similar in the plier jaws, but then again they can be polished.

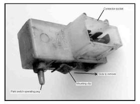
Problems

Slow or non-running
Poor clearing
Flying off
Parking on the wrong side

One thing that plagues BMC rack-and-pinion wipers is excessive slop after many years use. I used to think that this was all due to wear in the wheel-boxes and rack, and no doubt some is. If you think about it, the wheel-boxes consist of a gear wheel in which slightly less than half is ever used, and only one side of the rack is ever used. So if you remove the wiper arms, disconnect the rack at the motor and withdraw it until the wiper spindles are free, rotate the wiper spindles through 180 degrees, turn over the rack and put everything back, you should be running on unused portions of the wiper boxes and rack. I tried that on my V8 but if anything it has made things worse - maybe a PO had already done it - so I had a careful look at the rack. It consists of a flexible-ish straight wire with a stiff wire wrapped round it in a spiral to form the 'teeth' of the rack. It looked to me as if the pitch between the turns of the spiral that ran in the wheel-boxes was greater than elsewhere, not due to wear but distortion, and that would account for some slop. My next task is to see if I can get a new rack and try that. In fact shortly after writing this the rack broke anyway! I got a replacement from the MGOC, it had to be cut to the correct length, and it did indeed cure the slop!

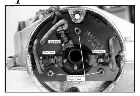
Slow or non-running: *Updated September 2008:* Another problem is slow running, and that is about the most difficult thing to investigate on the MGB, worse even than slow indicators. This can be caused by dry spindles in the wheel-boxes, some say old stiff grease in the gearbox causes it but I have not experienced this. Worn brushes can also cause it, and also cause intermittent running. A common cause is low voltage at the motor caused by bad connections. As the power has to come from the solenoid on the brown circuit, through the ignition switch (or ignition relay) onto the white or white/brown, through the fuse onto the green (or green/pink) circuit, through the wiper switch to the motor, and from the motor to an earth connection, plus the many spade and bullet connections in that circuit. The problem is that low voltage causes slow running, which causes high current. But mechanical drag also causes slow running, which causes high current, and both cause additional voltage drop. So it is extremely difficult to know whether the cause is electrical or mechanical, especially as the harness plug for the motor is hidden between the motor and the bulkhead and very difficult if not impossible to get meter probes onto. Removing the motor and connecting a good 12v and earth supply to the connector pins will show if the motor itself is the cause, but if not that still leaves mechanical drag from the rack, wiper boxes and blades, or electrical connections and doesn't put you much further forward.

February 2013: Manek Dubash of Lewes reported on MG Enthusiasts that his wipers weren't working or very slow, the motor got very hot and was blowing fuses. He measured the running current on the bench (i.e. not wiping the screen) at 5.2 to 5.5 amps, whereas the book says it should be 2.7 to 3.4 amps when it is wiping the (wet) screen (on the standard speed if a 2-speed motor). The wheelboxes and rack being attached or not made little difference, neither did resisting movement by hand. He decided to get a new armature as they are only £9.50 compared to £50 for a complete motor (well spotted), and with that fitted on the bench (i.e. no wiper blade load) it was drawing only 1.6 amps on the standard speed and 2.2 on the fast, so the fault was probably a partially burnt-out armature winding. Note that on a stationary motor a typical standard winding measures 1.5 ohms and fast 1 ohm, so it's possible to get a current of up to 14 amps with a stalled motor.



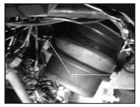
Failure to park (just stops when the manual switch is turned off) can be caused by a worn park switch in all types of motor as well as disconnected wiring or a faulty manual switch in the case of the later parking system. The park-switch (see left) is in a single unit with the multi-connector plug on the motor and has a nylon peg that pokes through the gearbox casing which is lifted up by a cam on the large gear, the nylon peg can wear down as well as the switch contacts fail. The park-switch/connector (which also kept playing up on the V8 until replaced) is also available from the parts houses.

September 2008:



Vee's wipers suddenly stopped working, moving about 1/4 the way across then stopping, and not parking or running at either speed. Fortunately I didn't need them as I had operated the wiper stalk instead of the indicator, otherwise it would probably have happened when I **did** need them! The fuse hadn't blown as the heater fan was still working. The electrical conditions at the (unplugged) harness connector seemed to be correct, so there was nothing for it but to remove the motor. Applying 12v and earth directly to the appropriate spades on the connector block got nothing out of the standard speed and just a brief movement out of the fast, then nothing, not even any sparking. So I opened it up, full story by clicking the thumbnail to the left.

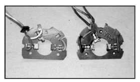
Brush Replacement *May 2016:* For a long time Bee's wipers have been reluctant to start moving, especially if not used for a long time like over winter. Sometimes I've had to switch to fast speed before they would get going properly, and after that they have continued to work back on normal speed. On our first run of the season I had to use them and they were even reluctant to start and keep going on the fast speed, so definitely time to investigate. We have a run in a few days where rain is expected again, so I decide to do something about it.



The first thing I did was check the voltage reaching the motor, which to do properly one must do right on the connectors for the brush wires, which means taking the motor off to get at them. Remove the U-clamp securing the motor to the bulkhead, which makes access to the gearbox cover screws slightly easier.

Take the cover off, slide the circlip off the large wheel crank pin, remove the shim under it, and remove the connecting rod that pushes and pulls the rack inner. Note another larger shim under the connecting rod. If you lift the blades off the glass, turn the wiper switch on, then turn the ignition on and off while watching the crank pin, you can position it to be lower down and so easier to access. Then the rack can be lifted out of the end of the gearbox, the motor unit lowered and turned over to unplug the harness connector. In theory you can undo the big nut where the rack joins the gearbox, and withdraw the motor complete with rack inner and so not have to fiddle with the connecting rod - if you can wield a large spanner that high up behind the dashboard. Many years ago that nut did work loose in torrential rain on a run, and I managed to reach up and hand-tighten it while still driving along, tightening it properly on our return home, but with all the extra wiring I have up there now I decided it would be easier to remove the con-rod as I did before.

I poked some thin single-strand wire up the normal and fast connectors where the brush wires go onto the connector block, plugged the harness back, connected a meter to the wires, and switched on. Now this doesn't have the load of the wipers of course, but even so I'm only losing about half a volt, so the connections are OK. Next was to examine the brushes. Remove the two long screws that go through the motor case into the gearbox, and pull the motor unit off.

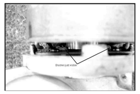


It was immediately apparent that the brushes were very worn, even more so than when I had changed Vee's brushes when that stopped altogether. However it was only when reviewing this picture that I realised something else. Whilst the brush material itself is considerably longer on the unworn new item, the springs aren't pushing the back of the brushes anywhere near as far out as the old springs are. So

unless they work out as they are used, only a small amount of wear will need to take place before these stop working properly as well.

When fitting the new brush set make sure the blue wire is positioned between the screw boss and the side of the gearbox casing, and doesn't get trapped. It's the earth wire so shouldn't cause an electrical problem, but it will affect the alignment of the brushes.

I took the opportunity to clean the commutator with white spirit, and draw a knife blade between the segments to clean them out.



When refitting the motor, carefully hook the brushes back one by one so they fit over the end of the commutator ...

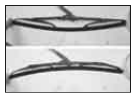
... and position the alignment marks correctly.

With the motor casing screwed to the gearbox casing I plugged the harness in for an electrical test - and immediately found the same problem I had had with Vee's new brush set and that was the motor binding and running very slowly. Slackening the motor screws and tilting its case slightly freed the motor up, again exactly as before. This time determined to try and find the cause, I removed the motor case, refitted the old brush set, and refitted the motor, and it ran perfectly. Several times I had the motor off and on with both new and old brush sets and it always ran correctly with the old set, and always ran slowly with the new. The only point of contact between the brush set and the armature is between the brushes and the commutator, so there is no way they can be causing it when tilting the motor 'cures' it. It can't be the upper bearing in the gearbox casting as that is spherical externally in a spring mount so orientates itself to match the spindle. And it isn't the large screw in the gearbox casing that bears on the end of the armature spindle as I slackened that to give a clearance and it made no difference, and there is a nylon bush between the two anyway. It's a mystery, so again I resort to a washer inserted to create a gap on one side, i.e. tilting the motor relative to the gearbox. I reinstall everything, but may well investigate further when time and no imminent runs allow.

Poor clearing: From time to time there are complaints on the various fora about poor clearing of the screen by the wipers - smearing and missed areas being the main ones. It's possible that people are comparing them with their modern cars, which is always a big mistake. It's also possible that people rarely use their MGBs in wet weather, so if they do get caught in a shower it's quite likely they are going to have dust, traffic film and flies, unless they are forever cleaning the screen before going out - and dust in particular is something I notice when taking one of them out after a break of a couple of weeks or so. After that it's down to arm and blade performance.

I've done nothing special to either of mine but find particularly on the V8 that after the first few strokes after not being used for a long time the clearing is perfectly acceptable, and very similar to the ZS under similar circumstances. The roadster needs a bit longer perhaps, but again is perfectly acceptable. I have Smartscreen on both and use that far more than needing the wipers to be on constant, even in quite heavy rain, it just seems to bead and roll off, as if I was using Rain-X.

Juddering is usually down to traffic film on either the screen or the blades, but can also be due to the 'angle of attack' of the blade to the glass. The blades work best if they can spread a microscopic layer of water across the glass as a lubricant, sweeping the rest away, a bit like when using a palette knife to ice a cake (you haven't lived ...). Lifted just off the glass the blade should be pointing straight at the glass, and movement in how the rubber is attached to the metal parts of the blade, and the shape and flexibility of the rubber tip, should allow the tip to lean first one way then the other as it sweeps across the glass. If the tip of the blade can't lean to perform a sweeping action and instead performs a chiselling action then it may well judder.



The 'refill' i.e. the rubber and its steel backing should be free to move up and down through the pivoting parts of the arm. This enables it to follow the curve of the screen, and to move from a curved part to a flat part staying in contact with the glass. When mine are parked - right down on the rubber surround - only the very tip of the blade is not touching the glass, and only by a tiny amount. As soon as the blade starts it sweep it is fully in contact with the glass.

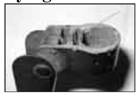
The spring in the arm may be weak. After the first six months of production heavier 13oz arms were fitted.

It's possible all the above may be correct, but the quality of the rubber (!) is just not good enough. From notes (which may be incomplete) Vee's came from Halfords in 2015, possibly Bosch, and Bee's have possibly been on since 1991! There are comments that 'Tex' blades are poor, but seem to be the ones most commonly stocked, NOS Trico being better. Googling shows Trico as currently available, quality unknown.

Parking on the wrong side: *November 2021*

- If you have just reinstalled the wiper rack/wheelboxes then check that the rack goes under the wheelboxes, not above, as here.
- If you have just fitted a different motor then remove the cover when the wipers are parked and see where the crank-pin on the large gear is. It should have pushed the rack out of the gearbox housing, as here.
- If it has pulled the rack into the gearbox housing on the 14W 2-speed motor then the parking cam is probably in the wrong position, see here.
- But if your wipers suddenly start parking on the wrong side when no work has been done, look here!

Flying off: *March 2020*



The arms should have some method of retaining them on the spindles. Mine have a spring-clip that hooks under the base of the splined section, and the blade has to be lifted off the glass to remove the tension between arm and spindle before I can remove them. If the splines are worn it may allow the arm to fly off when in use.

Smartscreen Intermittent Control

RWTM Windscreen Wiper Timer Module

Smartscreen:

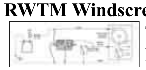
The MG Owners Club and others sell a device called 'Smartscreen' which is eminently suitable for MGBs and Midgets at least and because the time delay is set using the standard wiper switch the device can be tucked away out of sight as it has no controls of its own. You use the existing switch on and off to start a 'learning' phase, then use the existing switch a second time on and off to terminate the learning phase, thereafter it repeats the delay until you turn the manual switch on for longer than one wipe or turn off the ignition. There is an enhanced version which operates the wipers briefly whenever the electric washers are used. I have the non-washer version and they are extremely useful, I find myself using intermittent far more than full-time, which saves wiper motor, blades and screen, as well as the switch when light rain/spray means you would otherwise need to keep turning them on and off (or flick-wipe) manually.

September 2024: On a very wet journey to Doncaster and back for a photoshoot with the Vulcan I was using Smartscreen a lot when I started noticing my (instantaneous) voltmeter momentarily dropping a volt or two and wondered if the alt was on the way out, perhaps the rain. But then I realised it coincided with Smartscreen triggering the wipers so was less bothered. Next day I started looking at voltages and currents when I remembered that although the wipers are powered from the accessories position of the ignition switch Smartscreen is powered from the fused ignition, via quite a long daisy-chain of things I have added, together with the voltmeter. With Smartscreen disabled operating the wipers manually shows only a marginal dip on the voltmeter, so possibly one of those connections isn't 100%. But while I'm messing about I decide to power Smartscreen from the accessories position as well so both are the same, just leaving the voltmeter on the previous connection, and now both manual and Smartscreen operation result in the merest dip of the voltmeter.

February 2013: I fitted the Smartscreen to Vee in 2001 and it has just packed up (lasted longer than many replacements for factory stuff) - the wipers start to run as soon as the ignition was turned on. I knew it was the Smartscreen and not the wiper switches as on this era the wipers are available with the key in the Accessories position, and they worked as they should, it was only when turned to Run before cranking that they started up, and I had powered Smartscreen from the ignition and not the accessories. After a bit of confusion - I got no confirmation web page or email or entry on my credit card, so thought the order had failed somehow and ordered again a week later. This time I got a confirmation email, but still no credit card entry or Smartscreen after a few days. Contacted the vendor who said he had received both orders so at least I was able to cancel the spurious one, and eventually it came another week later. Easy enough to swap the wires one by one and we are back working again. Always intrigued as to what's inside sealed boxes I opened it up to take a peek.

Update January 2006: Apparently out of stock with the MGOC for a long time there have been rumours that they are available again. The suppliers web site is still online but there is no date information to indicate that it is still current, the contact page gives a phone number for enquiries. However Moss Europe show them with a price so maybe they **are** available again. *Update August 2008:* Allen Bachelder has commented on the MG Enthusiast BB that he ordered one from Moss (presumably UK as USA don't reference them) a couple of years ago but a different product arrived which uses its own control and so is not as neat as the Smartscreen system. Moss currently show the Smartscreen in the link above, so maybe you should check before you buy to see which you are getting.

RWTM Windscreen Wiper Timer Module *August 2021*



There has been a question about connecting these on the MGOC forum. A less convenient device as it has its own rotary switch that has to be mounted somewhere, and only has five fixed intervals. Of the

online instructions only one is directly applicable - earth-side switching for Mk1 roadsters - the rest vary to some degree. Mk1 GTs have a system that is only similar to Mk2 cars, Mk1 roadsters are completely different. Because the instructions are generic i.e. apply to lots of different marques and models they do not give any colours for the cars wiring, so you have to work that out for yourself. There is sufficient information on this site to work that out for the three (or four) options but I have added the colours to the Retronics drawings to make it easier.