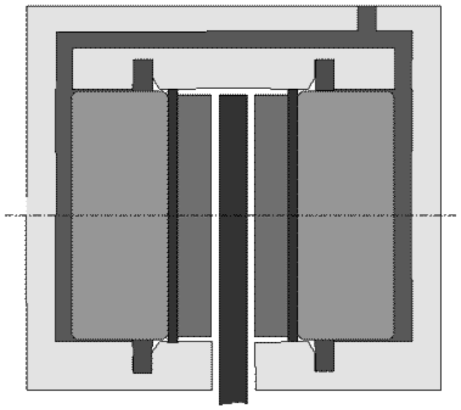
NEW Index Body Brakes Clutch Cooling Electrics Engine Fuel Gearbox Heater Ignition Propshaft Rear Axle Steering and Suspension Wheels and Tyres Miscellaneous

Braking System

Last updated 30-Dec-2017

December 2017: Someone has just asked 'how do brakes work' in terms of what releases the brakes after they have been applied. They also asked if it was the pedal being released that pulled the fluid back and so pulled the brakes off, but that definitely isn't the case. The design of both master cylinders is such that when the pedal is released and pulls the push-rod back, a spring inside the master cylinder pushes the piston and its seals back. Normally all the fluid that flows out of the master cylinder when the brakes are applied flows back in when they are released to release the pressure in the calipers and wheel cylinders. But if for any reason it doesn't, for example when pedal bleeding (can be done but not ideal) and some fluid has been expelled from a bleed nipple, then as the piston comes back more fluid flows from behind the pressure seal and the reservoir so the system remains full of fluid and at zero pressure, positive or negative. See the description of the master cylinder for how this happens. But even when all the fluid does come back, on single-circuit masters at least it does so through a restrictor, which only gradually releases the pressure in the pipes etc. As the master piston comes fully back straight away some fluid is always pulled from the master into the cylinder, to be pushed back into the reservoir again as all the fluid comes back through the restrictor.

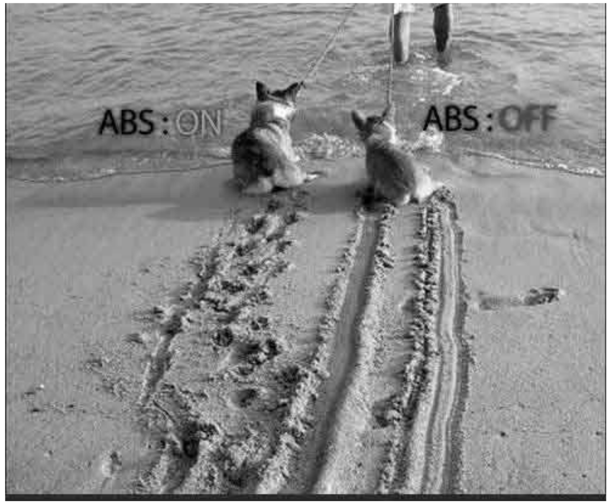


Source: Motor Vehicle Maintenance & Repair Stack Exchange

So how are the brakes released? Rear brakes with drums and shoes have return springs to pull the shoes away from the drum, and pushes the wheel cylinder pistons back into the cylinders, which pushes fluid back towards the master cylinder. But caliper pistons don't have return springs. They are self adjusting, and in normal use the pads sit just fractionally off the discs, maybe rubbing very slightly. As the brakes are applied fluid pushes the pistons out, past the seals, which pulls on the seals very slightly. When fluid pressure is released the seals will tend to return to their former shape and position, pulling the pistons back into the caliper very slightly, taking the pressure of the pads off the discs. There is a secondary effect on cars like the MGB in that there is a small amount of end-float at the front hubs. This end-float allows the hub and

disc to rock from side to side very slightly when driving, which also tends to push the pads and hence the pistons back a little. Some pooh-pooh this secondary effect saying not all cars have this end-float. That's true, and the intention of end-float isn't to push the pads and pistons back, but nevertheless it does happen. If you Google 'pad knock back' you can find many descriptions of the same effect caused by worn wheel bearings.

ABS Simply Explained



Bleeding

EeziBleed

For the original system with the single hydraulic circuit brakes should be bled starting with the longest run i.e. left-hand rear, then the next longest i.e. right-hand rear, and so-on to the shortest. Originally this was the right-hand front, but on cars rubber bumper RHD cars with the remote servo it is the left-hand front that is the shortest as there is a pipe direct off the servo to this brake. LHD dual circuit cars may also have the left-hand front as the shortest run. It may well be beneficial to release the handbrake while bleeding the rears, see below. Dual-systems, including the brake-failure shuttle switch, are outside my experience but I can't see how they can be pedal-bled very easily as the circuit **not** being bled will still pressurise and stop the pedal moving to the floor, which will greatly reduce pedal travel, and hence the amount of fluid that can be pushed through the system that **is** being bled with each operation of the pedal. It will also activate the brake failure pressure switch (earlier remote types) or need the switch to be unscrewed (later integral types). Continuous-flow bleeding as with a Gunson's EeziBleed should avoid both these issues, as well as making the job much easier on all systems. On both my cars I find that whilst the EeziBleed is perfectly adequate for the rear brakes, if the fronts have been dismantled and air has got into the system additional steps are needed, as after using the Gunsons alone I get a 'long' pedal. This can be 'pumped up' but after only a few seconds that effect is lost and the next application results in a long pedal again (the effect of the restrictor valve inside the master cylinder), which can be a bit disconcerting! I get my assistant to press down hard on the pedal while I rapidly open and shut each caliper bleed nipple in turn. The much higher pressures, and hence flow when the bleed nipples are opened, seems to blast any remaining air out of the pipes. Thereafter the brakes have always been as expected. Note that on twin-circuit brake systems this may well cause the shuttle valve to move and light the brake warning lamp. If it is still lit after doing both sides then on the side **opposite** to the one you did last, get the assistant to apply medium pressure to the pedal, open the bleed nipple just a fraction letting a tiny dribble of fluid out, get the assistant to shout as soon as the warning light goes out, and rapidly close the nipple. If it doesn't go out try doing it on the side you bled last.

Added October 2009: Following me giving the above advice on a mailing list a medic pal told me he had to do exactly the same thing with an arterial pressure measuring system. They had to get all the air bubbles out of the external tubing or it wouldn't work. The system came with a low pressure and flow flushing feature which was never sufficient, so they had to add a syringe to give a much higher pressure and flow which was successful in blasting them out. A 'negative' pressure system (akin to the Mityvac which some recommend for brake and clutch bleeding) was also of no benefit. A 'continuous flow' system would sometimes work, but on a car would need many litres of brake fluid to work, or a very long length of tubing from nipple back to master. However this method can be used when bench-bleeding master cylinders by looping the outlet directly back into the filler. But bench bleeding has own problems of mess and potential for contamination and I've never bothered doing it.

Update May 2013: However after working on the calipers and brake pipes of Vee I just couldn't get rid of the long pedal, so had to resort to another method people mention from time to time, and that is wedging the brake pedal hard down overnight. Even that didn't work the first time, so the second time I jacked up the front (the principle of wedging down being that any air in the system will float to the highest point over time - hopefully the loop of pipe right by the master, then when the pedal is released the bubbles will be sucked back into the master reservoir), and after that it was OK. But this brake work was done on my full-length ramps where the car was reversed on, and the construction of the ramps is such that even when fully erected the end you drive on is slightly lower than the other end, and even with the wheels off the nose of the car was slightly lower than the rear. So I suspect that was preventing my usual bleeding method from working first time rather than anything else.

Although I have never experienced this problem on multiple BL cars I'll mention it anyway. People from time to time ask why the bleed nipple on the rear cylinders isn't at the top like it is on the calipers, and why doesn't an air bubble get trapped in them and cause spongy brakes. The reason is that a caliper is self-adjusting for wear and the pistons gradually move further and further out so creating a larger and larger cavity behind the piston for air to gather in. So unless the bleed point is at the top air will never be fully removed when bleeding. Look at the diameter of a caliper piston and how far it can be pushed back in when you remove worn pads and you will see what I mean. By contrast wheel cylinder pistons should be pushed all the way back in by the springs when the brakes are released and this leaves just a tiny channel round the backs of the pistons and not a cavity between the pistons to trap air. Normal bleeding will push air down and out of this tiny channel just like it will push an air-bubble downwards along a length of pipe. Adjustment for wear is on the separate adjuster at the top, of course, and doesn't affect the hydraulic system like it does with calipers. However when the handbrake cable is connected and correctly adjusted the handbrake levers will be holding the lower ends of the shoes further apart against the springs, and hence the wheel cylinder pistons won't be pushed fully back into the cylinders. For this reason perhaps the handbrake should be released while bleeding the rears in order to allow the release springs to push the

wheel cylinder pistons right back, but in 35 years I have never found this to be necessary. A couple of people have mentioned that they have only been able to get rid of a spongy pedal by forcing the rear shoes to be locked on by the adjuster as this is the only way to force the wheel cylinder pistons fully in and so remove a larger space between the backs of the wheel cylinder pistons which is trapping air. If that is the case I'd suspect weak or missing return springs, or possibly stiffness in the handbrake cable or levers preventing the shoes from being pulled back by the springs, which could indeed leave a cavity that will trap air.

EeziBleed *March 2016* A couple of things to watch out for.

The spare tyre is typically used to pressurise the reservoir and pressures of 15-20psi are banded about, which will almost certainly need you to reduce the tyre pressure from its normal level (and need reinflating afterwards). However I've found that even 15psi is too high, leaking from the reservoir cap seal, which rapidly deflates the tyre. 10psi is enough, you are never going to blast the fluid out with an EeziBleed, only trickle it out, so you might as well use the lower pressure.

I've had mine many years but quite soon after purchase I found that screwing on the reservoir cap too tightly caused the rubber ring seal inside to be forced down into the neck of the reservoir and no longer seal, which is another reason for using minimum pressure and not needing to screw the EeziBleed cap down as tightly. Over time the seal distorted badly and would not lie flat on the neck of the bottle, which meant it was always leaking even on low pressure which made bleeding a pain having to keep re-inflating the tyre. I contacted the manufacturer and they kindly sent me a replacement free of charge, so now I remove and wipe it in the hope that it retains its shape and function for longer.

Make sure the tube is securely fastened and sealed to the cap that you will be using, and the cap will seal to the master. The system works by pressurising the fluid, and hence the air, inside the master reservoir. If either the tube or the cap doesn't seal the air will leak out to be replaced by fluid, and hence overflow. A pal inherited a system from his pal where the tube was not sealed to the cap, and fluid went everywhere. There is a brass fitting with two fibre seals and a nut which seals itself to the cap, and the tube passes through this. Make sure the tube has an alloy tapered cylinder inside, and this part of the tube is wedged into the brass fitting, as this forms the seal between the tube and the fitting. Finally there is a rubber seal inside the cap which seals to the neck of the master cylinder. If any of these seals are inadequate fluid will leak out. Note that if the top of the neck of the master cylinder is damaged or distorted the cap may not seal and again fluid will leak out.

Finally, **before putting any fluid in the EeziBleed reservoir**, connect it all up and check for leaks by listening for any hissing. If you can hear hissing from anywhere near the master cylinder fluid will leak out. Hissing from the EeziBleed cap threads will only flatten your spare tyre more quickly than it should, but if it is coming from the tube that leads to the master cylinder again that will leak fluid.

Brake Balance and Handbrake Warning

North American spec cars got the brake balance circuit with the dual-line braking system with the MkII in 1967, and the handbrake warning circuit in 1976. Other LHD markets got them in 1977 when only the North American spec was supplied. The UK (and other RHD markets) didn't get any of dual-circuit, brake balance warning or handbrake warning until 1977.

There were three arrangements of the brake balance failure circuit - a simple circuit for 1968 where the test switch merely tested the warning lamp and 12v supply. From 1969 to 1975 there was a more comprehensive circuit where the test switch checked the wiring right back to and through the balance failure switch. From 1976 on there was another variation that integrated a handbrake warning but deleted the test switch. Non-servo dual line systems had a remote splitter manifold containing the balance switch, servo dual-line systems had the balance switch as part of the master cylinder assembly. The UK only had the latest system from September 76 on.

The 1968 circuit has a single black/white wire running from the balance failure switch to one side of the failure warning lamp, the other side of the lamp being connected to the purple (always on, fused) circuit. A black earth wire was connected to one side of the test switch, the other side of the switch being connected to the same side of the lamp as the black/white wire. Balance failure results in a earth being connected to the black/white wire, which lights the lamp. The test switch merely connects a local earth to the warning lamp, the wiring to the balance failure switch could be disconnected but the test switch will still light the lamp.

The 1969-75 circuit has two black/white wires running from the balance failure switch to the warning/test panel, these two wires are linked together inside the switch. Both run back to the warning/test panel, one to one side of the lamp, the other to one side of the switch. The other side of the lamp is connected to the purple circuit as before, and the other side of the switch is connected to a local earth as before. Balance failure results in a earth being sent from the balance switch down both wires. One will light the lamp, the other does nothing. However with this circuit when the test switch is operated a earth is sent up one wire, though the link inside the balance switch, and back down the other to light the lamp. This proves the continuity of the wiring between the switch and failure lamp as well as the failure lamp and power supply as before. I have also heard from one source that fluid leakage through the switch will cause the internal link to fail, which means the test will fail. However whether this was a 'one-off' or a design feature hasn't been confirmed. If it **is** intentional it seems to imply that leakage through the switch was almost expected (it certainly does seem to happen by all accounts), in which case one would have thought they would make a better switch!

The 1976-on circuit is quite different, being integrated with a 'handbrake on' warning. The drawing of the brake balance switch implies that a) the warning light would be on all the time, and b) in the event of balance failure the green circuit fuse would blow! I think both of these rather unlikely, and so have drawn the switch as I think it actually is. *Update October 2009* The master/servo unit is identical for both pre 76 and 76 and on, and new ones from Moss at least are supplied with the later switch in the box but not installed. For earlier cars with the white/black wiring the earlier switch must be used instead or the balance failure warning will not operate although the test circuit will. *End of update.* One thing of interest is that there is no longer a manual test switch that checks the continuity of the wiring right though the balance switch itself. However there is a part of the circuit that will light the warning lamp every time the engine is cranked, so testing at least the lamp and its 12v supply is OK, which saves one the huge inconvenience of manually checking the circuit when one happens to think about it. But because the lamp also acts as the 'handbrake on' warning, and seeing as how on most occasions the handbrake will be on anyway when cranking the engine, the 'crank test' facility is almost entirely superfluous. Not only that but all it does is check the handbrake warning lamp and its local earth, it doesn't even check the continuity of the balance switch wiring. Another example of interfering American legislators not really understanding what they were doing.

The 4th circuit is the 1977-on UK spec 'handbrake on' warning which seems different to US cars in that the UK schematics show no brake balance switch in circuit. But this seems to be an omission in the drawings

as several cars checked do have the switch and wiring. UK cars can also suffer from 'continual cranking' problem as above.

But the biggest problem with these latter circuits that include the handbrake warning is that they include a diode, which if it goes short-circuit causes the starter to crank all the time, unless one has the presence of mind to drop the handbrake! When I first looked into this, based on a description of the problem from someone who had it, I thought it didn't occur until you turn the key to crank, then it kept cranking. But in fact as Roger Parker points out in the October 'Enjoying MG' it starts cranking as soon as you turn on the ignition. You might think that by turning off the ignition you would stop it cranking. But no, once it starts, it keeps going until you either disconnect the battery, or pull the wires off the starter relay, or drop the handbrake. This is because even though you have turned off the ignition and apparently removed 12v from the white, white/brown and green ignition circuits, the starter solenoid is feeding 12v direct to the coil, which comes backwards through the coil ballast resistor onto the white/brown, and from there onto the green, then via the handbrake switch closed and the short-circuit diode to keep the starter relay operated, which is keeping the starter solenoid operated. Even though the current has to come through the ballast resistor there is relatively little voltage dropped across it, leaving more than enough to keep the starter relay operated.

The diode is a cylindrical object (click the thumbnail for a picture) tucked high up behind the dashboard on the right-hand side in UK cars - labelled 'Pektron' with a diode symbol and 'A75-294', and I think US cars have them in the same location. It has a male spade for a female connector on the white/red feed from the starter relay, and a female spade for a male connector on the green/orange wires to the brake switch and warning lamp. If your diode fails short as a temporary measure disconnect the white/red from the diode, as the connector on that wire is insulated. If you remove the green/orange and don't tape it up you are more than likely to blow the green-circuit fuse. Part number AAU5034A available from several of the usual suspects, but you can replace it with any 1 amp 100v diode, with suitable male and female connectors on tails, connected the right way round!! Diodes usually have the positive end marked with a white band or '+' sign, this end connects to the green/orange wires and so needs a female spade connector.

October 2016: Roger also points out that the same problem can occur when you aren't even in the car, from a slightly different cause, and that is when the seat-belt module fails in a particular way. This has connections to both the purple circuit (fused always live) and the white/red starter solenoid circuit. If a fault develops inside the unit, or from faulty wiring, that connects the purple and the white/red wires together, then the starter solenoid will engage. The engine will try to start, as with the same sequence of events as above the ignition system will be partially powered, and as if thing weren't bad enough if left in gear the car will try to crank itself along. This usually damages the starter motor at least, and is a good advert for having a battery cut-off switch - and turning it off when garaged if not at other times. Roger does say that other components like the ignition switch or starter relay and wiring can cause the same problem, but that won't happen in the middle of the night. Oh contraire! Maybe not the middle of the night, but some years ago a neighbour's ancient Transit van started cranking while parked - left in gear, and crossed three front gardens before we could get hold of him to stop it.

Fault Diagnosis:

US 1968 circuit: If the light doesn't work from either the test switch or the balance switch either the 12v supply from the purple circuit is missing or you have two or more faults like power supply, earth supply, bulb blown, switch(es) faulty. If it lights from the test switch but not the balance switch either the balance switch is faulty or the wiring between the two is faulty. To eliminate this last possibility disconnect the wiring from the switch and connect a known good earth to the wiring connector. If it lights from the balance switch but not the test switch either the earth supply to the switch is faulty or the switch itself.

US 1969-75 circuit: If the light doesn't come on from either the test switch or the balance switch either you have two or more faults like power supply, earth supply, bulb blown, switch (es) faulty, or there is a disconnection in the wiring between the balance switch and the warning/test panel. If connecting a known good earth to both black/whites at the switch/light panel doesn't light the lamp either the bulb is faulty, it isn't making good connection with the bulb holder, or there is no 12v supply to one side of the bulb. If that works but not if you earth both black/whites as the master then there is a break in at least one of the black/whites between the master and the switch/lamp panel. This could be at the multi-plug behind the dash (later cars) or a pair of single connectors in the black/whites (earlier cars). If that works, link the two black/whites in the plug that goes on the balance switch and try the test switch. If that works the balance switch is faulty or not being operated by the shuttle valve inside the master. If the test switch still doesn't light the lamp the switch itself could be faulty, or its earth supply, or there could be a break in its black/white between the test switch and the balance switch connector. Note that the balance switch will only light the warning lamp if it is attached to the master, or has an alternative earth provided to its body. It won't light the warning lamp if it is removed from the master, even though it has two wires on it. However when the balance switch is removed from the master cylinder, the **test** switch should light the warning lamp as long as the wiring is connected to the balance switch and the rest of the circuitry is correct.

US 1976-on circuit: This circuit works 'the other way round' to the earlier circuits by extending a 12v signal from the balance switch, handbrake switch or test diode to the warning lamp, which is backed by a local earth. If none of them causes the lamp to light either the bulb has blown, its local earth is faulty, or the green/orange wire to it has a disconnection. If the handbrake switch lights the lamp but cranking (handbrake down) and balance switch do not then there is probably a disconnection in the green/orange between test diode and handbrake switch. If the handbrake and cranking lights it but the balance switch does not then either the balance switch is faulty, the green orange between it and the test diode has a disconnection, or the green 12v supply to the balance switch is disconnected. If the balance switch lights it but either or both of cranking or handbrake do not, then in the former case the test diode or its white/red connection to the starter relay is open-circuit, and in the latter the handbrake switch is faulty, incorrectly adjusted, its local harness disconnected, the green 12v supply to it disconnected, or something is preventing the handbrake from fully returning to the 'off' position.

UK 1977-on circuit: This circuit works 'the other way round' to the earlier circuits by extending a 12v signal from the handbrake switch or test diode to the warning lamp, which is backed by a local earth. If neither of then causes the lamp to light either the bulb has blown, its local earth is faulty, or the green/orange wire to it has a disconnection. If the handbrake switch lights the lamp but cranking (handbrake down) does not then there is probably a disconnection in the green/orange between test diode and handbrake switch. If the handbrake lights the lamp but cranking does not then the test diode or its white/red connection to the starter relay is open-circuit. If cranking lights it but the handbrake does not either the handbrake switch is faulty, incorrectly adjusted, its local harness disconnected, the green 12v supply to it disconnected, or something is preventing the handbrake from fully returning to the 'off' position.

Brake Hoses

As brake hoses deteriorate flaps of rubber can start to become detached inside the hose and act as a check-valve. This can either reduce braking effort on one side, or cause the caliper on one side to stick on. If slackening the bleed screw on the stuck side causes a spurt of fluid after which the disc can be rotated, then the hose should be replaced. If there is no spurt of fluid, or only one piston of the pair is sticking, then the caliper itself is suspect.

Should you fit steel braided hoses? "If they are good enough for aircraft they are good enough for my MGB" well, yes, but only if you are going to replace them on a routine basis like they are on aircraft - you can't see what is happening to the rubber under the stainless braiding! (However I was assured when buying a set (not by choice) in 2013 that they are not rubber but Teflon and shouldn't degrade). They may well give a harder pedal by not swelling under heavy braking, hardly a factor in road cars I would have said (and if you have silicone DOT5 brake fluid that is more compressible than any of the non-silicone types).

Brake Pads

Retaining springs:

The pad retaining springs on both 4-cylinder and V8 calipers are 'handed' in that the fingers on one side are longer than the other. They can be made to fit either way, but the correct way is with the longer fingers on each retainer facing each other.

V8 pads:

V8 pads are handed, but not 4-cylinder pads. Not right to left, but inner and outer. The pad almost fits in the 'wrong' half of the caliper but not quite, and it is very annoying when you buy a set, get them and home and start to fit them, then discover you have three inners and one outer as has happened to me!

Brake Pipe Change

May 2013

For a while now I've been aware of Vee's right front brake pipe being rusty (the left front looks like it had already been changed) and last year I got an advisory on it, so decided to change it before the MOT this year. Came off OK, but straightening out where it passes under the chassis rail to remove it maintaining as much of the shape as possible to bend the new pipe to match, it cracked where it was obviously paper-thin. The new pipe went in OK with almost nothing lost from the union, and that was where the problems started!

Went to undo the caliper bleed screw and it was stuck fast, I could tell it was twisting. Tried releasing fluid - no go. Took it off and went to Halfords where they go some heat on it - still no go and it sheared. Back home I drilled the old one out, increasing the drill size bit by bit (no pun intended) hoping to get to the point where I could remove the remainder without damaging the threads, but by the time it did come out I had removed the top of the threads on one side of the hole. It **might** have been OK, but I didn't want to risk it, so I'll have to spring for a new one. Better check the other side, and that is exactly the same! Very annoying as I'd replaced these myself in 1997. So two calipers required, and might as well change the hoses as well even though I'd also replaced them in the past. Heavy items so cost is an issue, but I was going over the Shropshire in a couple of days so a detour to Clive Wheatley was the best way. Clive didn't have standard brake hoses but did have braided Teflon at not that much more as they were old stock.

Right-hand caliper and hose goes on OK, but although I can undo the pipe nut from the hose end on the left side, the nut is seized to the pipe, so I've had to unscrew the caliper and the hose from the pipe rather than the other way round. I could screw the new ones back on the same way, but might well end up with a twist in the hose, so decide to replace the left front pipe as well (this is getting into Shipwright's Disease territory). And of course the screw that holds the clip to the inner wing is seized and has to be drilled out, whereas both screws under the chassis rails where the clips were more rusty came out OK. Subsequently with the pipe held in a soft-jawed vice I can tap the nut up the pipe and free it up, so that is ready to be used as a spare, probably many years hence! Eventually I get pipes, hoses and calipers fitted both sides, and as the braided hose kit came with the rear hose as well decide to try changing that. And of course the main line to the union on the rear axle is also seized to its pipe! But as that doesn't need changing (yet!) I decide to leave that for another day as Vee has been out of action for several days already. So time for bleeding, and that is where more problems started.

Bled low-pressure first, all four corners, longest to shortest, which left a long and spongy pedal as expected. Got my assistant to stand on the pedal as usual while I opened and shut each caliper nipple, but instead of more air after which the pedal is as it should be as in the past I just get fluid, and the pedal is no better. Do the same at the rears, with the same result. Same at the front again, still the same result. Getting a bit annoyed now, so leave it to ponder a bit, and remember some people recommend wedging the pedal down overnight. Do that and next morning it seems OK, and on a short test drive, but next day it is as bad as ever. Thinking about the theory behind wedging the pedal, I wonder if it is that under pressure any air bubbles will be compressed and knocked off the wall of the pipe, to float to the highest point. If this is the loop of pipe right by the master, then perhaps the back flow on releasing the pedal flushes them into the master and then the reservoir. So this time I jack the front of the car right up, and wedge the pedal overnight again. Next morning it is much better, but still a little long and a little spongy, and without the initial bite that I'm used to on both cars. This may be because of the new calipers - perhaps the pads having the bed-in again, I did notice the old ones had the cut-outs in the piston facing a different way to how they should be (facing towards the stub-axle) on at least one of them. I decide to leave things how they are and see what happens, and after a couple of weeks either I've got used to it or they have got back to normal.

Brake Squeal

Brake squeal seems to have been a problem for the last 30 years. When I started getting it the word in the industry was that different asbestos was being used which had a lower wax content. Whatever, even anti-squeal shims and caliper piston cut-outs aren't guaranteed to cure it. I put a very thin smear of grease on every metal-to-metal contact point of pads/shoes, shims, pistons, calipers, back-plates etc of both front and rear brakes and it seems to do the trick. Just once when first fitting new pads seems to be enough, but at every service for the rears. This used to cause some amusement amongst my friends many years ago but now one can buy brake grease for this very purpose. Be very careful not to get any on the friction material, discs or drums though. Generally successful for many years, I started getting one rear brake squealing on Bee which was very annoying on club runs with lots of short distances between turns. Greasing the shoes as above only worked for a short time and it came back. Eventually I swapped the shoes between the sides and the squeal went and hasn't returned so far after several years and thousands of miles.

After replacing Vee's calipers in April 2013 above I refitted the 'old' pads as they were nearly new, and after a short while started getting squealing from them. It started getting worse, so I removed the pads and greased them as I would new pads, and all seems OK since.

August 2014: At least, I thought it was. I've had to regrease them again since then, and now it is doing it again, in stop-start traffic they can really shriek. Googling brings up loads of problems and not a few remedies. One is chamfering the edges, and indeed when replacing the ZS discs and pads I was surprised to see a huge chamfer at a shallow angle and for more than half the thickness. A couple of YouTube videos showed people putting a chamfer of no more than about an eighth of an inch on them, which didn't seem much use to me. So I took mine out and using an angle-grinder cut a 45 degree angle for about half the thickness (still barely worn) on just the leading edge. I say 'edge' but it's radiused, so I cut the chamfer to the same radius. I checked the anti-squeal shims for orientation, and the cut-out was towards the leading edge, which is logical as that should mean the piston puts more pressure on the trailing edge. But note that with the V8 because the pads are handed - inner and outer - and the shims are also handed, you cannot get them facing the wrong way. However I did notice that the leading edge seemed to be worn more than the trailing, which goes counter to the logic of the shims, but then maybe they would have worn even more without them. The cut-outs in the pistons were facing the spindle as given in the manuals, but even that varies, sometimes even for other classic MGs, where recommendations can be that they should face down in the MGA but the other way in the Midget! (MG-Cars.net, about 3/4 the way down).

The backs of the pads were still well (copper) greased, but I did notice that the side edges of the backing plates were very shiny, so it's quite probable it's that part that is vibrating against the caliper. Nevertheless I didn't regrease them as I want to check the efficacy or otherwise of the chamfering. Reversed off the drive and a slight squeak when I braked, but then I had only chamfered the leading edges. After a couple of miles no squeaking, whereas unmolested they had been squealing within yards at the end of the road, and at the road humps and the end of the next road. However back again and pulling up outside another slight squeak, so the jury is still out. If that doesn't work there is talk of using specialist adhesives (but they only seem to be available from America with horrendous postage), or adhesive shims in place of the standard metal ones, or it might be 'Wurth' trying a specialist brake paste.

After just a couple more short journeys they are squeaking as bad as ever so chamfering is no good. Rather than use the Wurth paste which is just a different type of lubricant, I did more research and found these self-adhesive 'shims' to replace the metal shims (see also Mintex and EBC alternatives). Removed (but kept!) the metal shims, cleaned all the grease off the pads with brake cleaner, used the pad as a template to cut the self-adhesive shims to size, peeled off the backing, and stuck down. Refitted and wheels back in about an hour. First journey of a few miles on local roads to a pal's house was blissfully silent, but then leaving his house they were at it again at the end of his road. After another local journey they are as bad as ever - squeaking occasionally but when they do it is pretty loud.

So the next step is to use the offcuts from the self-adhesive shims to stick onto the trailing edge of each backing plate, the principle being to cushion that from the face of the caliper that the pads are pushed against under braking. The left hand pads have the shiniest edges, which is interesting given that the squeal seems to be coming from that side, and when I'm turning the wheel to undo the nuts it's even squeaking slightly then. A strip on the worst edge still leaves the pads a little loose in the calipers, so I put some down the leading edge as well, which makes them snug. Back on the road and less than 8 miles round local roads and they are squealing again!

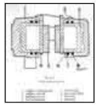
Next step is to try some CRC Disc Brake Quiet, which is reputedly a 'Paste that cures as a tough rubber. Prevents and stops disc brake noise and vibration.' However a few more trips with the self-adhesive shims and strips shows that squeal is only happening occasionally, and not as loud as before, so I'll leave things as they are for a while. And eventually I realise they are not squealing any more.

November 2016: Still quiet. But two more possibilities have come my way recently.

- The first is heat: One pal's squealed badly after trying everything above except the Bremtech shims and the CRC stuff, until someone suggested driving with the brakes applied very lightly to warm them up, and after that they didn't squeal. Interesting, but not very practical.
- The second came from an AA technician, who made some alloy shims to go between the pistons and the pads, and with new pads that stopped the squealing as well. However really he should have put the shims in with the old pads, or tried the new pads without the shims first. As it is, the pads themselves could have been the cure, so the jury is still out on that one. But someone else with the problem despite copper grease and soft shims is also trying it and will let me know.

Calipers & Discs

When exercising and polishing the pistons solved a problem
And when it didn't *Added May 2009*



Cross-section of a caliper from the Leyland Workshop Manual. As fluid is forced into the caliper it pushes the pistons out, which press the pads against the disc. Unlike wheel cylinders the seals are retained in the caliper body. As the piston moves out it tends to pull the seals with it a little and distort them slightly. When the fluid pressure is released the seals tend to return to their former position, pulling the pistons with them, so releasing the pressure of the pads against the disc.

When I changed Keith's clutch a week ago I'd noticed the car pulling quite strongly to the right on braking, but hadn't realised his MOT was so close, and it failed on that and emissions. Pistons and seals are £40 for a full set but I really don't like fiddling with caliper internals (I'd opted to swap Vee's calipers outright when she had a similar problem), and complete calipers were £40 each (not bad considering the clutch slave was also £40). So we thought it worth trying to clean the pistons up a bit and exercising them in and out. The inner piston on the right-hand caliper was very stiff as was the outer piston on the left-hand. I took the pads out and although there was plenty of meat on three of them I noticed the material was crumbling away, something I hadn't seen before (before Bee's caliper stuck on, that is). The 4th pad had worn quite a bit more and at an angle. Also noticed the left-hand disc was pretty new whereas the right-hand looked original and noticeably thinner. One caliper may also have been changed previously as only the right-hand caliper had the cut-outs in the pistons. I wedged a block of wood between the disc and the fully retracted 'good' piston so I could lever the 'bad' piston in without distorting the disc too much. Pumped the 'bad' piston fully out, then dipped some coarse twine in brake fluid, wrapped it round the piston and pulled the string back and fore to scour the surface of the piston. Also dribbled a little fluid round the edge of the seal, then started working the piston in and out several times. Both 'bad' pistons noticeably lightened up to something much closer to the 'good' pistons. Cleaned off any excess brake fluid from the pistons and refitted the pads, using an old one from Bee that had plenty of meat on it in place of the badly worn one. On a test drive it was much better, but still pulled very slightly to the right under heavy braking when not holding the wheel. So I decided to clean the 'good' piston on the left-hand side as well. Might have been slightly improved after that, but still pulling very slightly. I know there is a limit of imbalance but had no idea how close it was to that limit, but Keith thought it worth a punt at a retest, and it was declared 'fine' so many of Keith's quids saved. Before that I also reset the carbs, which seemed very close in both balance and mixture, but I did weaken it by an 1/8th turn which showed as about 3.9%CO on my Gastester and 3.8% on the retest and also OK (limit being 4.5%). He does need new pads though, and the rear brakes looking at as the pedal is a bit 'long' for both our tastes, so that will probably be the next job.

Caliper and Disc Change *Added May 2009*

On the way home from the Yorvik Run we tanked up about 2/3rds the way home and after that Bee didn't feel right - pinking much more than she had been all weekend (none at all on the way up) and seemed to be holding back. In a town and some stop-starts on slight inclines although Bee would roll it wasn't as freely as normal, and I had a couple of whiffs of hot metal. One could be someone else, two is worth investigating, and I found the left front hub a bit warm, disc blued (used to smoke them) and smelly. Jacked up the wheel and found it was definitely dragging more than it should, although it loosened up when I banged on the side of the tyre, and the pistons weren't seized. Took it steady the rest of the way home (40 miles or so) to find it as cool as the other side when we got back home. Next day jacked up both sides to compare and the left side is definitely dragging more after the brakes have been applied. Took the pads out that side and the edges are badly crumbled, and although I pump the pistons all the way out and all the way back in again, polish them and there is no corrosion, that side is still dragging after applying the brakes. As it looks like the dust seals are breaking up (bits of rubber sticking up) I decide to replace calipers, discs and pads both sides. Leacy are doing rebuilt exchange at £39 each, so half an hour sees both sides off, hose clips on hoping to reduce bleeding effort. With new discs, pads and lock-tabs the bill comes to £119, pretty reasonable I reckon and not worth the hassle fiddling with pistons and seals.

As I'm changing discs first job is to remove the hubs. Pull the grease seals off, remove the split pin and nut. Pull the hub and disc forward and tip it outer face down and catch the outer bearing, shims and outer grease seal, put them in a safe place to keep them clean. Now for the struggle to undo the disc to hub bolts. I did this once before when swapping the discs over from Rostyle hubs to wire wheel, and it is tricky. Both are 9/16" but the nut really needs a long-reach socket as the wider diameter needed for the 1/2" drive fouls the edge of the taper the wheel sits against. But that is nothing compared to the bolt heads, which are recessed, and only have a very small clearance to a raised portion of the disc, and really need a thin-wall socket, a standard socket only goes about half way on. Although the new discs have more clearance it is still too tight. Add to that the problems of putting a lot of torque into the nuts and bolts to undo them, and you really need a jig of some kind to keep both sockets square to the nut/bolt, particularly the bolt, as well as press the bolt socket onto the head. Eventually I managed to get them all undone, changed and torqued back up again using a foot holding a tommy-bar on the bolt socket onto the earth, one hand pressing the bolt socket onto the head, and the other hand using a torque wrench as a breaker bar on the nut, 40-45ftlb. One of the old discs is about half the thickness of the new. The other is much closer, perhaps that had been replaced by a PO.

No grease came out of the bearings i.e. from excess heat but nevertheless I squeezed some more into the back of the inner bearing while it was still in the hub (retained by the grease seal) and pressed some into the outer bearing while it was still out. Reassembled it all, torqued up to the minimum of 40ftlb, and checked the endfloat was still OK. I found both split pin holes ready lined up so didn't need to tighten any further (maximum 70ftlb), fitted those, and the grease caps. I just used large pliers and wiggled to get these grease caps off, but have an idea of using a 1/4" UNF nut welded to a short length of tubing with a screwdriver or something to lever them off, and used as a drift to tap them back on.

Next the calipers go back on. Something to watch here is that unless the flex hose thread starts in exactly the same place on both old and new calipers then when the hose is tightened down the caliper won't be at the correct angle to attach to the swivel axle, and forcing it will put a twist in the hose. If you are replacing hoses as well this isn't an issue - you would fit the hose to the caliper first and then to the body bracket and pipe, but I've changed mine not that long ago. One of mine was as bad as it could be at 180 degrees out, the other not so bad at 90 degrees. Fortunately the other end of the flex hose is easy to get at, unlike the clutch! Support the caliper on a block, slacken the locknut on the hose, use one spanner on the fixed nut on the hose and another to slacken the nut on the end of the pipe, then carefully twist the hose relative to the pipe until the caliper lines up again. Unfortunately a little fluid seeps out, let's hope not to much air has got in. Tighten the nut between pipe and hose and loosely fit the caliper with its bolts and new locktab, turn the steering from lock to lock to make sure the hose clears the side of the damper mount, making any adjustments to the relationship between pipe and hose as required. Torque up the caliper bolts to 40-45ftlb and bend over the lock-tabs.

With the thicker discs and new pads, although the pistons are well back into the calipers I have to press them back all the way before I can get the pads in, doing a trial fit first. When they fit I smear a little copper grease on the backs (no anti-squeal rubber on these I notice) and on the edges of the back-plate where it contacts the caliper and retaining springs. Note that the springs are 'handed' in that one pair of fingers is longer than the other, so they have to go round a certain way. The Leyland Workshop Manual shows the longer fingers facing towards each other (confirmed), the Haynes drawing shows them the same length so is no help, and you can't tell from the photo! I can't remember which way round I put mine but one way seemed more logical and a better fit than the other. Just bend the long end of the split pin back about 45 degrees, that is more than enough to keep them in. One tip when inserting them is to turn them so the short end of the pin is facing towards the pad, locate the long end over the spring, then rotate the pin 180 degrees and that will depress that side of the spring so you can push the pin across to the other hole. Then fit the long end of the pin in the other hole, rotate 180 degrees again, and that will compress the other side of the spring and allow you to push the pin through the second hole. Just a bit easier than trying to depress the spring on its own.

Now for bleeding. I've still got the hose clamps on, so I open the bleeder on the driver's side (easier to get at the air hose connection to a wheel), set up the EeziBleed, lower the air hose down through the engine compartment rather than draping it over the wing, slide a wheel with the pressure reduced to about 15psi partly under the body, and connect the air hose. There is some hissing which is air leaking from the EeziBleed bottle cap. This has always been a problem with mine, and overtightening causes the seal to pop out which leads to rapid deflation of the tyre, so I live with it. What **is important** is that you have a good seal where the EeziBleed cap attaches to the master. If this leaks fluid will completely fill and overflow the cylinder. Fit a drain hose to the caliper bleed nipple directed into a jam jar, and release the hose clamp. Pretty soon fluid comes out, a few tiny bubbles and that is all, so I close the nipple and release the air hose. Round to the other side, and this time I have to bleed a lot more fluid at as every couple of seconds a large bubble of air comes out. When none come out for a few seconds I close that nipple, although in the meantime I have had to top up the EeziBleed bottle with more fluid, which means disconnecting the air hose and reconnecting it again. Check the pedal and it is its usual after any brake work and that is a long pedal that pumps up, but goes long again when released for a few seconds. So get the Navigator installed in the car with pressing down as hard as she can on the pedal, while I open first one side then the other. Nothing comes out the drivers side, but two or three inches of air comes out of the passenger side, so we do that side again and this time it is OK. Check the pedal and it is as it should be. The passenger side was the one where the hose had to be rotated 180 degrees relative to the pipe, and it took a bit of fiddling to get the angle right going from lock to lock, so I suppose that let more air in than on the other side.

Wheels back on, go for a test drive on a beautifully sunny afternoon, and all is well.

Update March 2010: Oddly exactly the same thing happened to a pal the same year, but for health reasons he was unable to do the job himself and asked me, and what with this last winter it's taken until now for the weather to be suitable for working outside. Interestingly his

old discs had more clearance to the bolt heads even though the sides of the well were unmachined casting and a socket fitted right on for removal. I'd taken a large bench vice up with me to grip the discs while we were wrestling with the bolts and that worked well. But the new discs were the same as my new ones (same source) i.e. even though the very bottom of the sides of the well were machined it wasn't machined back as far as the casting surface so again I had problems getting a socket on the heads. I then had a brain-wave and remembered I had some old box-spanners inherited from my Dad (which I hadn't used since I got a socket set well over 40 years ago) and one of those fitted a treat. These fit better as they don't have a circular outer surface like a socket, and if you align a bolt head flat with the side of the disc the flat on the box-spanner fits into the space available. Other than that the only other problem was I couldn't get the old brake hose (fortunately had already planned to replace those as well) out of the left-hand caliper and the new hoses didn't come with copper washers. Cost-cutting like this is ridiculous, but fortunately my pal is a hoarder like me and had a spare. Back home a bit of heat, Plus-gas and a couple of whacks with a hammer and chisel got it moving. Other than that the job went very well, starting at 10am done by 3:30, including greasing the kingpins and topping-up the dampers. Another brain-wave was that to stop fluid draining out of the master while the hoses are being replaced, rather than fiddling about putting polyethylene over the master filler (which never seems to work) is to wedge the brake pedal partly down. Once the piston has moved far enough to cover the bypass hole i.e. starts applying pressure no fluid can drain out of the reservoir. Unfortunately I didn't think of this until after bleeding, so it remains a theory to be tested. Bleeding went exactly the same as on my two cars - low pressure on an EeziBleed gets the main air out but leaves the pedal spongy, then applying heavy pressure to the pedal while each caliper nipple is rapidly opened and shut a couple of times blasts any remaining air out and after that the pedal is good. However on the test drive it was obvious something was still dragging, which proved to be both rear wheels. Whilst the car had been unused for six months, it had been in a nominally dry garage with the handbrake off, so they weren't rusted on. Unfortunately the adjusters were also very stiff, so nothing for it but to strip, clean, grease and rebuild both assemblies which was done in about an hour, so pretty good going. The worst side did show droplets of moisture on the outside of the wheel cylinder which proved to be water, so I suspect the linings had absorbed moisture and swollen to jam on to the drums. Free now, when the car starts to be used on a regular basis again they may well shrink back down so need readjusting.

V8 disc change April 2016:

For some unknown reason I decided to change Vee's discs. Much the same as before, except the new ones had an even greater problem holding the bolt heads still while torquing up the nuts. These are machined much deeper than the originals, almost the full height of the head, but with not enough gap to get even my old box spanner on them. I had to wedge the flat blade of a screwdriver in the gap. However the gap on the second disc was even less, so there wasn't enough space for the flat blade to go in far enough to be gripped. A second smaller screwdriver proved to be too thin and turned round with the bolt head, a third one was just right - Goldilocks eat your heart out. A thick washer would raise the head enough to get a socket on, but would need a longer bolt to have the same number of threads protruding. Nevertheless with repacking the outer hub bearing each side took no more than a couple of hours.

Dual-line Plumbing *Added September 2011*

A lister has queried the connection of the brake pipes to the dual-circuit master with servo as depicted by Moss (US and Europe) and Victoria British. This appears to show the rear circuit being connected to one of the ports nearest the driver, the right-hand front caliper being connected to the other port nearest the driver, and the left-hand front caliper being connected to the port nearest the front of the car, with the two ports on the master nearest the driver being the same circuit. This is quite wrong, and could well throw your car into the nearest hedge or even worse oncoming traffic if you braked hard and either circuit failed. Brown & Gammons and MGOC are even more confusing with the rear circuit being Teed with the right front off the front port, the second port going to the left front (with the same effects as above on circuit failure), and an unlabelled component being connected to the third port.

The correct way is for both front calipers to be connected to the primary circuit which is the one closest to the pedal, and for the rear brakes to be connected to the secondary circuit which is the single port furthest from the pedal. This is for both early and late dual circuits, the only difference between those being that the primary circuit is furthest from the driver on the early system, and closest on the later.

E-clip Fitting

Which way round does the clip go?
I've never seen it pictured or described, but one way does seem more logical than the other. Part fitted it seems that the curved sections between the tabs should be up against the back-plate. Then when the tabs are pushed into the slot, which will tend to flatten the spring-shape of the clip, the clip will be pulling the cylinder firmly against the brake side of the back-plate.

April 2015: Needing to change yet another wheel cylinder on the roadster, I was pondering the E-clips. Some years ago I made the tool below which made fitting them pretty easy, but on the previous roadster wheel cylinder the nut wouldn't turn on the pipe, so I had to remove the bleed nipple and unscrew the wheel cylinder from the pipe. Still couldn't free the nut, so to fit the new wheel cylinder I had to reverse the process, which meant I couldn't use my tool, and it was the usual cussing fiddle to fit.

These can be a real pain to fit trying to keep them lined-up while pressing the tangs over the boss on the wheel cylinder, only to have them ping off somewhere never to be seen again. I know some have resorted to circlips instead of E-clips, but one of the functions of the E-clip is to pull the wheel cylinder to the back-plate with spring pressure which stops it rattling around. But it occurred to me that I might be able to use a pair of outside circlip pliers to fit an E-clip, and so it proved. Even though mine are straight pliers so the U-bolts get in the way a bit (angled pliers would probably have been even easier) by reaching round the back-plate with my hand, using thumb to press the wheel cylinder against the back-plate, and a finger to angle the E-clip in the pliers so it was square to the wheel cylinder boss, squeezing the handles to open out the E-clip just enough it slipped on as easy as anything. Once on the boss just finger pressure is needed to push each tab into the slot. Probably took me less time to do than write this.

Prior to discovering the circlip plier trick I saw a feature in the MGOC magazine describing a tool to fit them, but at £15 I thought they were a bit pricey for all it seemed to be. I subsequently found a similar tool to a slightly different design at almost half the price of the MGOC item (since vanished), but by this time was intrigued enough to see if I could make one, even though fitting these clips isn't an every-day occurrence. After some thought and rooting around my stock of nuts bolts, washers and plumbing bits I assembled this tool which makes fitting the clips a doddle in seconds. See here for how I did it.

Fluid *Added October 2009*

Fluid Loss

Someone on the MG Enthusiasts bulletin board asked about DOT 5 brake fluid. Wanting to confirm to myself that this was in fact silicone fluid, I Googled it and the first (non-sponsored) result was an article from American Auto Club UK. Basically this says whilst it was originally used because it had a higher boiling point than DOT 3/4 fluids and didn't absorb water, Super DOT 4 developed since is preferable. Furthermore it says if you do convert **don't** flush you systems with spirits as they are known to cause system failure, but unless the system is completely clear of DOT 3/4-contaminated sludge it will react with DOT 5 to cause a gelatin-like crud which will attract more crud and block orifices, and you will never get the silicone of DOT 5 out of the system in order to change back. So you are damned if you do and damned if you don't. It also says the American Military are the only major users of DOT 5 now, and have asked the SAE for a way of changing back, and if they stop using it DOT 5 will go the way of leaded fuel. There are any number of pages on Google (except from suppliers selling silicone-based fluid!) saying much the same thing. Halfords don't stock it anymore, just DOT 4 in vanilla and Super flavours, and Haynes for my 2004 ZS180 specifies these and not DOT 5 - I always knew not following the herd and changing to DOT 5/silicone was the right thing to do :o). Confusingly the spec for Super DOT 4 i.e. glycol-based like DOT 3/4 is DOT 5.1, even though DOT 5 isn't compatible with it! Why the powers that be didn't call it DOT 4.1, or even DOT 6, is a mystery. And ironically, even though silicone fluid doesn't absorb water, it doesn't mean there isn't any water in the braking system. What there is will just sit there as a lump of water alongside the fluid. It will still boil and kill the brakes, and it will still cause corrosion. In fact according to some sources silicone/filled systems need **more** frequent flushing than non-silicone. Silicone readily aerates (one source claims a trip from the shop to home on a motor-bike is enough to cause problems unless it stands overnight), which causes a spongy pedal, and it cannot be used with ABS as it gives inadequate lubrication to the ABS pump.

Updated September 2016: This page from Advance Petroleum gives information and a warning about brake fluid colours as follows:

> Brake Fluid DOT 3 is available in clear, Pale Yellow, Blue & Crimson Red colour, similarly brake fluid DOT 4 is available in Clear, Pale Yellow & Crimson Red colour, brake fluid DOT 5.1 is available Clear, Pale Yellow & Blue colour. Brake Fluid DOT 5 is available in Purple & Violet colour so colour is not a criteria to distinguish between the different types of brake fluids.

It also gives the following warnings about DOT 5:

> It absorbs more air and giving poor pedal feeling. It is unsuitable for racing due to more compressibility under high temperatures. If as little as one drop of water enters the fluid, severe localized corrosion, freezing or gassing may occur. This can happen because water is heavier and not mixable with silicone fluids thus it is unsuitable for ABS.
>
> DOT 5 fluid is highly compressible due to aeration and foaming under normal braking conditions, providing a spongy brake feel.

Updated December 2009: I see quite frequent references to Castrol LMA as being the best fluid to use. This is non-silicone and so theoretically compatible with DOT 3, 4 and Super DOT 4/DOT 5.1 but not DOT 5. It's said to have lower water absorbency than DOT 3 or 4, and a similar boiling point to DOT 5 silicone and Super DOT 4/DOT 5.1, so after that it comes down to price and availability. Whilst Google has loads of references to LMA it is almost all club and list talk, no suppliers that I could see in the UK, and only a couple in the US.

Updated January 2010: DOT 3 still seems to be available, however it has a significantly lower boiling point than even DOT 4, let alone DOT 5 and 5.1, additionally damages natural rubber seals, and still damages paintwork. It's advantage apparently being it is cheap! Given that most peoples usage is surely minute, I can't believe people would choose to buy it over DOT 4 just to save a few pence. But then Wikipedia (yes, I know I know) claims most cars produced in the US as of 2006 use DOT 3! And another update, apparently Super DOT 4/DOT 5.1 and Castol LMA are both harmful to paintwork.

> *Update December 2017* That was subsequently corrected to DOT4, so my "yes, I know I know" was well founded. Even so, it implies that American-produced cars up to 2006 may well have had DOT3, and it goes on to say that cars originally supplied with DOT3 may be OK with DOT4 and DOT5.1 if the elastomers (i.e. rubber!) are not harmed by the additives used to raise the boiling points of the later fluids. People in America tell me DOT3 is still very common there, and the implication of the 2006 date is that DOT3 was in common use for new vehicles up to then. There are stories going round there that it is British cars that need DOT3 to avoid destroying natural rubber seals, but I've been using DOT4 for nearly 30 years in my 73 and 75 MGBs, so far from British cars needing DOT3 it is more likely to be American cars.

April 2013: If anyone is still wondering whether to change to silicone or not, they might like to read this from AP Lockheed:

> **Silicone brake fluids - beware**
>
> A comment by Brian Smart, Service Technical, AP Lockheed:
>
> Our technical service department is receiving an alarming number of calls from motorists reporting problems with silicone fluids. AP Lockheed neither markets such fluids nor recommends their use with our own or any other braking system.
>
> Virtually all the problems relate to long/spongy pedal, sudden loss of brakes and hanging on of brakes. They reflect certain properties of silicone fluids identified by us over many years and recently ratified in SAE publications, namely high ambient viscosity, high air absorption, high compressibility, low lubricity and immiscibility with water.
>
> Research has shown that the relationships between problems reported and properties identified may be expressed as follows:
>
> **Long/spongy pedal**
>
> - Compressibility, up to three times that of glycol based fluids.
> - High viscosity, twice that of glycol based fluids, leading to slow rates of fill and retention of free air entrapped during filling and hence bleeding difficulties.
>
> **Sudden loss of brakes**
>
> - Air absorption - gasification of absorbed air at relatively low temperature produces vapour lock effect.
> - Immiscibility (failure to mix) with water - whilst the presence of dissolved water will reduce the boiling point of glycol based fluids, any free water entrapped in silicone filled systems will boil and produce vapour lock at much lower temperatures (100C or thereabouts).
>
> **Hanging on of brakes**
>
> - Low lubricity - in disc brake systems the sole mechanism for normalisation of system pressure upon release of pedal pressure is a designed-in tendency of seals to recover to their "at rest" attitude. Low lubricity works against this tendency.

> - High viscosity, exacerbating the above effect.
>
> It should not be assumed, therefore, that the high price of silicone fluids implies higher performance in hard driving or even normal road use.
>
> AP Lockheed glycol based fluids do not contain the adverse properties described above. The recently introduced Supreme DOT 5.1, which exceeds the performance criteria of DOT 5, is suitable for all conditions likely to be encountered in modern driving conditions.

Fluid Loss *September 2015*

Brake fluid loss can happen at any time, and is pretty serious in the single-circuit system used in most MGBs. Having said that the dual-circuit system isn't that much better, if the front circuit fails then OK you still have the rear circuit, but that is pretty puny by comparison.

You can get leaks at any time - slow leaks should be visible from regular checks of the master, and may be visible as drips or runs inside the cabin at the pedals or anywhere under the car. Leaks other than at the master should also be detectable as a slowly sinking pedal when you apply pressure - which also happens when the master seal starts leaking back, but without fluid loss. Leaks from the master that are not detectable when applying the brakes will almost certainly run down the pedal (secondary seal failure).

But there is one 'invisible' source of fluid loss that can be very rapid - total loss during a single journey - and that is when you have a brake servo which under certain fault conditions causes the fluid to be sucked into the intake manifold and burnt. This certainly is an issue with the remote master used on single circuit systems, but I'm not sure about the later integral master. Not common, but it does occur, and I have read of a few instances.

I started pondering this nearly four years ago, and came across this commercial fluid level monitor. However at the thick end of £100 (in 2011) and being the tight-wad I am, I felt I could produce something that did the same job.

Handbrake (See here for handbrake warning light on later cars) *Updated October 2014*

Cable
Levers (inside the drums)
Lever Boots
Springs

The handbrake is not, as is claimed in some quarters, an 'emergency' brake, it is a parking brake. Whilst one may well go for the handbrake if the foot brake fails, if you only discover the failure when you need to stop for something then unless you can swerve to avoid whatever it is you are braking for you are doomed. The handbrake should not be able to lock the rear wheels unless the road surface is very slippery, as to do so would cause loss of control by inducing a rear wheel skid. By far the greater braking effort is applied to the front wheels when you are using the foot brake, even with the 50/50 static weight balance of the MGB, because under braking during forward travel the centre of gravity of the car moves forward (the pendulum effect, because the centre of gravity is above the axles. If the axles were above the centre of gravity the effect would be reversed) which puts more weight on the front tyres and takes weight off the rear, so the front tyres are less likely to skid but the rear tyres are more likely. This means that braking with handbrake only even from 30 mph is leisurely, to say the least.

Having said that BL handbrakes were always poor if not given regular and comprehensive cleaning and lubrication. At each 3k service I completely dismantle the shoes and the actuation levers from the backplates and cables. With the cables off you can get plenty of free movement on the levers on the diff casing, make sure these are free and oil the pivots. Also make sure the cable at the handbrake end and the handbrake itself are free. If the cable sheath has a grease nipple then pump some in and work the cable back and fore to distribute it in any case make sure the cable is not stiff or catching in the sheath, which indicates broken strands. Check the wheel cylinder pistons move back and fore and there is no fluid inside the rubber boots. Ensure the pivot on each actuation lever is clean and free, work a little grease in to it and wipe off any excess. Screw the adjusters all the way in (from the back, out from the front) and remove, clean and grease the wedges and adjuster thread. Replace the adjuster, screw it all the way out the back of the backplate (minimum adjustment) then apply more grease to the threads that are exposed on the back, so when you screw the adjuster back to set the shoes a collar of grease builds up protecting the threads inside the adjuster body from water ingress. Apply a thin smear of grease to every metal-to-metal contact point of shoes, actuators and backplates (you can see the rub marks). You don't want great gobs of it that will get on the drums and friction material, just a thin smear. Refit the shoes and springs observing the correct orientation, reconnect the cables, and adjust as described in Rear Shoes.

If I get Bee rolling down my slightly sloping drive then reach in and pull the handbrake on I can easily lock the rear wheels, although not if I'm sitting inside. Vee could also lock them if I really pulled up the lever, although less easily. My MOT man has commented in the past at how good they are, saying most of the ones he tests are rubbish. But since changing Vee's shoes after a wheel cylinder leak (and washing the drums with brake cleaner) the handbrake is almost useless, even struggling to hold it on a bit of an incline at one time whereas I've parked Bee halfway up Hardknott Pass in the past! I've had the shoes on and off several times looking for witness marks from high spots, and rubbing those down a little, but it seemed to make little difference even several thousand miles and a year later. I was bothered it would fail the MOT, but it didn't, and a few months further on it does seem to have improved slightly, but it is still not good in my opinion. Having said that even the roadster and the ZS are spectacularly poor at slowing down when the handbrake is used on its own in testing.

One cause of poor handbrake operation is wear in the notches in the handbrake levers that the shoes sit in. The handbrake is most effective if the shoes contact the drum when the lever the cable attaches to is parallel to the back-plate. As parts wear - or if the wrong shoes have been fitted - the angle between the lever and the backplate increases so reducing its efficiency by reducing the leverage available. In the case of worn handbrake levers the notches can be filled with weld and filed to the correct depth, but new levers are available and not expensive.

Once the rear shoes are correctly adjusted the handbrake lever itself can be adjusted using the nut under the tunnel at the front of the cable. I prefer to be able to pull it up one click without affecting the brakes so as to be sure they aren't dragging when it is fully down. This should give you about five clicks to full engagement.

Handbrake cable: There were no less than 10 handbrake cables for the MGB over its life:

- Banjo axle with stud wheels AHH5227 (77.69", 1,973.3mm)
- Banjo axle with wire wheels AHH5228 (76.5625", 1,944.7mm)
- Mk1 tube axle with stud wheels AHH7391 (78.5", 1,993.9mm)
- Mk1 tube axle with wire wheels AHH7392 (78", 1,981.2mm)
- Mk2 and V8 chrome bumper with stud wheels AHH8450 or GVC1004 (78", 1,981.2mm)
- Mk2 chrome bumper with wire wheels AHH8451 or GVC1005 (77.25", 1,962.15mm)
- Rubber bumper (including V8) to July 76 with stud wheels was BHH1470 now GVC1016 (69.25", 1759.0mm)
- Rubber bumper to July 76 with wire wheels BHH1471 (69", 1,752.6mm)

- Rubber bumper August 76-on with stud wheels was BHH2074 now GVC1014 (69.5", 1,765.3mm)
- Rubber bumper August 76-on with wire wheels BHH2075 or GVC1015 (68.5", 1,739.9mm)

The dimensions given are the overall length from the tip of the adjuster at the cabin end to the bracket at the left-hand wheel end. These and the dimensions of each part of the cables can be found in this Moss document, although they include the statement that they were measured from 'samples', not unused original examples. Also not from the drawing on that Moss document that it is not completely clear where the measurement is to at the wheel ends. The long cable to the left-hand wheel seems to be taken to the tip of the nipple on the cable inside the bracket, but on the short cable to the right-hand wheel it seems to be taken to the back of the bracket. Also on one of my cables from a rubber bumper V8 the short cable length is given as 28", but mine measures 30". However that is nipple tip to bracket tip, cable tip to cable tip is 29". But Moss shows their measurement is taken from the face of the trunnion that the short cable extends from to the back of the bracket, and on that basis my cable is 27". So a huge variation depending on datum points, more than the typical difference between stud and wire wheel axles.

The last two have a steel rod going along the axle to the left-hand wheel instead of the previous cable, and a different compensation arrangement as detailed here. The Moss table has some distinctly odd measurements (as well as at least two errors - item '331-530 MGB GT 74 1/2 on BHH1471 with Disc Wheels' should read 'with Wire Wheels' and is for both roadsters and GTs, and item '331-510 MGB 68 thru 74 1/2' is shown as having an overall length of 69.3mm instead of 1,962.15mm). The stud wheel axles are always longer than the wire wheel (as detailed here), but the overall lengths can differ by as little as 0.25" (rubber bumper to July 76) or as much as 1 1/8" (banjo axle). However these differences could be balanced by differences in length of the sheath and the short cable to the right-hand wheel (but then the differences get even curiouser, for example the banjo wire sheath is 1/2" shorter, but the short cable is 2" longer!).

Why the length changed from Mk1 tube axle to Mk2 tube axle, and from chrome bumper to rubber bumper, can only be guessed at. Mk1 to Mk2 could be the handbrake being repositioned on the wider 4-synch and auto tunnel, but the chrome bumper to rubber bumper change seems an odd one, in that the early rubber bumper cable is fully 8" (wire wheels) or 9" (stud wheels) than the late chrome bumper cable. My first thought was that can't possibly be right, for one thing all of the other changes are only about an inch different, and the axles and the tunnels are surely the same. The only difference is that the body is about 1" higher relative to the axle on the rubber bumper compared to the chrome bumper.

But then I remembered something strange when I replaced the cable on the RB V8. Sometime previously I had replaced the roadster stud wheel axle with a wire wheel axle, and fitted the correct shorter cable. The stud wheel cable was perfectly sound so I kept it, then some years later I noticed the V8 cable rusting and fraying. That has a stud wheel axle of course, and thinking it would be the same cable as the late chrome bumper I simply fitted the 'old' roadster cable to the V8 without comparing the lengths. But there seems to be too much cable looping round behind the axle now on the V8, and if I fitted the supporting clip to the bottom of the axle as per the roadster, the cable hits the bottom of the fuel tank as the suspension moves, so I've had to leave that clip off and let the cable hang down a bit. In the Moss table both the overall length and the sheath length differ by that 8", it can't possibly be that the roadster handbrake is 8" further forward on the tunnel than the V8, so just where the difference is requires further investigation. However I have estimated the roadster handbrake pivot point as being about an inch further forward than the V8. I have had to add a 1" 'shortener' to the V8, which originally I thought was due to cable stretch having previously been used on the roadster, but is probably another effect of it being the wrong cable.

September 2016:

Then, in an idle moment and being in a position to inspect both together, I discovered the reason why the rubber bumper cable is 8" or 9" shorter than the immediately preceding chrome bumper cable - it is simply down to routing:

- The CB cable comes out of the corrugated 'tube' the prop-shaft goes through, takes quite a sharp bend to a clip on the **front** outside corner of the battery box, curves round and back to another clip on the axle bracket for the rear brake flex hose, then continues curving under and across the back of the axle to the compensation lever on the diff.
- By contrast the RB cable comes out of the corrugated tube and takes a significantly shorter and more gentle curve to a single clip near the middle of the **rear** of the battery box cradle, then passes under the axle well inboard of the bracket for the rear brake flex hose, and across to the compensation lever on the diff.

The upshot is that the greasing point on the CB cable is much closer to the outside of the car, almost to a line fore and aft from the damper drop-link but several inches in front of it, whereas the RB cable greasing point is several inches further under the car.

Be aware that wire-wheel hubs, both original and special conversion hubs, can be fitted to a stud-wheel axle, and vice-versa, so going by the hubs/wheels alone is not necessarily enough. An old stud-wheel cable I have (bear in mind this probably has stretched) measures almost exactly 30" from the tip of the nipple at the compensation lever end to the tip of the U-clip that attaches to the lever at the brake drum end. I looked into this following a question on the MG Enthusiasts BBS from J F Demerath who had a new cable, unlabelled, so he didn't know what axle it was for. His measures 28.5" i.e. 1.5" less than mine. That's a bigger difference than you might expect, given that the axles are 2" different, and in theory half that should be in this short cable and the other half in the long cable to keep the compensation lever on the diff case in about the same position. But mine is an old i.e. stretched cable and 1/2" of stretch isn't unreasonable, and his is new, so almost certainly a wire wheel axle cable.

Before fitting the new cable anchor the ends of the inner so as to pull it straight, this makes it easier to get plenty of grease into the sheath using the grease nipple and sliding the sheath up and down the inner, than waiting until it is on the car before greasing.

Cables stretch over time, in fact it is only because they spring a little when you pull them on that the handbrake works at all. Eventually they can stretch so much that there is no more adjustment on the nut and the lever starts going higher and higher before the handbrake holds the car. If the cable is obviously sound and has no broken strands or corrosion it is a waste to replace it, but in the UK at least eventually it will fail the MOT. My V8 cabin lever got higher than I would have liked, and I had run out of adjustment under the tunnel (which originally I thought was due to stretching, but is probably due to it being the wrong cable). Some time earlier I had reused the cable I had taken off the roadster when I changed its axle to a wire-wheel type, when the V8s developed some broken strands, but subsequently discovered late chrome and early rubber take different cables. Looking at the cable the short length of inner from the RH drum ends in a nipple by the diff casing. I removed the nut at the lever to give me plenty of play, then clamped a bracket around the inner between the compensator and the nipple effectively shortening that cable by an inch. This actually moves the end of the sheath to the right about an inch, which pulls an inch of inner out of the sheath, so shortening the cable! I now have plenty of adjustment left at the nut by the lever. The bracket was actually off a handle-bar mirror from a motorbike and was used to clamp the mirror onto the rod that

comes up from the handlebars. As such it was about 1/8" thick with turned-over edges so that even when clamped with a bolt the cable itself isn't clamped tight which could cut through strands, but the clearance is small enough to stop the nipple pulling through, you might get some idea by clicking on the image on the left. You could have a more 'engineered' solution using a thick plate about 1" square, drilling a hole off-set to one side and cutting a slot just big enough for the inner, off-set to the other side. Then a 1" square closing plate with a hole lined up with the hole in the other piece, and a bolt and nut to clamp the two together. It obviously needs to be secure since if the 'shortener' suddenly comes free the handbrake will effectively be fully off, with obvious results if parked on a hill.

1977 and later models have a completely different handbrake cable and compensation arrangement. Both my 73 and 75 have a quite complex and expensive system of levers and bushes mounted on the diff cover. Later models have nothing more than a square piece of rubber bolted between a flange near the left-hand end of the axle and a bracket on the end of the cable outer (*November 2016:* plus a rubber strap supporting the cable from one of the diff cover bolts). The cable inner carries on to the left-hand shoes, and a metal rod goes from the cable bracket to the right-hand shoes. Not only is this extremely cheap, but apart from the rubber eventually breaking there is nothing to go wrong, and the rubber experiences very little stress and movement anyway. The downside is that if you put an early axle on a late car it won't have the bracket for the handbrake cable. You could jury-rig a bracket for the rubber flap, other than that it will mean replacing the cable and obtaining the compensation levers if they didn't come with the axle. If you are going the other way you should just be able to transfer the compensation levers over from your axle to the replacement, and cut off or just leave the bracket and rubber piece.

Handbrake Levers:
Handbrake levers - the ones inside the drums - generate quite a bit of confusion, not to say argument. They are handed, some appear to have 'L' and 'R' markings, but many don't. There were also 'early' and 'late' levers according to both Parts Catalogue and Clausager, changing sometime between April and July 1967 - chassis numbers 123879 to 132463 - depending on the axle (banjo or Salisbury) and wheel (stud or wire) combination fitted to the car i.e. you could have either type on either axle. This is despite some insisting that the early type have to be used on banjo axles and the later type on Salisbury. 'Tuning the MGB 4-cylinder engine' by mgbgt.wordpress.com (page 898) says that they have to be used one way up with the banjo axle and the other way up with the Salisbury, which is also incorrect. The earlier type were 17H 6787 (RH) and 17H 6788 (LH), both NLA according to the parts suppliers I have checked, and the later type are 37H 2005 (RH) and 37H 2006 (LH). Note some sources give the later RH lever as 17H 2005 but this is incorrect.

Clausager says the later ones were 'longer', and this relates to the length of the arm that comes through the backplate and to which the cable is attached. These give more leverage hence greater pressure of the shoes onto the drums, at the expense of more travel of the cabin lever. Up to a point and despite the handing either type can physically be installed to either side of the car on either axle, but that can mean that on the 'wrong' side you may experience any or all of the following problems:

- The long lever fouls the wheel cylinder
- You can't refit the drum even with the shoe and cable adjusters fully backed off
- The drum will go back on but you cannot adjust the cable correctly
- It all appears to go back together correctly, but effectiveness is significantly reduced.

The levers consist of a short lever and a long lever pivoted together. The short lever engages with the rear shoe and has a portion that sticks out through the back plate, then turns backwards at 90 degrees for the cable attachment. The long lever goes from the pivot across the back-plate above the wheel cylinder to the front shoe. Depending on which side you fit the levers, the long lever can either be above or below the short lever at the pivot. The manuals and suppliers drawings appear to indicate that banjo axles have the long lever below the short lever, and Salisbury have them above, but from examples of the two types from banjo and Salisbury axles this isn't the case.

The shape of the long lever on both versions is the same, and in practice the long lever always has to be above the short lever or you get the first two problems above. This is because the long lever is kinked in two places and not flat. Just before the long lever goes through the front shoe there is an upward kink to lift the arm away from the wheel cylinder. Then just before the pivot there is another upward kink to put it above the short lever, which keeps the notched ends of the two levers square with the slots in the shoes.

If these levers are installed on the wrong sides of the car, i.e. so that the long levers are below the short levers, the central section of the long lever will be pressed against the wheel cylinder which will prevent the shoes sitting correctly - if they can be installed at all, and make operation stiff by binding on the wheel cylinder dust covers.

The second problem is caused by a rectangular extension on the long lever at the pivot end which projects past the short lever. Given the curve of the shoes, if the long lever is below the short lever, this extension bears on the back of the shoes and pushes them further out than they should be, which can prevent you refitting the drum. This extension may be deliberate to prevent the levers being fitted to the wrong sides.

While developing this section some people have told me that they found it impossible to get everything back together with the long lever below the short lever, while others have said they did find theirs below and correcting them improved the performance of the handbrake. This includes John Eklof who has the earlier levers on a banjo axle, which would only go back together if the long lever was above the short lever i.e. the same as for the later levers on the Salisbury axle, and not as shown in the various banjo drawings.

So far then, both types of lever have to be installed the same way, as they have the same kinks in the long lever and the same extension beyond the short lever. This has to be such that the central section of the long lever is lifted away from the wheel cylinder, rather than being pressed against it. Also that the extension on the long lever should be clear of the back of the rear shoe, although this will be behind the web so difficult to see. This always puts the long lever above the short lever, with both lever types, on both axle types.

So how come the drawings show the banjo levers the other way up? One has to be careful with drawings as they can be representative rather than exact, and can be taken from documentation of an earlier application, whereas the item itself has been modified for the later application. There are many examples of this throughout the Workshop Manual and Parts Catalogue. Looking at the lever for the banjo axle in the Parts Catalogue, it seems fairly clear that the long lever is kinked up to clear the wheel cylinder, then kinked back down again to pass under the short lever. Also it is very clear that the side of the short lever is rounded by the pivot, and the long lever does not extend beyond it. By contrast the Salisbury lever is kinked up near the front shoe as before, the second kink is not very clear but it has to be upwards again in order to be above the short levers as shown. The end of the long lever clearly has a rectangular extension beyond the side of the short lever.

So did the design as shown for the banjo axle ever exist? It could have been a very early change, with a second change to lengthen the cable attachment point which is the one referenced in the Parts Catalogue or Clausager, but there is no mention of an earlier change. It remains to be seen whether any exist in the field, perhaps on a very early car.

Even with all that, Toni Kavcic wrote from Slovenia with another 'Gotcha' that tripped him up. He had had problems with his handbrake for many years and no-one seemed able to sort it out, until he spotted something in my photos showing shoe orientation and the position of the short lever. Toni discovered his had been on the wrong sides all along, and correcting this solved his long-standing problem. But what did catch him out were the new levers he had purchased. Although the holes and notches were in the correct places the long lever came back too far such that it still fouled the rear shoe and held them too far apart to get the drum on, even when installed correctly i.e. with the long lever above the short lever. Toni had to remove 5-6mm of material from the extension in the long lever at the pivot end to correct it.

NEW **Lever Boots:** *July 2016*

These are probably the worst for poor quality rubber, in a world full of poor quality rubber parts. I replaced both Bee's and Vee's in 2013 and at this year's (2016) service found one of Vee's ripped where it goes over the back-plate hooks and hanging off. The other was slightly ripped where the lever goes through which means it was still hanging on. They were from Brown & Gammons, the news ones are from MGOC but appear to be exactly the same so I doubt they will last any longer. Fortunately they are relatively cheap (£3.60 a pair) and relatively easy to change. It's not too bad if your car only does dry miles, but otherwise if the boot fails and water gets in it will reduce the effectiveness of the rear brakes as well as allowing things to rust up.

Easiest done with the axle on axle stands and the wheel removed. Pull the split-pin out, and if you have regularly greased the clevis pin (can be done without dismantling if you do it when the rear brakes are stripped off then you can waggle the cable bracket back and fore on the lever so it penetrates) tap it up from below then pull it out. Pull the old boot off (if it hasn't already fallen off) and slide the new boot on. It's best now to reconnect the cable to the lever as that pulls the lever away from the back-plate to give you more room to fit the boot over the back-plate hooks. If you haven't previously lubricated the clevis pin, lever and back-plate now is the time to do so! I use copper-grease as that seems to resist washing off better.

However as well as this lever-end having moved towards the back-plate, so has the other one pulling the cable-end with it! So you have to push this lever away from you, and pull the cable-end towards you, in order to get the clevis pin back in. Which needs three hands. But if you wedge this lever out as far as it will go with a suitably sized block of wood, you then only have to pull the cable-end (and the other lever) towards you with one hand, which makes inserting the clevis pin much easier. I reuse split-pins until one end has broken away, others will insist on using new every time, wrapping the ends around the sides of the pin in opposite directions.

With the free end of the lever pulled out of the way it's time to fully fit the boot. Push the slotted part as far along the lever as it will go. The levers have a 'waisted' section just as they pass through the backplate, the slot should be pushed onto here. It could well be that careful filing of this waisted section to remove burrs and sharp edges would help protect the slot in the boot from splitting, at least. Getting the edges of the boot over all four tabs on the back-plate is not easy. Three are, it's the fourth that's the tricky one, no matter which one you leave until last, as that always seems to dislodge one of the others. The only way I have found is to get the top, front and back ones on, then hold the front and back ones in place with a finger and thumb of one hand from above, while getting a small hooked implement under the edge of the boot from below and hooking that over the bottom tab. But I'm sure being able to practice it every two or three years will soon make it easier

Master Cylinders *Added November 2009*

Initial movement of the piston by the brake pedal pushes fluid up into the reservoir via the bypass hole and doesn't apply the brakes. As soon as the primary seal covers the bypass hole further movement of the piston pressurises the fluid in the lines and applies the brakes. As the primary seal continues moving forward and clears the bypass hole fluid is free to run into the space behind it from the reservoir, the secondary seal prevents fluid leaking out the back of the and down the pedal. If the primary seal is faulty pressurised fluid can leak back past it into the space between the two seals, and back into the reservoir, which cases the pedal to sink, a ripped primary seal may develop no pressure at all and the pedal will go straight to the floor (which can also be caused by air in the hydraulics). If the secondary seal is faulty, fluid, even though it is not under pressure, will leak back towards the pedal linkage and run down the pedal.

The final problem occurs when something prevents the piston coming back far enough for the primary seal to clear the bypass hole. Ordinarily simply withdrawing the piston will release the pressure, and any expansion or contraction of the fluid in the calipers, wheel cylinders or pipes from heating or cooling while the brakes are released flows via the master cylinder and the bypass hole to or from the reservoir as appropriate. The problem comes when the piston hasn't come back far enough for the primary seal to clear the bypass hole. If the fluid should heat up and expand while the brakes are released it can't flow into the reservoir as it should, so the fluid pressurises applying the brakes. This can be caused by the mechanical brake light switch (on the pedal cover or by the pedals, not the hydraulically operated switch screwed into the brake pipe manifold) being screwed in too far, or if a master push-rod that is too long has been used. A similar thing can happen if a brake hose starts delaminating and acting as a one-way valve, although that will only affect one caliper or both rear brakes. The two problems can be discriminated between as follows: If both calipers are binding on, and slackening a caliper bleed nipple either side releases both calipers, then it is a master problem. If only one front is binding, and slackening that bleed nipple releases it but not the other, then it is the brake hose feeding that caliper that is at fault. With dual-circuit systems diagnosing the rears is a little more difficult as only one hose feeds both wheel cylinders.

The above drawings have been adapted from a description of how a split braking system master works, click on a red arrow to see it operates. The movement of the pistons isn't as consistent as they show in practice though, only while both circuits have yet to develop any pressure i.e. are taking up free play in their respective circuits. On an MGB the front calipers come off the piston nearest the pedal (which I'll call the first piston), and the rear wheel cylinders off the furthest (the second piston). As soon as pressure develops in one circuit the pistons will move differently. For example if it develops in the first circuit first both pistons will start to move at the same pace until pressure develops in the second circuit. If it develops in the second circuit first then the second piston will stop moving and only the first piston will continue to move, until that circuit also develops pressure. The free play in a caliper is usually

less than in a wheel cylinder, which ordinarily would mean they would start to develop fluid pressure first, but they are a larger diameter than the wheel cylinders which means they need more fluid to travel a given distance. I don't understand why there is a double bypass hole shown in front of the first piston, as the seal would have to pass both holes before it would start developing pressure. It's possible it should be shown **behind** the seal as in the second piston, so fluid expansion and contraction can freely occur in between the two seals on each piston when the brakes are released, as well as in the calipers/wheel cylinders and pipes.

In the MGB system both circuits develop the same pressure, this is so the pressure failure warning device (North American cars only) has equal pressure both sides, unless one of the circuits has a leak. In the event of unbalanced pressure (which could be a caused by a seized secondary piston as well as a leak in either circuit) a shuttle valve is pushed to one side or the other from its normal central position, which operates a switch and lights a warning lamp. The shuttle valve remains offset and the warning light lit (while the ignition is on) until the fault has been repaired and the shuttle valve centralised again. The pads/discs and shoes/drums require different mechanical pressures for correct brake bias, which is always significantly more at the front than the rear, and that comes from the relative diameters of the caliper and wheel cylinder pistons. The need for this brake bias towards the front comes about from what happens when you apply the brakes in a moving vehicle, as well as from static weight difference front to rear. Weight effectively moves forwards under braking, putting more pressure on the front tyres and reducing it on the rears, and you can see this in the way the suspension moves under heavy braking. This means that even in a car with almost exact 50:50 **static** weight balance front to rear, you have to apply much less retardation to the rear wheels than the fronts, or the rears will lock and cause most people to lose control. You should always be able to lock the fronts on dry tarmac, but not be able to lock the rears on wet tarmac. Ice is another matter! Front wheel drive cars with a much heavier bias of static weight to the front of the car require even more bias towards the front brakes. Competition vehicles often have adjustable brake bias which can be adjusted on the move from inside the cabin to cope with changing conditions. Some French cars have a dynamic bias controlled from the rear suspension - the more the rear suspension rises under braking the lower the hydraulic pressure applied to the rear brakes. Fine on dry tarmac, but a liability on ice I would have thought where the suspension will move little if at all, and lots of complicated stuff to go wrong - so probably a Citroen!

The animation when there is a leak in one circuit is similarly incorrect. It shows the second piston not moving until the first piston has reached it, but in fact both pistons will start to move as before, i.e. the first piston at about twice the rate of the second. The second piston will stop when its circuit has taken up all its free play, and the first piston will keep going until it reaches the second piston. Only then will any significant pressure be developed in the second circuit to slow the vehicle. If the leak is in the second circuit again both pistons will initially move as shown in the first animation, then when the first circuit has taken up all its free play the second piston will start moving as fast as the first, until it reaches the end of the cylinder. Again only then will sufficient pressure develop in the first circuit to slow the vehicle. A leak in either circuit results in a noticeable increase in pedal travel before any back -pressure is felt. Unfortunately because both calipers are on one circuit and the rear brakes on the other in the MGB, it means that if the front circuit fails only the rear brakes will be operative which means pretty minimal braking - try stopping from a normal speed with just the handbrake! If it's the rear circuit that has failed it's quite possible you will only notice from the warning light (where fitted) and a slightly longer pedal travel, as 80% or 90% of normal braking effort will be available. More modern systems use diagonal circuits where one front is linked with the opposite rear, or even dual circuit calipers, but I'd expect a tendency to pull to one side with both these systems. And what happens with ABS when any one, two or three wheels can end up unbraked is anyone's guess.

Types:

The original rectangular metal reservoir single-circuit type are no longer available and have been replaced by various plastic reservoir types. However the original clutch master, which went NLA at much the same time, is now available again, hopefully the same will soon apply to brake masters. **Note that** the cap for the plastic reservoir type is larger than that for the original master cylinder, and MG parts suppliers do not seem to have replacement caps.

Originally GMC 122, it changed to GMC 150 on Mk2 cars some time before the start of the 77 model year. Otherwise interchangeable, the internals differ which must be considered when purchasing repair kits. The V8 used the same master cylinders, again with the change point unspecified, but sometime between car number 101 (Dec 72) and car number 2903 (Jul 76). The same thing happened with clutch masters and Clausager estimates that was some time during 1973. The change is denoted by 'Identified with two concentric rings' in the parts catalogue, and by this drawing on the Moss Europe site. However that drawing shows two rings near the flange, and what looks like a letter 'O' at the port end. That puzzled me, since my 75-built V8 only has one groove near the flange on each cylinder, and nothing (that I can see in-situ) at the other end. It was only when I read this on the Moss US site: "Cylinder body is marked with two concentric circles at end or grooved by flange" that it became clear that the Moss Europe drawing is wrong, showing two **parallel** grooves near the flange, and what looks like the letter 'O' is in fact the two concentric rings referred to by BL and others. Brown & Gammons also appears to show two parallel rings or grooves at the flange end.

American-spec cars had a dual-circuit master with Mk2 cars, originally unboosted, changing to one with an integral booster for the 75 model year, and all other models gained the same system for the 77 model year.

Typical problems can be:

1. The pedal sinking if constant pressure is applied, caused by a faulty primary or pressure seal.
2. On both single-circuit systems with or without remote servo, and dual-circuit systems without servo, fluid leaking down the pedal, caused by a faulty secondary seal.
3. Similarly fluid loss with no apparent exit point on systems with the later integral servo can be caused by a failed secondary seal, allowing the servo chamber to fill with fluid.
4. Fluid loss with no apparent exit point on systems with the remote servo can be caused a servo seal failing, whereby fluid is sucked into the engine and burned. This can empty the master cylinder quite quickly.
5. Brakes binding-on, caused by a maladjusted brake light switch, an incorrect (too long) master cylinder push-rod, or by a sticking air-valve on the remote servo.

Residual Pressure or Non-return valves *May 2015*

Like many things, quite a lot of confusing and conflicting information and opinion about these.

- Some say they are to retain anything from 2 to 10 psi in the hydraulic lines, and are fitted to drum brake systems to prevent the springs pulling the shoes too far from the drum, which would make for a long pedal. But that doesn't make sense, the shoe adjuster (and the handbrake cable adjuster on the MGB) is used to control that, and it would be almost impossible to balance the hydraulic pressure against the return spring pressure such that the shoes only just cleared the drum. If they didn't clear the drum they would be rubbing all the time, getting hot, wearing away, and ruining mpg and performance.

- Another opinion is that the pressure keeps the wheel cylinder seal lips pressed against the cylinder wall to prevent seepage. But the seal diameter is bigger than the cylinder, so is always pressed against it anyway. Admittedly modern cylinders don't seem to have as much sealing as I remember, on my Mini in the 60s I had quite a job getting pistons with new seal into the cylinders even daubed with brake fluid, whereas new MGB pistons and seals push in quite easily. Probably explains why they only last about 10 years now! It may be that a residual pressure valve would make these cylinders last longer.
- Yet another opinion is that when you release the pedal it stops the return of the master piston causing air to be sucked in at the wheel cylinders. This doesn't seem likely as it is the strong return springs that push the pistons back into the cylinders, and hence the fluid back into the master reservoir, not that the master sucks the fluid and hence the pistons back. If that could happen on the brake system then it's more likely to happen with the clutch with its shorter run of larger bore pipe i.e. even more 'suction' at the cylinder and no restrictor in the master. It can't happen anyway, the design of the master cylinder and seals for the MGB at least that means any negative pressure in front of the pressure seal sucks fluid from behind it.
- It's said that where the reservoir is mounted under the floor, disc brake systems need a 2psi residual pressure valve is needed to prevent flowing running back from the wheels into the master, which has to be replaced before any braking effect is applied, hence a long pedal. But that doesn't apply to the MGB, the high mounting position of the master is already applying gravity pressure throughout the system.
- It's also said that drum brakes need a 10psi valve regardless of where the master is mounted, but one purveyor of these valves only 'recommends' fitting them.

In fact they are not residual pressure or non-return valves, but 'slow return' valves i.e. they open fully to allow the maximum fluid through when the brakes are applied, but close leaving just a small bypass passage open when the pedal is released so the fluid only returns slowly. This is said to be in the event of a long pedal so that repeated rapid pumps of the pedal will allow full pressure to be built up. This does make more sense for drums as wheel cylinder pistons do move further than caliper pistons, particularly if not adjusted correctly. Also I have noticed when bleeding MGB single-circuit brakes that while there is still air in the system and you have a long and soft pedal, a few rapid pumps do bring the pedal up and make it harder - briefly, but if left they go long and soft again in a few seconds, and these systems do have just such a valve. The valve also means that it takes quite a lot of effort to push caliper pistons back when fitting new pads, as you are having to force fluid back through this very small bypass passage.

The single-circuit master this valve, as shown. This valve is part of the replacement seal kit and fits inside the cylinder at the outlet end but is not shown in the Parts Catalogue. Neither of the dual-circuit master seal kits seem to contain this type of valve.

The early North American dual-line master does appear to have one of these valves, the Leyland Parts Catalogue shows a 'body - trap valve' (27H 8453, but NLA everywhere I've seen that lists them) in the port for the rear brakes, which would tend to support the drum brake theory. However they do not appear to be fitted to the later dual-line master with integral servo, although there is no parts break-down for these in the Parts Catalogues. Out of interest, some Midget and Mini catalogues also show two i.e. one in each port. If these feed drums front and rear again it would support the drum theory.

Repair kits:

Be careful when buying these. With various original and replacement masters to a different external design and construction, there are at least two designs of internal components. The pre-73 original master has a kit including one cup-type and one ring-type seal, the later master and non-standard replacements contain two ring-type seals, and have one of two external markings to identify them. More info here.

MOT Test (UK)

Had the roadster tested today (July 2008) and for the brake test was asked the strange question "How much does the car weigh?". Apparently they now use a computerised system where they have to select the vehicle from a list to do the test, but vehicles of advanced years or rarity aren't on the list and in these cases they have to input the weight manually. I could remember it at about 2200lb, but it has to be input in kilos. In the end the tester selected another vehicle! The curious thing is that this system has been in use for about 12 months, but it didn't crop up when the V8 was tested just two months ago in May. I emailed the MGOC and they replied that they often get phone calls from people at testing stations asking what the weight is (you would think they would put a note to that effect in the magazine ...).

Updated September 2008: Briefly the weights from the Workshop Manual are as follows:

Mk1 Roadster	871kg
Mk1 GT	993kg
CB Roadster 68-71	1044kg
CB Roadster 71-74	1085kg
CB GT 68-71	1088kg
CB GT 71-74	1110kg
CB V8	1107kg
RB roadster	1100kg
RB GT	1133kg
RB V8	1146kg

Note the Mk1 figures are quoted as being 'unladen' but the others as 'kerbside weights with a full tank of petrol and all options and accessories' so in practice most Mk2 and later cars will weigh a bit less ... depending on what you carry by way of tools! But it isn't critical, just another Government requirement to record pointless information. The full weight information including front/rear split and with other loadings can be found here.

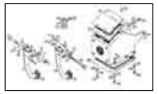
Pedal Box and Frame *October 2016*

Two basic types were used - single-circuit originally, the same type was used for early unboosted American dual-line systems which I'll call Type 1. There was a minor change to these when the brake light switch was changed from being hydraulically actuated to pedal actuated with Mk2 in North America, other dates for Sweden, Germany and Switzerland, and finally in the UK and all other markets with the change to rubber bumpers.

A completely different system was used for dual-line systems with the servo integral with the master cylinder which I'll call Type 2. These were fitted to North American spec for the 1975 model year on, and to all other markets including the UK for the 1977 model year and on.

Type 1 has both clutch and brake pedals on a common pivot shaft as the masters are side-by-side behind the pedal box, and the push-rods both operate towards the driver. The pivot shaft is below the push-rods and consists of an assembly of two pivot bushes, two spacer washers and a distance tube which are a loose fit on a long bolt. When the nut and bolt are tightened this assembly is clamped

between the sides of the pedal box. There is a second bush that is pressed into each pedal, which rotates snugly on the pivot bush. The dimensions of the two bushes are such that when clamped up the pivot bush is slightly longer than the pedal bush, which leaves the pedals free to pivot but with minimal sideways movement, as well as the clearance between the two bushes ensuring there is little or no 'wobble' in the pedal. However parts suppliers web sites can be confusing as to which bush is which. For example Brown & Gammons shows two bushes with one pedal - item 63 Pedal Shaft Bush AAA4129 and item 64 Distance Piece Pedal AAA4130. Moss Europe shows five bushes with two pedals - 2 off Bush, Pedal AAA4129, 2 off Bearing tube AHH7201, and 1 off Spacer tube AHH6063. From the Moss drawing AAA4129 would seem to be the larger bush that is pressed into the pedal, and AHH7201 the smaller bush that fits inside the pedal bush, with AHH6063 plus the spacer washers sitting in the middle of the two pedals. Thus B&G would appear to have the pedal bush (plus the central distance tube and spacer washers) but not the pivot bolt bush. **Note:** When first writing this section in October the pedal bush did not seem to be available, but by January 2017 several places now seem to have them.



Type 2 has the clutch as before, but the brake operates the push-rod away from the driver as the master cylinder is in front of the pedal box. This means the brake pedal pivot is above the push-rod on its own pivot with a short bolt, and although the clutch pivot is in the same position as before it is on a shorter bolt. From here on the picture gets confusing when comparing components with the Type 1, and trying to work out from the parts catalogues which part is which.

The pivot bush for the clutch pedal is now called a 'distance tube', as it fills the gap between its sides of the frame, and is clamped up by the shorter bolt. The distance tube is significantly longer than the pedal bush, and there is a wide spacer on one side of the pedal, which also sits on the distance tube, to position the pedal correctly. The pedal plus the spacer is fractionally shorter than the distance tube, to give freedom of movement with minimal sideways play. The pedal bush is not currently available.

The brake pedal is slightly different in that the pedal fills the gap between the sides of it's part of the frame. The distance tube is only fractionally wider than the pedal, and when clamped between the sides of the pedal box by its bolt leaves the pedal free to pivot but with minimal sideways play. The pedal bush is the same as for the clutch, i.e. not currently available.

Someone has complained that his Type 2 brake pedal is wobbling because the distance tube (pivot bolt bush) is loose on the clamp (pivot) bolt, and saying this is because the bolt threads extend into the tube instead of it sitting on a plain section of the bolt (the 'dowelling' function beloved of James May). But as stated above the distance tubes (that the pedals pivot on) are supposed to be clamped between the sides of the frame so the bolt threads extending into the distance tubes is irrelevant. If a pedal wobbles when the bolt has been tightened then either the pedal bush or the pivot bolt bush or both are worn, or there are incorrect components, or the pivot bolt has not been tightened correctly.

Rear Cylinders

E-clip Fitting

The rear brake cylinders on the 4-cylinder GT are of a larger bore than for the roadster - 7/8" (GWC 1122) as opposed to 0.8" (GWC 1103, applicable to both Banjo and Salisbury/tube-type axles). This gives more braking effect without locking using the additional rear weight of the GT. They differ externally in the position of the locating peg, and hence the back-plates are also different from GT to roadster. However note that the V8 GT wheel cylinders are the same as the **roadster**, hence they also have roadster back-plates. Presumably this takes account of the more powerful front brakes and wider tyres of the V8 giving more retardation, more weight transfer, and hence a greater chance of locking than the 4-cylinder GT. Note that weight transfer and hence the likelihood of locking is dependant on the grip between the tyre and the road, not how powerful the brakes are - assuming they are at least powerful enough to lock the wheels. In fact making the front brakes more powerful with the same tyre to road grip without changing anything at the rear can be counter-productive, since a lower pedal pressure for maximum retardation i.e. just short of locking the front wheels means the back brakes aren't doing as much as before, hence the overall stopping distance could **increase**.

Update August 2007: Richard Atkinson has contacted me to say that the GT originally had the same wheel cylinders as the roadster, only changing to the larger item in May 1968 at chassis number 142735 for wire wheel cars, 148083 for disc wheel cars, and this is confirmed by both the Parts catalogue and Clausager. In Richard's case even though he ordered the correct items for his 66, i.e. the Roadster items, they did not fit his back-plates. So either his backplates had been modified to accept only the later GT items, or the backplates and possibly the whole axle had been changed at some point. This picture from Richard shows the GT item with the locating peg slightly further away from the fluid port, whereas the roadster item has it noticeably closer.

June 2012:

At the service in May I stripped, cleaned and lubricated Bee's rear brakes as usual, then just after a replaced the drum noticed a spot of something on the floor - brake fluid! Fluid inside the lower boot, but none on the shoes or drum, so presumably my fiddling had disturbed a seal just on the way out. Two thoughts chased each other round my head - the first being we had a run planned in a few days time, and the other was that the cylinders were new when I replaced the axle recently. Recently? When I checked I found it was in 1999 i.e. 13 years previously, but still almost certainly less than the originals. Not a good idea to leave it with a run in four days time, so a phone call to Leacy to check they had them in stock, and an hour's drive there and back immediately after lunch. While there the salesman commented "Don't last like the old ones, do they?" Must be so used to customers saying that he decided to get it in first, but he gave me four E-clips in case I lost one. Clamped the rear flex hose, the brake pipe nut came loose easy enough, but turned the pipe with it. Releasing fluid did nothing, so I pinged off the E-clip, removed the bleed nipple, and that gave me enough room to unscrew the wheel cylinder off the pipe. Easy enough to screw the new one back on - luckily the thread start on the new cylinder was very close to the old one, but that meant I couldn't use my E-clip installation tool and will have to wrestle with it instead. Tried getting the outer tangs on first but no go. So got the middle one on first, and the outers went on quite easily with only a little blood drawn. All this time not a drop of fluid had come out of the old cylinder or pipe, so I was hopeful bleeding would be easy. Fitted the EeziBleed tube with one -way valve, removed the hose clamp, pushed the brake pedal a couple of times and only a couple of small bubbles came out. Tightened the nipple, and the pedal felt fine - 45 minutes from returning with the new cylinders (got a second one for when the other side goes, although it is dry both ends) which I reckon is pretty good going. Examining the old cylinder later the lower end (as fitted) as well as having rusty fluid round the piston and in the boot, also has roughness in the bore at that end, whereas the other end is clear. I'm guessing water has migrated to the bottom, maybe proof that the fluid should be changed as recommended i.e. every 3 years when the seals are replaced (how many people do that?).

September 2013: I usually push Vee out of the garage to limit the fumes which inevitably leak into the house. To get Bee out because Vee is usually in front in the tandem garage I roll her down the slight slope of the drive so I can get Bee past, leaning in the window and pulling on the handbrake to stop her. Normally she stops pretty sharply, but one day she barely

stopped and made a non-metallic graunching sound, which sounded to me like oil or fluid contaminated linings, although there was nothing on the garage floor or the inside of the tyres. At the first available opportunity I got the drums off. The offside definitely had contaminated shoes, wheel cylinders and backplate. Damp in the boots, although there was no visible fluid drips. I did find one of the pistons seized though, which I had not noticed before. The nearside had fluid dripping off the wheel cylinder and in the boot, so two wheel cylinders and a set of shoes. I can't complain, they are original to me which is nearly 100k and 18 years, and they were 'old' when I got the car so are quite possibly originals at 210k and 38 years. I also ordered new handbrake lever boots for both cars.

Expecting problems I decided to do the work on the ramps at the back of the garage so at least I could get Bee in and out if it took longer than a day, although I would need to do one side then turn the car round to do the other. The ramps didn't need raising as even lowered they raise the car enough for relatively comfortable working underneath as well as from the side. Used the cross-pieces to get axle-stands under the offside to get the wheel and drum off. To my surprise the pipe came undone as it should (the last few joints I have tried to undo the pipe was turning with the nut), and the wheel cylinder came off very easily. For some time I've had a clonk when applying either foot or hand brake, from that wheel, the wheel cylinder was very loose even with the E-clip in place, and once remove I could see why as the roll-pin was no longer there. It looks like it has completely rusted/worn away as the stub still seems to be in the body of the wheel cylinder. I had wondered whether the backplate was to blame, so had cleaned up and painted a spare. But to use that would have meant removing the hub, and as the problem seemed to be the roll-pin (lack of) I decided against changing the backplate. Cleaned up the drum, backplate, springs and handbrake lever.

The new wheel cylinder was offered up, and after trying the fasten the new E-clip (supplied with the wheel cylinders from B&G) with a screwdriver which works fine on the bench, but less so on the axle especially with the Ron Hopkinson rear anti-roll bar cluttering up things even more than usual, I used my home-brew tool which put the clip on without any fuss. Refitted the new shoes and drum, adjusted them up, and refitted the wheel. Removed the axle-stand, rolled the car off and turned it round ready to drive on to tackle the other side. I'd got a brake pipe clamp on the rear hose so as long as I didn't stamp on the brake pedal the front brakes would be fine, and the handbrake was working. And that was where the problems started.

Although I've reversed both cars onto the lowered ramps, and driven Bee on, this was the first time I had driven Vee on, and found the spoiler hit the leading edge of the ramps - which are 6" off the earth - before the tyres reached the pre-ramps and start lifting the front. No time to correct the ramps, so I had to raise the rear of the ramps on their supports (leading edge now only 1" high) and drive Vee up. Pulled on the handbrake and put it in 1st gear and put chocks behind the two nearside wheels. Then I had to clamber across to the passenger side - which is a lot less easy than in the roadster with the top down! First problem was that I couldn't get my leg between the steering wheel and the pulled-up handbrake. So had to put my foot on the brake pedal, drop the handbrake, get my left leg out, and pull up the handbrake with my right leg still on the brake pedal - car on the significant slope of the partially erected ramps of course. Then get my bum over the pulled-up handbrake while contorting by back and neck under the roof (sunroof tilted, removing it altogether would have made it easier I suppose) and finally extract my right leg. Finally I could get out and raise the rear of the ramps to make the car safe again, and tackle the near-side.

That side done, and the rear of the ramps lowered again, I had to reverse the contortion process to get back in and reverse off the ramps. Not once but twice, as the wheels had settled onto the chocks so I had to drive the car forwards a couple of inches to clear the chocks, get out and remove them, and get back in again. Somewhere along the way I caught the centre console cubby lid and broke off the plastic peg that latches it closed. I suppose I should have opened it all the way first, and it would have given me an extra inch of headroom as well, but there we are.

All that had to be done to turn the car round again so I could reverse onto the lowered ramps, as that gives me the space to connect the EeziBleed from the offside. Even lowered because the ramps raise the car by 6" I can get at the bleed nipples from underneath fairly easily with the car on its wheels. Started bleeding the offside, and waited for all the air to be pushed out and fluid to start which seemed to be taking a long time, when I noticed fluid dripping off the bottom of the backplate from the inside! Whilst cussing crap parts quality I closed the bleed nipple and had to jack and support the axle to get the wheel and drum off again and remove the shoes and pull the handbrake lever out of the way to give me the greatest visibility. I was expecting it to be coming from one of the boots on the cylinder, but it was from between the cylinder and the backplate. Then I realised it had stopped dripping, slackened the bleed nipple again, and it started dripping again. Got to be coming from the threads, but why isn't it coming from the nipple? Along the way I actually reconnected the EeziBleed, only on low pressure of about 10psi as usual, and with the bleed screw open, with the drum off to see what was happening ... and the pistons popped out because I hadn't got the shoes and springs on! Disconnected the EeziBleed and pushed them back. It was then that I realised it was the nipple that was blocked, and temporarily replaced it with a spare. Must have just been some swarf as turning a twist drill in the outer bleed hole was enough to clear it. I suppose I was fortunate in that it wasn't the offside or I'd have gone through the palaver of turning the car round again thinking it was a wheel cylinder problem, when all I needed to do was remove the nipple from underneath.

Refitted the shoes and the drum, reconnected the EeziBleed, opened the nipple, and this time fluid came out. Very soon just an occasional tiny bubble, and only a few of them, so tightened that side. Got underneath and bled the other side without any problems. Stuck my leg into the car to check the foot brake and gave it quite a hard prod - and after a moments resistance it went to the floor with the sound of fluid gushing from the back! Drum off again, and this time it was the rear piston that had passed fluid, fortunately not spraying the new shoes. So shoes off yet again, piston pushed back in again - this time with the bleed nipple undone so that they would both go all the way in. The last time I may not have done that so perhaps the rear piston wasn't fully in. But then I was able to fit the shoes and the drum (admittedly with the adjuster backed right off being new shoes) and adjust them up so I can't really see how the pistons hadn't been in properly - worrying. Refitted shoes and drum, re-adjusted and re-bled. Tried the foot pedal again and this time it was OK, and to be as sure as I could be ran the engine (to 'refill' the servo) and pressed down hard and still OK.

Rear Shoes

As well as the springs and handbrake levers each shoe has a steady pin, spring and washer attaching it to the backplate. Rather than trying to press and turn the washer at the same time in order to disconnect it from the pin (and stop the spring from flying away at the same time), I press down on the washer with a pair of pliers with one hand while reaching round the back of the backplate with the other hand to turn the pin with my fingers. Same goes for refitting.

Each shoe has the friction material bonded or riveted offset to one end of the back-plate. The 'empty' portion of the back-plate denotes its leading edge, that is, the end which a point on the drum will pass first when the car is travelling forward. Thus the front shoe has its leading edge or 'empty' portion uppermost and the back shoe has it at the bottom as indicated in these images (click to enlarge), and that is the situation for both sides of the car.

Tip: Cut a slot in the end of the adjuster with a hacksaw, then you can use a screwdriver from the front to fully remove it for cleaning and greasing and refitting instead of groping round the back with a spanner and only being able to turn it 1/4 or 1/2 turn at a time. Cleaned and lubricated regularly (at least once per year) the adjuster should never be seized or even stiff. I remove mine completely, clean it, then smear copper grease into the threads and screw it fully back in. Then I smear some more copper grease on the exposed threads at the back, which not only protects them from corrosion, but also as you screw the adjuster back out again to adjust the shoes the grease on the back forms a 'collar' which prevents water and corrosion working its way into the threads.

Screw in the adjusters until the shoes just rub on the drums, at this point I pump the brakes and pull on the handbrake a couple of times then strike the drums with a mallet to ensure the shoes are centralised. Experience will tell you how much to pull up your adjusters, after a short run they should be barely warm and definitely not hot. Cars seem to vary, for example my V8 has to have the adjusters one flat looser than the roadster or they overheat. Finally adjust the screw at the handbrake end of the cable. The first click should not add any retardation, that way you know the brakes are fully off when the lever is fully down. The 2nd click should start to add retardation and should be fully on in five or six clicks.

After all that, I find that when rolling my roadster down the sloping drive and leaning in to pull on the handbrake I can lock the rears, but not while I'm sitting in it. I couldn't do that on the V8 - probably because of it's greater weight from the body style as well as the rubber bumpers, and after changing the shoes which had been contaminated by leaking wheel cylinders the handbrake was very weak indeed, and took several bouts of taking the drums off to sand down the high spots until I got wear marks over the majority of the surfaces. Even so it's still not as good as the roadster, but has never been a problem on the MOT even when first fitted.

Springs:

Which spring goes where and in what orientation can also be puzzling, two shoe springs and a handbrake spring are used inside each drum. *December 2016:* Haynes says on page 161 "(Note the 3 springs on later vehicles)", which was a comment I reproduced, but from the Parts Catalogue three springs were always fitted. It's just possible that very early cars only had two springs (like the MGA), which caused binding, so the third one was retrospectively fitted at an early service, the Parts Catalogue being updated accordingly. Thanks to Craig for seeking clarification on this.

A single spring at the top between the shoes, with a single shortish coil with long wire ends. This goes under the adjuster behind the shoes, with its hooks in the holes in the shoes, not the slots as shown in some places. It can go either way up, but I find that with the coil positioned higher than the wire ends it rubs on the adjuster, so I fit it below.

At the bottom there are two springs, the inner being between the shoes, and the outer being in holes in the handbrake levers. The inner spring has two separate coils near the ends of the spring, and is fitted behind the shoes, with the hooks again going through the holes, with one end having a long wire hook which goes under one of the levers as it comes through the shoe. As to which shoe it goes through, banjo axle drawings show it going through the front shoe and Salisbury axle drawings through the rear shoe. But this may have changed when the levers changed, rather than being specific to the axle. I've not found any issue with installing it either way round, and I can't really see why the long end is required anyway.

The outer lower spring is the handbrake spring, and is fitted in front of the shoes through holes in the ends of the handbrake levers. This spring changed at about the same time as the levers, banjo drawings show a single long coil and Salisbury drawings show two fatter coils, but again this probably changed with the levers rather than the axles. In theory this will pull the handbrake lever back further than the shoe springs have already pushed it, but in practice if the handbrake cable adjuster by the cabin lever has been set correctly it will effectively take up all of this play.

See here for information on the handbrake levers.

Servo/Booster *Added December 2009*

Available as an option via a remote unit on single-circuit braking systems from February 1970, standard on the V8 and on UK 4-cylinder cars from August 1973. Some non-North American export cars may have continued without one (Clausager pun?) until 1976. North American spec dual-circuit systems had a servo integral with the master from December 1974, and the same system was used on UK cars after May 1977. Clausager says there was a change in the remote servo in May 1970 with the bore increasing from 5/8" to 7/8". However in a master cylinder increasing the bore would result in more mechanical pressure being needed to achieve the same fluid pressure and hence the same retardation at the wheels, and to my simple mind increasing the servo bore would have the same effect. The Parts Catalogue shows a change in servo from BHA4842 to BHA5076 at chassis number 220129/219491, which dates to August 1970. Clausager says the new one had a clamp ring instead of a crimped ring, but the catalogue shows many changes in the components. Other sources talk about MGB servos giving either 1.65:1 or 1.9:1 assistance, but browsing the part numbers has as many claims for the later servo having the lower ratio as the higher. So it's not clear whether the ratio and hence the assistance went up or down, or when. Several sites say BHA4842 has 5/8" bore and GSM125 (Lockheed Type 6) 7/8" which at least agrees with Clausager. David Manners shows GSM125 as 1.65:1 ratio. Midland Sports and Classics says their complete kit BEK028 as an alternative to the bare GSM125 servo has a ratio of 1.9:1. Delphi LR17812 is often quoted as an alternative to GSM125 but I've not found any statements of bore or ratio for that.

Ever wondered how it worked? Maybe this description of the remote servo will help, click the thumbnail. Originally the remote servo was an option, which means that braking performance **without** the servo must be adequate at least, and in fact this servo only gives light assistance. I've driven V8s (on which it was standard) with and without this servo operational and even though the first time I drove one without and was looking for the difference, I was amazed at how little it was, and after a couple of test prods I didn't notice it at all in normal driving. I believe the later integral servo does give more assistance, and the master cylinder diameter was reduced to give less pedal travel for the same overall retardation. This means that if the **integral** servo is not functioning the effects are much greater and significantly higher pedal pressures will be required for 'normal' levels of retardation.

For the purposes of the UK MOT if a servo is fitted it must be functional, there are a couple of ways you can check it. Firstly, turn off the engine with the footbrake released, then try the footbrake. Initially the pedal should feel pretty much as normal, accompanied by some clicking and wheezing from the servo as it is operated and released. But after the third or so operation the wheezing should reduce to nothing as the vacuum in the servo is 'emptied', and the pedal won't go down as far. This shows that the servo - and its non-return valve where the vacuum hose attaches to it - are functioning as they should. The second test is performed after the first, and involves pressing the pedal down hard before starting the engine. You **should** feel the pedal go down a bit further as vacuum is applied to the servo again. If the first test results in no wheezing, and the pedal seems higher than in normal driving, but the second test works, then the non-return valve in the vacuum port of the manifold is probably stuck open.

July 2016: Recently someone posted on a forum that if they pump the brake pedal, the idle speed rises, and asked if it was a fault. I said I'd never noticed it on either of mine, a couple of others said theirs did it too, but none of us have any reason to suspect a fault. There is a possible reason, although why some do it and some don't I don't know.

- If you look at this page which describes servo operation, when the brakes are released there is a high level of vacuum both sides of the servo diaphragm, which are connected together by the bypass pipe.
- When you apply the brakes firmly, the air valve closes off the bypass and lets air at atmospheric pressure in to the back of the diaphragm, so the vacuum on the front of the diaphragm pulls it forwards to push on the fluid piston so increasing the pressure on the fluid going out to the brakes - the servo assistance.
- When you release the brake pedal the air valve closes and the front and back of the diaphragm are connected together again via the bypass. This allows the pressure on both sides of the diaphragm to equalise, so the diaphragm moves backwards under spring pressure to release the brakes.

This equalisation and the diaphragm moving back, allows a small amount of air to be drawn into the inlet manifold, each time you release the brake pedal. Ordinarily this has no effect on the engine, but repeated and rapid presses and releases of the brake pedal will increase the volume of air that passes into the inlet manifold. So how does that cause the idle speed to rise? Far from 'idling' in the sense of 'doing nothing', an engine is pulling a vacuum of about 20 in.Hg in the inlet manifold, which takes quite a bit of effort (try sucking on a vacuum gauge and see how far you get). Let air in, the vacuum goes down, which means the engine is doing less 'work', so the idle speed will rise for a given idle throttle opening.

Since the exchange of experiences I have tried both of mine, and found that when warming-up and on minimal choke, rapid pumping of the pedal causes the idle to **drop** slightly, but as it warms it takes more and more pedal presses before it happens, until at normal operating temperature it doesn't happen at all. That is also an indication that a small amount of air is passing through the system - on minimal choke with fast idle I can see that the weaker mixture will cause the revs to drop rather than rise. Perhaps the reason different cars do different things is down to mixture strength.

However if the revs rise and stay risen when the brake pedal is held down, that does indicate a fault, in that the air valve is opening but the bypass pipe is not being closed off.

Other problems can be:

- The most serious is when the seal round the push-rod fails, allowing fluid from the cylinder to be sucked into the engine via the vacuum chamber and vacuum pipe. This will empty the master cylinder, the first thing you know about it being when you suddenly don't have any brakes! A fluid level warning system is available from TE Electronics, however I made my own for a fraction of that cost.
- A leak in the vacuum hose or main diaphragm, which will cause a gross vacuum leak into the manifold with the consequent effect on mixture and running, as well as both tests failing. Note the hose is special vacuum hose to resist collapsing under vacuum, not standard hose as for, say, cooling and heater systems.
- A sticking air-valve piston causing the brakes to stick on. This happens on Bee in very warm weather when we are following a route on a run i.e. slower speeds, but not more normal speeds i.e. 50-70mph when presumably the engine compartment is cooler. It happened on a pal's V8 touring Ireland, and got so bad we opted to disconnect the hose from the servo and seal it with the pointy end of a spark plug clamped with a hose clip (that's when I had the opportunity to try one without the servo). One recommendation has been to put a dab of silicone grease on the air-valve piston. Mine had brake fluid on it, so I didn't think that was it. Someone else has said that the servo should be turned so that the air-valve assembly points

downwards rather than upwards to keep fluid round the piston, but again as mine had fluid round out I didn't think that was it either. Yet another person reckoned he had tried both those without effect, so removed the piston and polished the bore with fine wet-and-dry and that did the trick. It does seem more likely i.e. jamming due to differential expansion in higher temperatures.

- The servo can also be the cause of difficult bleeding. The 'correct' mounting position on an MGB is with the cylinder feeding the outlet horizontal and the air-valve assembly facing upwards and slightly forwards. However this can allow a small amount of air to get trapped under the air-valve piston, as well as a larger amount in the cylinder. This latter is because the outlet is drilled concentric with the cylinder and not at its upper edge like a bleed port is in the calipers and clutch slave. The effect would be much worse if there was any tendency for the cylinder to be tilted downwards, either due to the mounting brackets used or the attitude of the car. This is where mounting the servo with the air-valve assembly pointing downwards may help, and angling the cylinder upwards towards the outlet. I have seen fitting instructions for an after-market Powertune/Lockheed servo which is outwardly identical to the MGB unit, but shows a totally different mounting arrangement.