Bee's Clutch Change 2016

Last updated 22-Dec-2023

Previously replaced in 1994 I foolishly opted for an after-market roller-bearing release-bearing. As recounted elsewhere almost from the start it was making squeaking and wittering noises, then graunching noises in 2014, and finally this year I noticed it was dragging the idle down i.e. had seized. As this means excessive wear would now be taking place I started keeping a close eye on the clutch fluid level, as that is a good indicator of the wear. Finally the wear got to such a point that the slave cylinder started weeping, presumably the piston and seal having moved along the cylinder to a place it had never been before, possibly rough or corroded, where it couldn't seal. So that's it, change due.

I borrowed the same hoist as for the 2008 change, although as this would be done in a single-width garage there was no opportunity for lifting the engine from the side of the car as I'd had to do for the rubber bumper as the arm wouldn't reach the middle of the engine. Hopefully being chrome bumper it might reach ... but no, so the bumper and grille have to come off, and when horizontal the end of the arm reaches just past the middle of the engine, which is a relief. Another consideration doing it in the garage is do I have enough clearance to the ceiling to lift the engine over the slam panel. Up and over garage doors would reduce the available height still further, but as mine is a double-length garage I'm doing it in the middle so well clear of the open door. This also gives me plenty of space at the back for removed parts, and plenty at the front for the hoist and engine when it is removed so I can just shut the door on it all at night. The front of the car will need to be raised to get at the lower bell-housing bolts at the very least, again reducing the available space.

With the car in the middle of the garage the back wheels are on the lowered full-length ramps which raises it just enough to slide under to get at the middle exhaust clamps. It's quite close to the wall that side so reaching under from the side isn't an option. As I've previously found the drive-on ramps skid on the concrete floor if I try to drive up, I jack up the front of the car so I can slide them under the tyres. This hoist fits between drive-on ramps under the front wheels of the car, but the available height reduces still further as you take the weight of the engine on the hoist and the body rises on the suspension. A large hoist with long legs with the ends wide apart may not fit between drive-on ramps, so you may have to use axle-stands further back under the chassis rails. This will eliminate the problem of the body rising on the suspension as the hoist takes the weight of the engine, but I preferred the security of the ramps.

This time a leveller had been supplied with the hoist, but as that increases the distance between the end of the hoist and the top of the engine the arm has to be raised higher, and that brings the point of lift forwards from the middle of the engine as well as closer to the ceiling, so I decided to use the tow-rope under the front and the back and crossed over on top as I had before.

Then it was a steady plod disconnecting/removing everything. But first I redrilled the holes in the bonnet hinges to aid reassembly - they were on both pieces but didn't line up. Don't know why as alignment has always been good. Then a pal came round to help me lift it off. Next was bumper complete with number-plate and badge-bar, and grille.

I removed the air-cleaners, carbs and inlet manifold. On the bench the inlets of the carbs are uppermost, so they are plugged with a twist of clean paper. The crankcase ventilation hoses are removed, the fuel supply and servo hoses are tucked out of the way as well as the disconnected accelerator and choke cables. For the choke rather than undoing the inner clamp screw on the front air-cleaner bracket, which makes it a right fiddle getting the splayed strands of the inner back through the trunnion hole, I pulled the split-pin and disconnected the outer from the choke interconnecting lever. I removed the near-side engine restraint bracket, which has the carb overflow pipes attached to it, as an assembly. I have a solenoid valve in the vacuum line from carb to distributor so that comes off with the tubes as an assembly.

I had thought about disconnecting the exhaust manifold from the head and with the front, middle and back supports slackened pulling it across to the side of the engine bay. I did that for the head gasket change, but looking closely it seemed it wouldn't give me much clearance if any to the flange at the bottom of the block, and I didn't want to make things any more difficult for myself than needed, so opted to remove the down-pipes from the manifold. A 3/8" socket on extensions and with a UJ reached all the nuts easily, and I was surprised at the good condition of nuts and studs, although they had been replaced when this manifold was fitted in the early 90s. However three studs came out with the nuts. Getting the down-pipes out of the manifold was another matter! I had to wedge a piece of timber across the top of the pipes and under the chassis rails, lift the engine until that bowed, then hammer down on first one pipe and then the other with another piece of timber and a lump hammer. But that couldn't be done until I had disconnected the engine mounts. Shortly afterwards I came across someone who had done it leaving the manifold on the down-pipes, which is definitely easier.

Removed the bottom hose from the radiator, with a large padded envelope under it to guide the coolant into a bucket rather than it going everywhere. Rather than pulling it off and everything rushing out, with the clamp slackened and pushed out of the way I wedge a screwdriver in the joint to create a small gap for it to trickle out, getting on with other things while it does so. Remove top and bottom hoses, and heater hoses - remember to open the heat valve when draining! Also the heater return tube from the rocker cover studs, just to get it out of the way.

Disconnected the oil gauge pipe from the block, then the cooler hoses from block and filter adapter, and remove the radiator, diaphragm and cooler as an assembly (over-slung cooler on CB may be OK, but you wouldn't want to hit it with the engine. Under-slung on RB can be left along with the diaphragm). Hoses need to be held up or positioned over containers to catch oil, and the filter adapter port needs to be plugged or a container positioned under it as unless you remove the filter first that will drip slowly but steadily the whole time. Plug and cover the oil connections on the block to stop anything falling in - I used the cut-off end of an old cooler hose and the old gauge hose.

Remove the temp sender from the head, removing the lower bolt from the heater tap to release the support bracket, and carefully tuck the capillary and bulb out of the way.

I had pondered leaving the starter on the engine, but it looked like it might foul the rack-shaft when pulling the engine back, so again opted to remove it to avoid making things more difficult than they need to be. That needs the distributor to be removed, which I do complete with clamp-plate, again plugging that hole. The bottom starter bolt needs a socket on an extension as the clutch hose is in the way, although you could disconnect that from the bell-housing first (it's been said that hanging down the spring can push the piston out and you lose the fluid, but I and others haven't found that). Top bolt is easy to access from above, then the starter can be pulled back and angled to lift out from above. This is with the inverted canister oil filter, the earlier hanging filter arrangement may be different.

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

Alternator has to be removed to get at the off-side engine mounting nuts and bolts. Annoyingly, a couple of the nuts and bolts are non-standard and fractionally bigger across the flats, so my 1/2" ring spanners won't fit, and the open ends have to be wiggled on and off. There is often a spacer plate under the near-side mount - don't lose it!

Just the bell-housing bolts left. I remove the top, upper side (the upper starter bolt also acts as the upper off-side bell-housing connection) and lower side nuts leaving the bolts in place to act as guides, and leaving the lower nuts until last. As you are lifting the engine initially with the gearbox attached to get the gearbox to the top of the tunnel, these are all that are required to keep the two halves together.

Incidentally all bolts removed from tapped holes, and nuts from studs go back in and on so they don't get lost or mixed up. That pretty-much leaves just the engine mount nuts, washers and bolts to be fitted together and those and the bell-housing nuts and washers to be kept in a safe place.

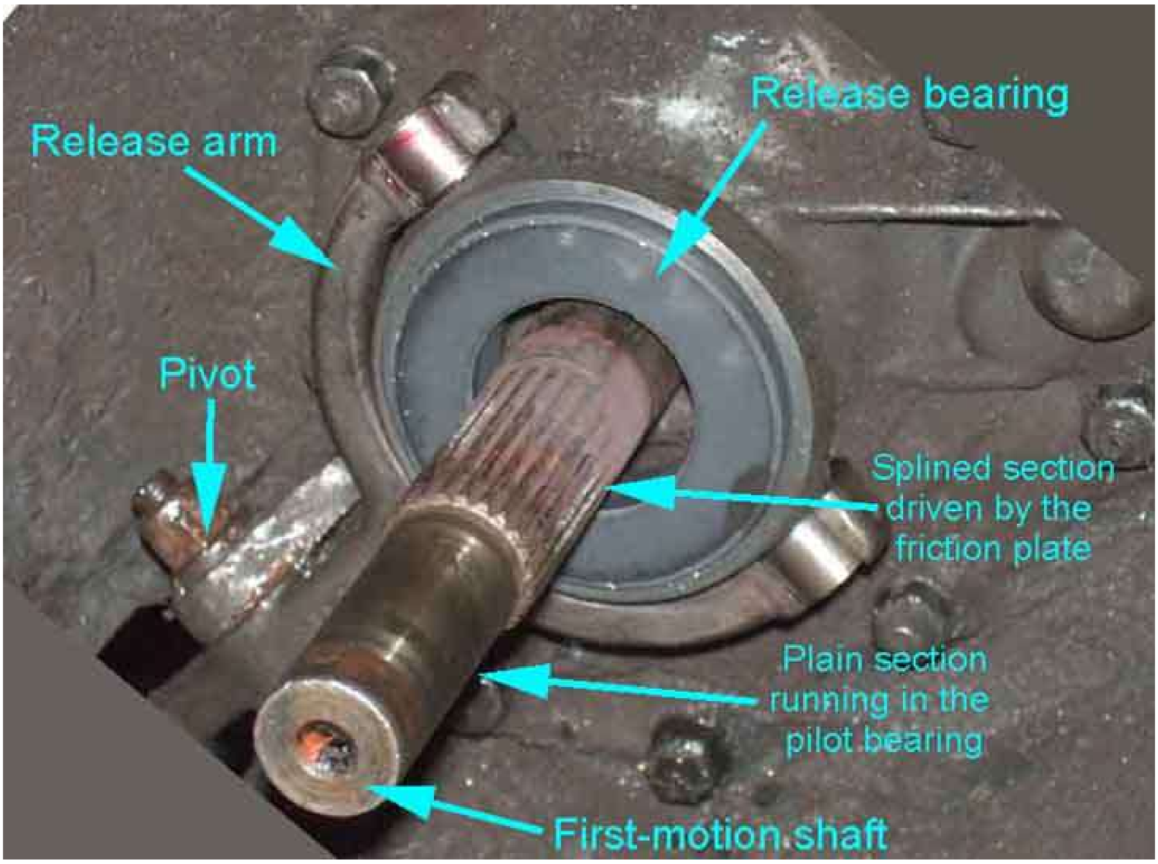
Now ready for the main lift. The front mountings come free with a bit of a bang, and I lift until the bell-housing reaches the top of the tunnel. Once there I jack under the bottom of the bell-housing to keep it wedged up there, and the lower bell-housing nuts can be removed, again leaving the bolts in place to act as guides.

Which leaves the separate. Pull the engine back, only to find that the sump hits the cross-member before the end of the first-motion shaft clears the cover plate, so I can't lift it straight up, which didn't happen with the rubber bumper. Don't think about it too much at the time, and lifting and wiggling does eventually get the engine up and out, pulled forward clear of the front of the car, and lowered onto my saw-horse for additional support. (Subsequently asked someone else who had just pulled a CB engine without mentioning this problem, and he said he had the same thing. I wonder why no-one has every seen fit (in my sight) to mention this before). While doing that the pilot bearing came out of the crankshaft, which I wasn't expecting, normally people have to resort to some quite ingenious methods if changing that with the clutch. Personally I don't think it should be necessary, the only time that bearing is getting any wear is when you are in gear with the engine running and the clutch is fully or partially disengaged.

First sight of the release bearing and cover plate - and it is shocking! Bearing completely knackered with balls jammed and them and the housing ground down, the boss on the cover plate practically worn right through, and the ends of the diaphragm springs showing blue from excessive heat, and some partially cut through from the outer corners of the release bearing fork. No-one could accuse me of not getting the maximum life out of it! The air-gun gets the cover-plate bolts undone without having to jam the crankshaft in some way, to reveal the friction plate, which is barely worn. If it hadn't been for that damned release bearing the clutch itself would almost certainly have lasted another 50k and 15 years or so. The flywheel does have a slight wear groove, from a previous friction plate having worn down to the rivets, but as it's been like that for the past 22 years I'll leave it as it is, not worth removing it and getting it skimmed. The inside of the bell-housing is well mucky of course, but dull dry dirt rather than the shiny wet-look of the previous two, so again I just check the gearbox front-cover nuts for tightness.

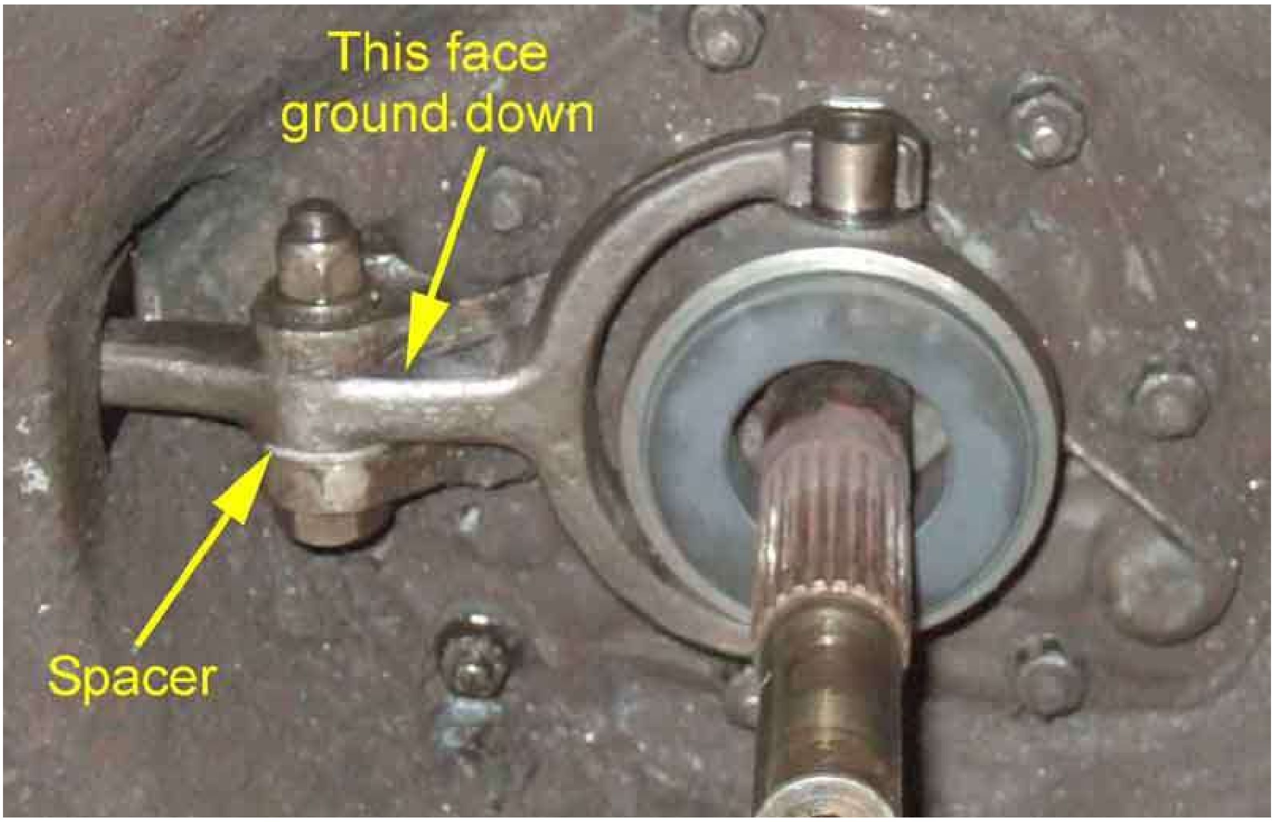
The other thing I notice is how offset the release bearing is to the first-motion shaft - sideways relative to the orientation of the release arm pivot bolt, getting on for 3/16". Even with the bearing removed the forks are still offset, and removing the arm and turning it over is just the same. I.e. it isn't the arm that is bent, but the pivot bolt bracket is not in line with the shaft. That's almost certainly what has caused the roller bearing to fail, which is why John Twist says roller bearings have a high rate of premature failure when used on a gearbox not designed for them. OEM applications like the Midget 1500, MGB GT V8 and modern cars, have a special carrier that keeps the bearing concentric with the shaft, compensating for any misalignment between arm and shaft.

Note the release arm pivot bolt is installed from underneath with the nut on top of the bracket, probably because the bolt can only be inserted from that side due to the design of the bell-housing and position of the bracket. V8 is the same:



Not surprisingly I'm going to be using a standard graphite bearing this time, which are better able to cope with misalignment. However as the previous clutch replacement was caused by the release bearing casting wearing away and breaking, I'm wondering if the misalignment is so bad it caused that to fail, and so will cause the new bearing to fail. I find that with the pivot bolt nut slackened there is quite a bit of free-play between arm and bracket, and that tightening the nut would remove that free play to the point of the arm binding in the bracket, which was obviously too much. Adjusting the free-play in this way improved the alignment of the release forks to the shaft, but not enough to get an equal gap both sides. Note that this can only be done on CB gearboxes, RB gearboxes use a shouldered bolt which can only be tightened so far, leaving whatever free-play that exists between the brackets or in the bushing as slop.

Pondering some time, I decide to grind away the boss on one side of the pivot point of the arm, and fit a spacer washer underneath. But before removing the arm I remove the clevis pin between it and the push-rod, and the slave promptly evacuates its boot, piston, seal, seal spreader and spring and all its fluid ... onto the floor before I can get a container underneath it. The garage floor is painted concrete, and hydraulic fluid makes an excellent remover of that as well as cellulose! Modifying the arm probably takes most of a day grinding, flatting, checking the thickness with a dial caliper at six points around the pivot bolt hole, and trial fitting with a 0.2" washer. I'd previously ordered a new bush and pivot bolt in case the old ones were well worn, but to be honest there didn't seem much difference. Nevertheless I used them, driving the old bush out with the double-socket technique in a vice, and pressing the new one in with the bolt. Of course the new bush was now longer than thickness of the arm, so I opened up the hole in the spacer washer to fit over the protruding end of the bush rather than grind it off. It made refitting the arm much easier, than trying to line up the holes in the washer and the bush to get the bolt through. Finally I tightened the pivot bolt nut to bring the new release bearing into concentricity with the shaft, as judged by the shank of a 8mm (I think) drill bit which just fitted into both sides, checking that the arm was free over its full travel. Note that as the release arm is moved back and fore the alignment of bearing to shaft varies in a longitudinal direction i.e. in line with the arm, there is nothing you can do about that. However - it was only subsequently that I realised if I had done nothing, and simply put a new release bearing and clutch in and they lasted the same as before, I would probably be over 90 before it needed doing again! Oh well, it's done now.



I'd contemplated tidying up the engine bay while the engine was out, but whilst I could have done the sides the back is so bad that short of removing everything it wouldn't have been worth it, so I left it. I could also have painted the radiator and diaphragm ... but where do you stop? (see 'Shipwright's disease'). However I did decide to clean the engine, as that was very dirty with thick crud from oil leaks having absorbed dirt. I couldn't do a proper job with my tow-rope still on, so I replaced that with the leveller attached to the rocker cover studs. I also removed the exhaust manifold to give better access. Engine cleaning probably took a day scraping, spraying with engine degreaser, working it with a brush, and wiping off. I couldn't pressure wash it in the garage, so laid a sizeable sheet of plastic DPC down, put a grow-bag tray (without drainage holes!) on top of that, then an old cake tin in that to catch as much of the crud and fluids as possible. I'd previously spent some time sealing the rocker cover, and also replacing the side cover gaskets and seals, cleaning around those areas at the time, and they had stayed clean so hopefully they were now leak free. The gunge looked a little shiny under the mechanical oil pump blanking plate, so I took that off and made a new gasket - the original looked to be paper. The near-side engine mount needs to be removed to properly clean that side, but the off-side doesn't obstruct. The off-side was so mucky I couldn't tell what had been leaking, although having previously replaced cooler and gauge pipes I was pretty sure they were sealed. Which left the distributor - of which more later. I covered that hole - already stuffed with paper - with duck-tape to keep displaced crud and degreaser out.

Whilst scraping the side of the engine back-plate that faces the sump, on the distributor side, some large lumps of what initially looked like underseal came off. Then I noticed it had revealed a large flat metal washer, and it turned out to be a very large grommet (12H 541) in a hole in the back-plate, the reason for which (the hole) can only be guessed at. That'll have to be replaced, so goes on a list in case I find anything else along the way.

With the manifold off I refit the three studs that came out on exhaust removal. Clamping them in a large vice I got the nuts loose, then with double-nuts could tighten the studs back into the manifold.

With the engine clean I can fit the new clutch! I check the friction plate fits the splines on the first-motion shaft. I also check the fit of the dislodged pilot bearing on the plain end of the shaft, it's not overly sloppy, so I refit it just tapping lightly with a suitable socket, whereupon it seems firm enough. Offer-up the friction plate on the alignment tool, checking that it is the right way round (friction plate butts up to flywheel, the wrong way round there is a big gap between the two), and loosely fit the cover-plate bolts. I'll need to hold the crankshaft still to torque up the cover-plate bolts, but a 1 5/16" socket fits the crank pulley nut well enough even with the lock-tab still in place, with a short breaker bar in that resting against the side of the sawhorse. Tighten and torque up bit-by-bit and evenly to 25-30 ft lb. As I do so I continually check the alignment tool is free in the friction-plate, if the friction-plate is fractionally off-set as you start to tighten the cover-plate bolts, it can wedge the alignment tool between the pilot bearing and the splines, which makes it difficult if not impossible to pull out. If it moves freely with the cover-plate fully tightened, then so should the first-motion shaft.

Clean the very mucky starter motor and its cable/wiring, and the not so bad alternator.

I'm changing the clutch slave and flex hose as a precaution. In 2008 we didn't bother but after the disturbance the slave weeped and was impossible to bleed. In the end we changed it and had planned to change the flex, but with the engine back in just could not get the pipe and chassis bracket nuts undone. So we had to reuse the old hose, but the new slave had a different thread start position to the old which meant that when tightened the slave wouldn't sit against the bell-housing without putting a twist in the hose. Fortunately an extra copper washer at the slave end brought it into alignment. I've opted for a braided hose, as for years and particularly when changing the master seals two years ago I ended up with a low biting point despite repeated bleeding using various techniques, and wondered whether hose swelling was a contributory factor. First thing is to undo the slave bolts - and they are tight all the way. They are also different to each other - one 1/2" with an integral washer, the other 15mm. When I get them both out I can also see the threads are different, so one of them has been forced in - presumably at a previous slave change as I can't imagine it being done like that from the factory. The bolts were quite rusty and cruddy, so I ran a hacksaw blade along both faces of the threads for the full length to clean them up. I wondered about using a tap to clean up the bell-housing threads, but didn't want to remove any metal, and in any case didn't have one that fitted either of the bolts so that was that.

Whether it was ease of access with the engine out, or they weren't that bad anyway, the pipe and hose nuts came undone easily enough, and the shiny bits go on. Screw the hose into the slave first, attach the slave to the bell-housing copper-greasing the threads, and making sure they go back in the same positions. Oddly the 15mm bolt goes in quite easily now, but the 1/2" one is still stiff. Then I can tighten the hose in the slave, and fit the hose to the pipe and chassis bracket, and refit the push-rod and clevis pin. The first thing I notice is that the wear in the clevis pin - which I had noticed earlier but ignored as the hydraulics compensate for any wear at that end (unlike wear at the top end which leads to a low biting-point). The pin didn't look too bad when out, but with the corresponding wear that must be in the end of the release arm the two are way out of line and looks really bad, so another part to go on another list, together with a release arm gaiter, as I've already ordered the engine back-plate grommet.

Then I notice that having raised the release arm on its pivot bolt by 0.2", the slave is not directly in line with it anymore - buggah! What to do? Put the release arm back in its original position by putting the washer on the ground down side? Which leaves the original misalignment and possible future release bearing problems? So I decide to modify the slave. It's alloy i.e. quite soft, so I opt to overdrill and file the holes somewhat in order to slide it across to closer alignment. It does mean that one has to hold the slave in the correct alignment while tightening the bolts, but it's not something I'm planning on doing again for a while yet ...

The engine back-plate grommet has arrived, I thought it might be a bit of a struggle sandwiched in the narrow gap between that and the sump, but it pops in quite easily. With that, the engine is ready to go back in.

Fit the seven UNF bell-housing bolts before offering-up the engine - there are three different lengths so if you removed them but didn't note which went where, as a rule of thumb when in the right places they should all project forwards by about the same amount as shown here, which also indicates the position for the upper UNC bolt for the starter. More info here.

I've already lubricated the release bearing pivots with the red grease supplied with the clutch kit, so apply more to the splined and plain part of the first-motion shaft, and the splines of the friction plate and pilot bearing. As I have removed the tow-rope from the engine for cleaning, if I refitted it for lifting I could no longer rely on it holding the engine at the correct tilt for the gearbox. But this time I have the leveller, so decide to use that. However that adds many inches to the distance between the arm and the top of the engine, which means the arm has to be raised higher, which means the reach into the engine bay won't be as much, and may reach the ceiling before the engine is high enough to clear the slam panel. I could lower the front of the car by taking it off the ramps, but that compromises getting at particularly the lower bell-housing bolts. I shorten the two chains on the leveller, and the one between the arm and the hook by as much as I can, and I do have enough lift to clear the slam-panel and ceiling at least, and push the hoist with engine forwards, lowering as I go, in small increments as the cover plate gets closer to the end of the first-motion shaft. The leveller also proves its worth to get the correct tilt, although as you vary the tilt you are also varying the fore and aft position of the engine, so all that has to be taken into account to avoid hitting the shaft. Also although you can move the pump-end of the hoist from side to side, because the arm is at its fullest extent, the engine is very close to the wheels on the legs, so the engine itself hardly moves from side to side. So if the leg wheels aren't in the right place, you have to back out, slide the pump-end across, and push back in. And then comes the problem.

Although I have the engine correctly positioned, when I try to lower the cover-plate past the end of the first-motion shaft, the front of the sump hits the cross-member first, which pushes the engine back, until the cover-plate is overlapping the end of the shaft. I suddenly realise this is the same problem Terry had. It wasn't a case of the pulley fouling the rack as I thought then because with the gearbox raised that is well clear. Fortunately the suggestions I made of moving the gearbox cross-member back and only putting the bolts back in the minimum amount to give more tilt did help, but Terry's still needed a shove to get them together. I didn't have this problem with the rubber bumper, then it struck me that they have the body raised on the modified cross-member, which means the gearbox when at the top of the tunnel will also be raised relative to the cross-member, and maybe that gives just enough clearance for the engine to be lowered all the way down before the push back.

However with the leveller I can over-tilt the engine i.e. clutch end down, till the cover-plate can go over the end of the shaft while the sump is still clear of the cross-member, which allows the engine to go back an inch or so, which gives more clearance between the front of the sump and the cross-member. I adjust the leveller, arm height and hoist position bit by bit in concert, sort of swooping the engine down, back and onto the shaft, until the engine is correctly aligned with the gearbox in terms of the shaft being in the middle of the cover-plate hole and there being the same gap all the way round between the engine and the bell-housing. I've got the gearbox in 4th so the shaft won't turn, and pushing back on the engine and with the pulley socket back on the nut turning the crank back and fore, the splines engage quite easily. Push back further and wiggle the engine so I can get the bell-housing bolts in the back-plate holes. The top starter bolt helps keep the two halves aligned as it can be screwed on from the front while you get the bolts bell-housing bolts through the back-plate holes, and pushing back further allows me to start getting the nuts back on. I get to within about 1/4" but with the leveller and the higher angle of the arm the hoist is as far back as it will go with the pump up against the front of the car. So with a combination of wedging a piece of wood between the pulley and the rack tube, and tightening the nuts bit by bit, I pull the two together. In hindsight if I had left the back chain on the leveller one link longer, I would have had to wind the leveller to move the engine forwards to get the correct tilt, which may have brought the two fully together. However that may have then compromised my ability to get the back of the engine raised enough to 'swoop' the engine onto the shaft.

With all nuts fitted and the bottom two tightened, I can remove the gearbox jack and lower the engine onto its mounts - phew! 'Just' the reassembly to go.

First is to get the top two engine mount bolts each side in. These go head up, thread down. Even though it is easier to get the nuts on the other way up, the excess thread sticking up compromises alternator adjustment on the off-side as well as the fitting of the restraint plate on the near-side. Remember to refit the spacer plate under the mount on the near-side. A bit of lifting and wiggling with just the bolts pushed through may be needed to get them all in, before you can fully lower and start fitting lock-washers and nuts, tightening them while you still have maximum access.

The exhaust was slightly fiddly, the clamping plates had slid down and I couldn't get the front one up past the sump flange. I couldn't pull the pipes sideways enough to get it past as the pipes were fouling the studs, so had to completely disconnect the front mount to bell-housing so I could push the pipes down, then sideways, then slide the front clamp-plate up. With the exhaust released that stayed there and I could get a couple of nuts started, and I could slide the back one up and get a couple of nuts on that as well. The ends of the pipes wouldn't go up into the manifold initially, and needed pulling and pushing back and fore and sideways. Then I could get all the nuts on and tighten them.

After that it is a case of refitting everything else, in reverse order. Well I say 'everything', but I wanted the minimum back on so I could run the engine and check the clutch before I went too far, discovered a problem, and had to remove it all again so wouldn't be putting the hoses or coolant back, connecting the heater valve, temp sender etc. So carbs, choke and accelerator cables, fuel pipes, crankcase breather and servo hose go back on. On the other side refit the starter and its cables/wiring. Then the oil cooler (and hence the radiator and diaphragm just loosely attached and the cooler resting on the apron) and gauge pipes, distributor static timed to 10 degrees, cap and plug leads. Then the dreaded clutch hydraulics filling/bleeding!

As the car was on its front wheels on ramps reverse bleeding from the caliper wasn't initially an option, so I went for conventional bleeding from the top with the EeziBleed. Pedal felt very light, with a 'dead' area near the top, so probably still air in there which didn't surprise me. I checked the push-rod travel by measuring from a flange on the master to the furthest edge of the release arm - first with the clutch pedal released and then with it wedged fully down ... and got 11mm or 7/16", which is less than the 1/2" I've always considered the minimum. Nevertheless I started her up, tentatively checked reverse and got grinding. Wasn't that surprised, but could select 4th, and whilst the biting point was low it wasn't that much lower than before, so rather bothered by the grinding. Switched off, and as it was near the end of the day wedged the clutch pedal fully down overnight.

Next day released the clutch pedal hoping to flush any air back into the reservoir, but travel just the same, with the same grinding and biting point as before. Buggah. It all gets a bit confused now, but by supporting the off-side spring-pan on an axle stand I can get the wheel off for reverse bleeding, and it is no better. Intending to drain only some out it took me by surprise and emptied, but then I've filled a completely dry system this way on the V8 and had a full clutch straight away. Move on to plan C and take the slave off letting it hang on the hose, and with a cross-point screw driver force the piston all the way in as far as it will go, with significant gurgling up at the master at one point which is promising. Refit the slave - aligning it to the release arm as before. Check the travel as before i.e. fully wedged down and fully up and still 11mm. Run the engine again and reverse still grinding, but paradoxically the biting point is now a lot higher. Double-bugger, the friction plate must be dragging on the flywheel or the pressure plate, or the first-motion shaft binding in the pilot bearing. I could take the engine out again, but what would I be looking for? Without mating it up to a bell-housing with a great hole in it I wouldn't be able to check anything. Eventually I decide to complete the job, and see what it is like on the road. One thing I had discovered along the way is that if I nudge it into first before selecting reverse, it goes in with just a slight crunch not the full grind. Also only partially operating the clutch pedal, or waiting with the pedal fully down before selecting reverse, makes no difference.

So fit the rest of the stuff except for bonnet (fitted with the Navigator who is always happy to help with 'clean' jobs), bumper and grille, fill with coolant, and take it up and down the road. Idle was very rough and lumpy, so check the setup to find the air-flow balance very close but the mixtures on both carbs needed richening by several flats for some reason - I'll check it again after some shake-down mileage. Biting point is very high - uncomfortably so, probably due to my extended master push-rod I fitted in 2014 in an attempt (only partially successful) to raise the biting point when I had all the problems bleeding after changing the master seals two years ago. Still crunching into reverse, reduced by nudging into first immediately beforehand, so I'll just have to get used to doing that every time, until I can see if it 'beds in'. Leave the pedal wedged down for another night - next morning no different.

Finally fit the bonnet, bumper and grille and take it for a few miles. It's so annoying, the new clutch is beautifully smooth and light, and no judder in reverse that the previous clutch did from new, just that crunch engaging it, and the uncomfortably high biting point. Post 'finally' I take out the extended push rod which lowers the biting point to a more comfortable level. I recheck the slave piston travel and it is still 11/12mm (but then so is the V8 checked at the same time), so I just can't understand why getting-on for an inch difference at the pedal isn't more visible at the slave. Swapping the cars round for these latest checks the roadster went into reverse with just a click, but then swapping them back it was more like a crunch again. So maybe it will get better with time ... or maybe not.

Post post 'finally', I get a free clutch pedal, with that fitted it should be back to standard. Well it certainly improved things, but still seems higher then the V8, but as pedal, piston and master-pushrod are all now as standard I'm not going to do any more with it.

Having cleaned the engine I've been looking carefully all round to see if I can see any oil escaping, and did see a small trickle under the distributor. Originally engines for Mk1 cars had an O-ring on the distributor shaft, then it was deleted for the rest of chrome bumper production, only to reappear again for rubber bumper cars which had the 45D4 distributor. Although the distributor for this engine wouldn't originally have had an O-ring, or even a slot for it, I decided to buy one to see if I could make use of it. On removing the distributor I was surprised to find a slot, then remembered this was a remanufactured unit and not an original. So O-ring fitted. However the block face the distributor clamp plate butts up to seemed clean, and there are a couple of plugged oil-ways immediately below that so it could be from there. But after a few dozen miles there is no sign of more oil, so O-ring it was.

A couple of years and a few k later I realise I'm no longer bumping towards first before reverse, and no noise at all if I have the clutch pedal down for a second before moving the lever.

Release Bearing

The 8000 mile release bearing. Not a trace of carbon left in it, or any pieces in the bell-housing, just a fine dust spread all round the inside. Note the roll-pin on the bottom left-hand side, is this the pin that causes the problem? (Photo: David Bolton)

Two more pictures of the roll-pin in the old bearing. Is it supposed to be sticking out like this or flush? (Photo: David Bolton)

The inner end of the roll-pin. Part shows obvious signs of wear, but there is a recessed part that doesn't. It's not possible to determine whether the pin projected into a hole in the carbon ring and so has had quite a bit ground off by the boss on the cover plate plus some broken away, or whether the pin only bears on the side of the carbon ring (so holding it slightly off-centre) so very little has been ground away. (Photo: David Bolton)

An NOS AP/Borg&Beck release bearing I've had since 1994, no sign of a roll-pin, protruding or flush.




These four photos by Bob Muenchausen: Badly broken-up bearing but still a ring of carbon seems to be left. Probably once the boss on the cover plate had worn down the carbon to the top of the carrier there was a mis-match that meant it was bearing on the casting rather than the carbon ring, wearing that down instead, note the upper piece of the outer ring of casting is much thinner than the lower piece. Eventually it go so thin it couldn't take the force of the clutch and it broke suddenly, further operations of the clutch pedal pushing the slave piston out of the end of the cylinder. This is very similar to what happened to the clutch on my roadster many years ago (mileage unknown), although on that the offset was worse and towards one of the pivots which snapped off leaving the rest of the bearing relatively undamaged.

Inside of the bell-housing liberally coated with carbon.

Friction plate with the lands worn away but still well clear of the rivets, not bad for 75k

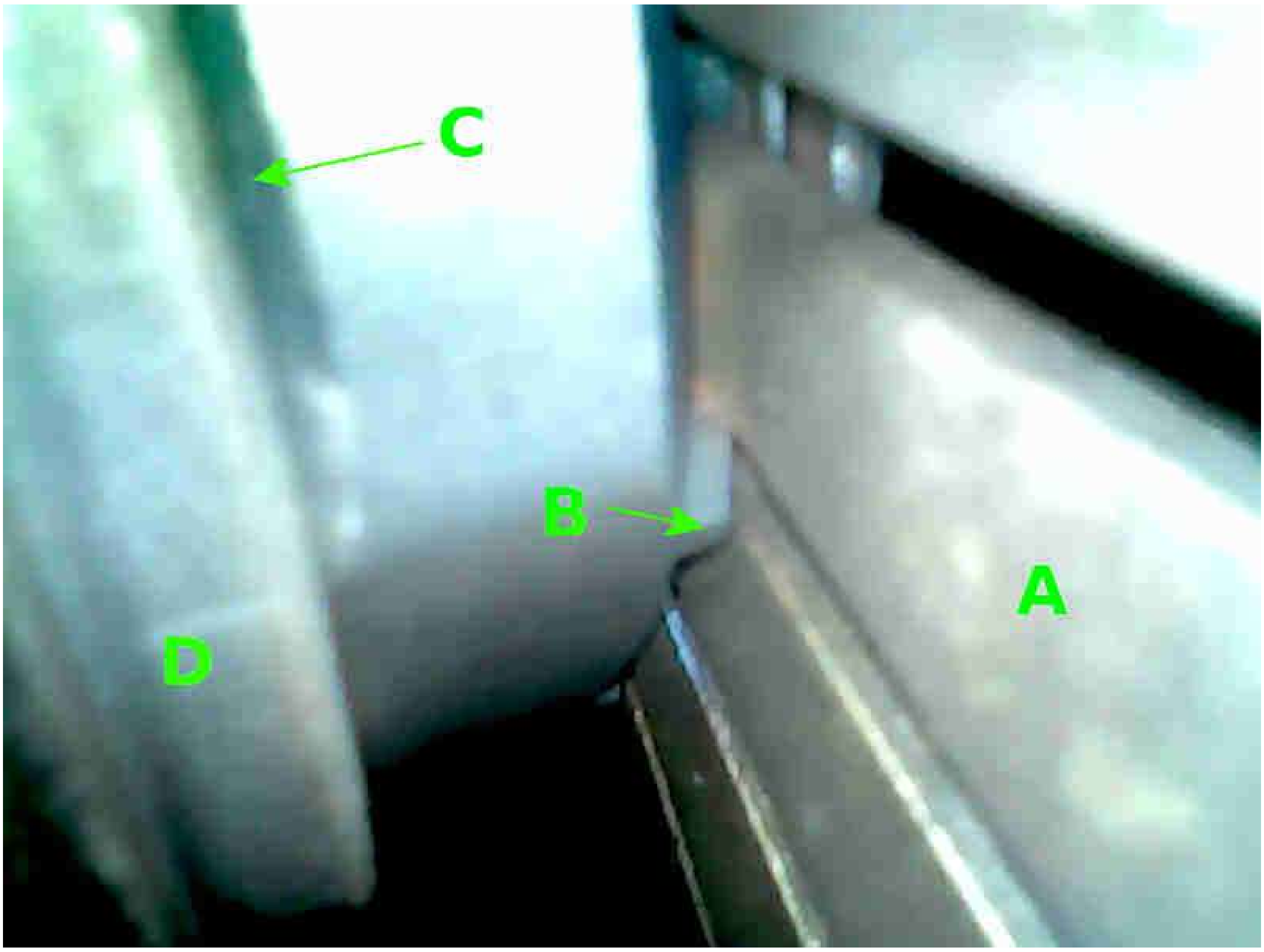
Deep wear groove in the cover-plate, although Bob reports that the flywheel itself was fine. I found much the same on the clutch change I did, perhaps deliberately dissimilar strength metals?

A claimed release bearing failure having caused the release ring to have been ripped off the diaphragm springs of the cover plate, rather than the release ring having come off and damaged the bearing: (*Name withheld to protect the naive ...*)

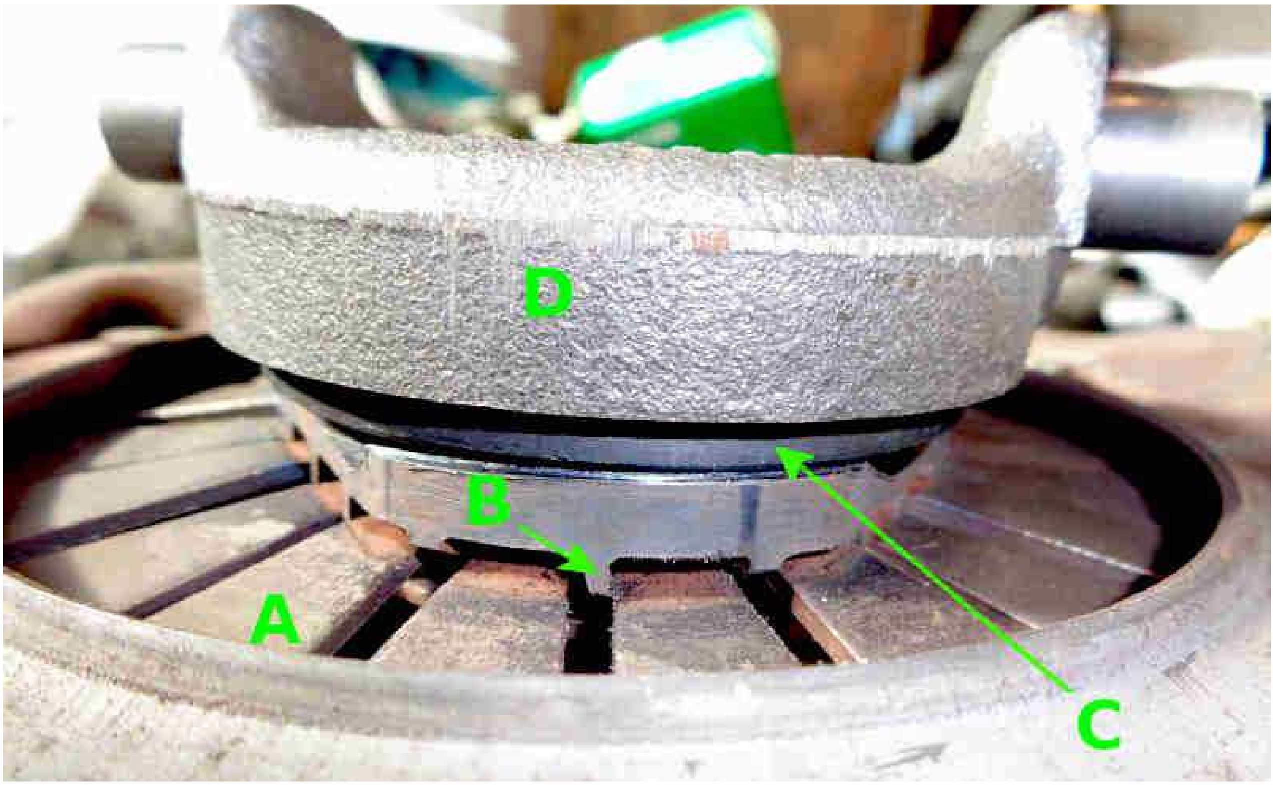
Peter King's showing the edges breaking away most of the way round, and further cracking elsewhere:

But the off-setting of the bearing to the first-motion shaft is very low:

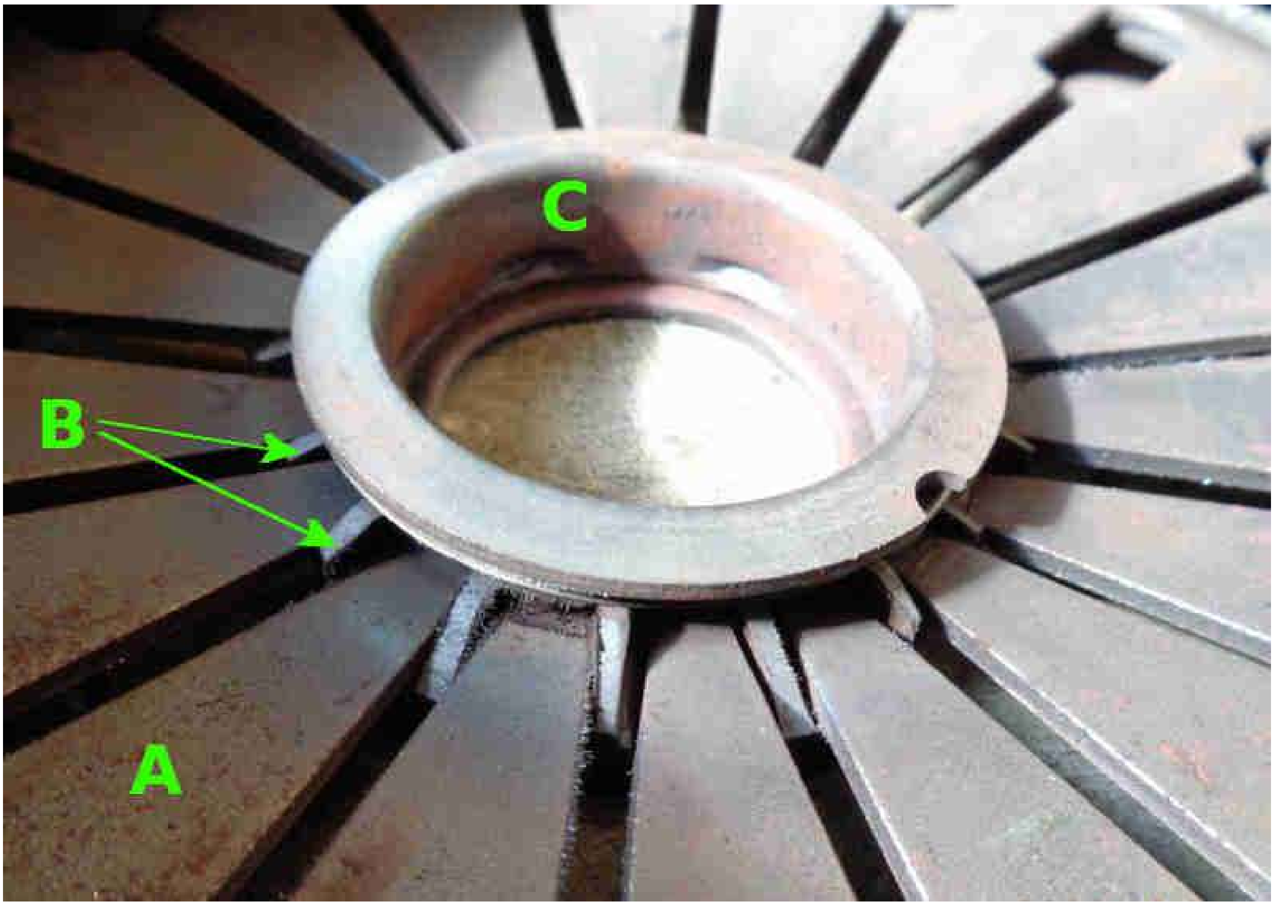
Looking up through the release arm hole, gaiter pulled back - 'A' are the diaphragm spring 'fingers' on the cover plate; 'B' is the release ring with 'teeth' (arrowed) that locate the ring in the slots between the spring fingers. The ring is retained to the cover plate with a flanged sleeve (see below); 'C' is probably the graphite ring on a new release bearing; 'D' is the release bearing casting. As the graphite wears down the casting will get closer to the release ring and the graphite vanish from view, but that will happen some time before the bearing needs replacement: (*Mike Dixon*)



As above 'A' are the diaphragm spring fingers on the coverplate, 'B' is the release ring with its location teeth, 'C' is the graphite on e new bearing, and 'D' is the bearing casting:



The 'back' of the cover plate with 'A' and 'B' as above, 'C' here is the flanged sleeve that retains the release ring on the spring fingers:



Richard's Ford Type 9 gearbox showing the guide tube for the release bearing (as per the V8), and also how it has to be cut back to fit to the MGB engine: (*Richard*)

Clutch Hydraulic Travel

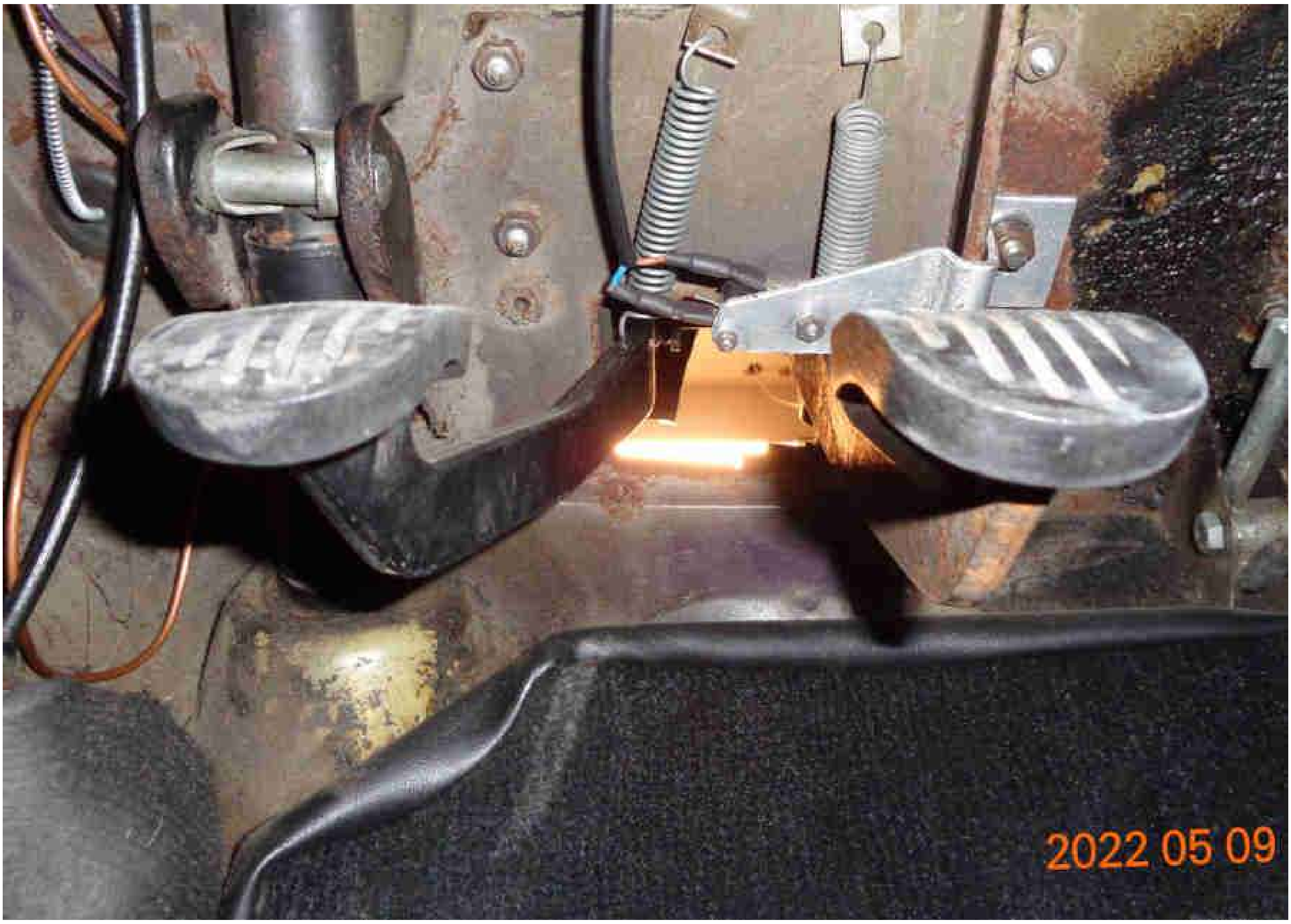
People with clutch woes often ask what the travel of the slave cylinder push-rod should be. Usually most say around 1/2", with some saying theirs is less and others more, which have fallen into the range of 3/8" to 5/8". One person on the MGOC forum had replaced a POs plastic-bodied reservoir with another when that failed, but that started leaking after about 100 miles. It seems he had also been having difficult selecting gears, so started investigating travel and came to the conclusion that there was no way the system could generate 1/2" of clutch slave travel and was talking about using a V8 slave as that has a smaller bore. As well as the different shape and size of the V8 slave compared to the 4-cylinder it would increase pedal effort significantly. The V8 already has a heavier pedal as it has a higher ratio, and the larger bore of the 4-cylinder master would make it heavier still. More info on bore sizes and ratios on the main clutch page. He got really bogged down in taking dismantled measurements and making calculations, and whilst I agreed with the bore of both the master and slave I did not agree with some of his others, particularly only having 26/27mm of master piston travel whereas I reckoned it was more like 35mm. In the past I'd modified the master push-rod and pedal to give even more travel in an attempt to lift the biting-point on the roadster (which turned out to be caused by misalignment of the release-bearing with the cover-plate, more info on that here).

I said several times that you can measure components and do calculations until the cows come home but until you get an installed system with no air (which he had problems getting out anyway) you cannot get an accurate measurement of slave travel, but he didn't do that. His installation is further complicated by him having a Ford Type 9 gearbox so I wondered if the release arm could be a factor, but apparently the MGB release arm is used so unless the bell-housing or other parts of the gearbox are badly out of line it cannot be a factor. I know others use the Type 9, and also that others use the plastic-bodied master, but I don't know if anyone has both. I suggested he ask on the forum, but he didn't do that. The plastic-bodied cylinders do seem have less depth than the tin reservoirs - 120mm as opposed to the 125mm I measured on an old one, but I still couldn't see that making the difference as by my calculations he should still get more than 26/27mm of master piston movement when the pedal hits the carpet. I'm sure it was discussed at the outset that 'difficulty selecting gears' could mean a multitude of things, lack of clutch disengagement being just one of them. The type 9 does not have synchro on reverse so that is the first test - does it grind selecting reverse? No. Where is the biting point? Not answered. With the off-side rear wheel raised, engine running and in gear, does the wheel stop turning when the clutch is fully depressed? And it should do that without being fully depressed? Not done. With just the reverse test the conclusion has to be it's not the clutch but the gearbox, and then he said the difficulty is changing up or down between 2nd and 3rd. You shouldn't need a clutch at all changing from 2nd to 3rd (as long as you give it a moment in neutral ...). When he started talking about gear sets with different metal synchro rings having different effects I left him to it, he has repeatedly got bogged down in irrelevant minutiae on a number of topics in the forum.

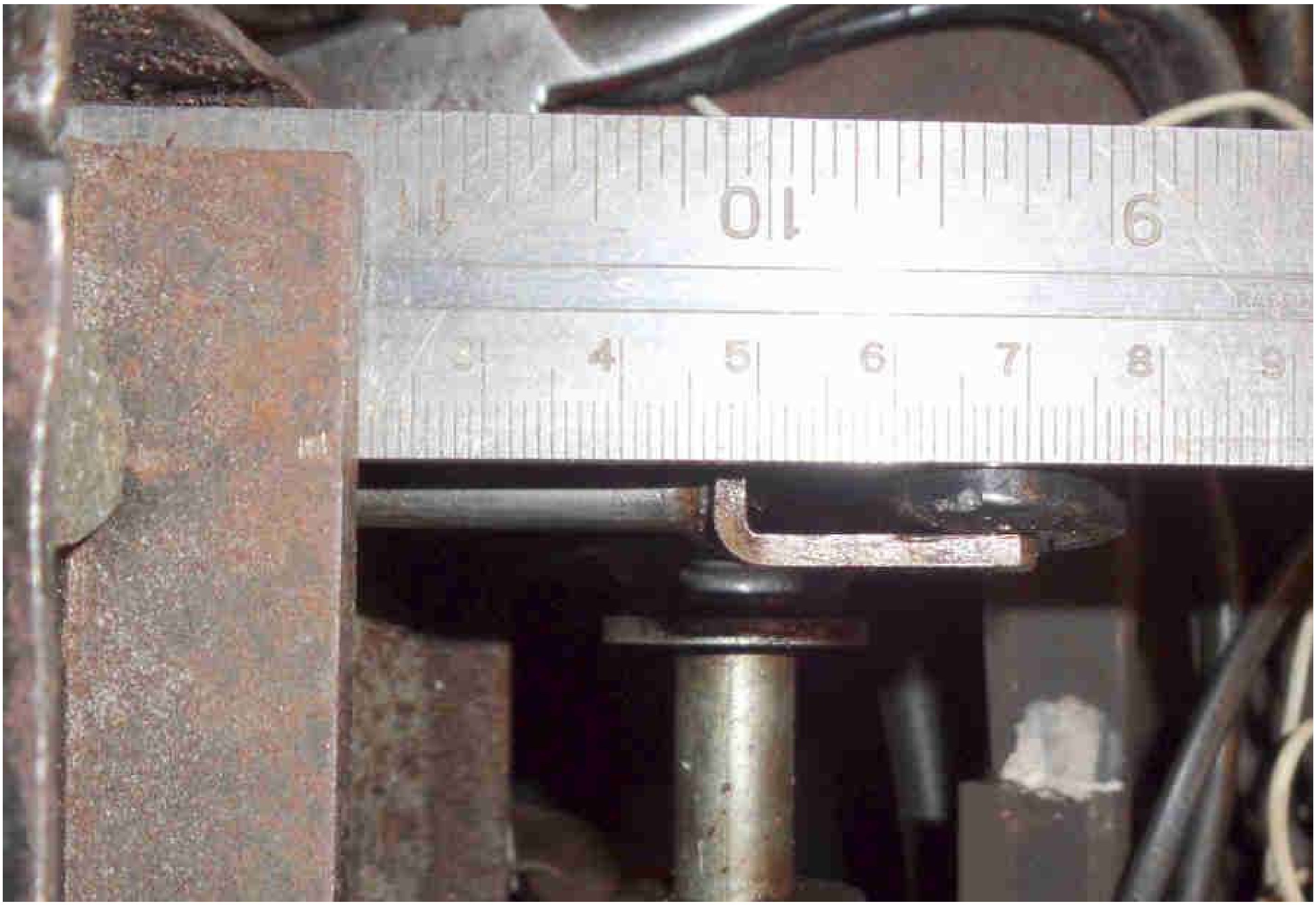
Practising what I was trying to preach, I removed the roadster pedal cover and took a number of measurements there of my standard tin master, as well as down at the slave.

Standard pedal and push-rod, centre-point of the clevis pin at an arbitrary 65mm:

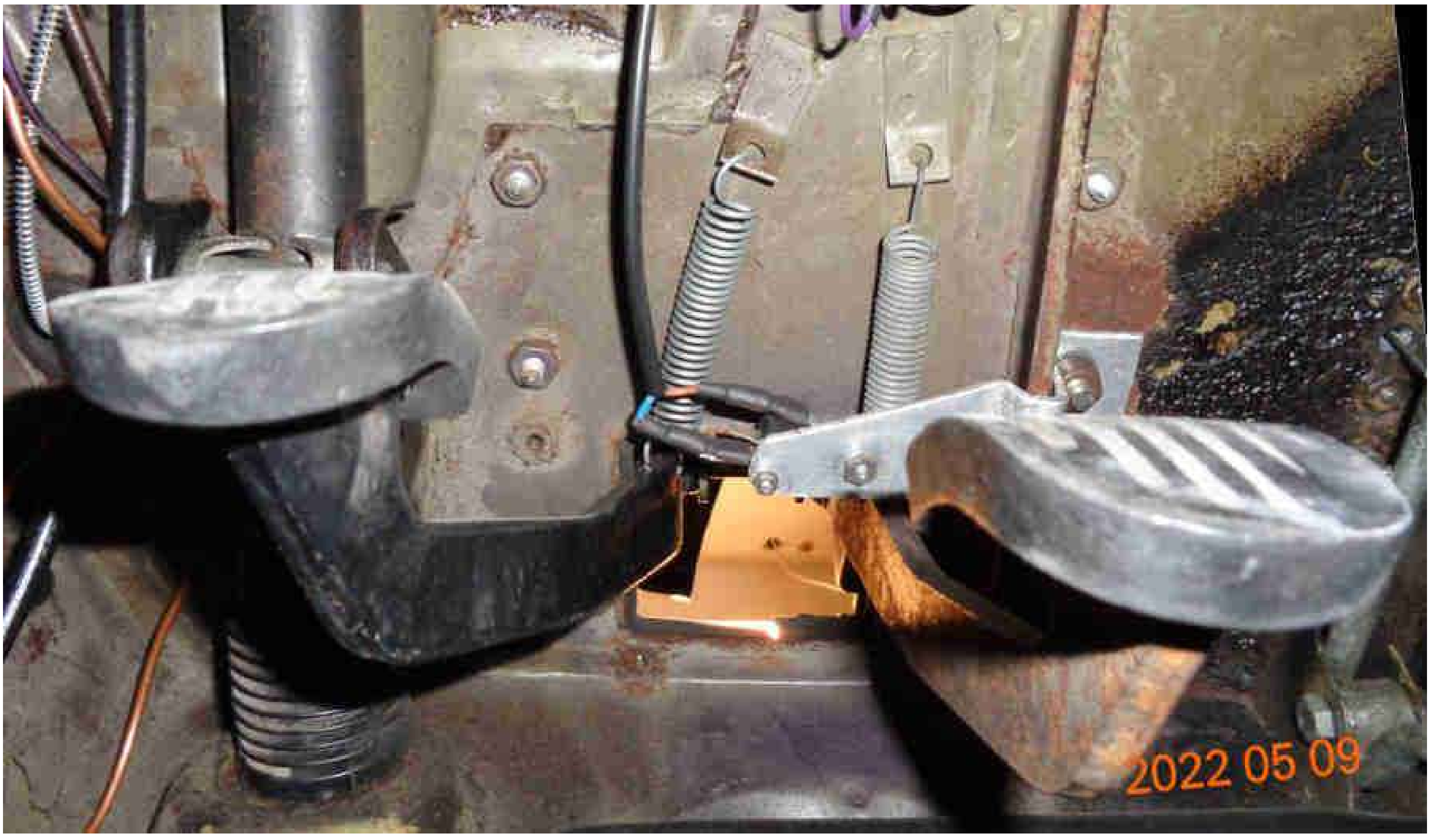
Pedal foot-pads equal:



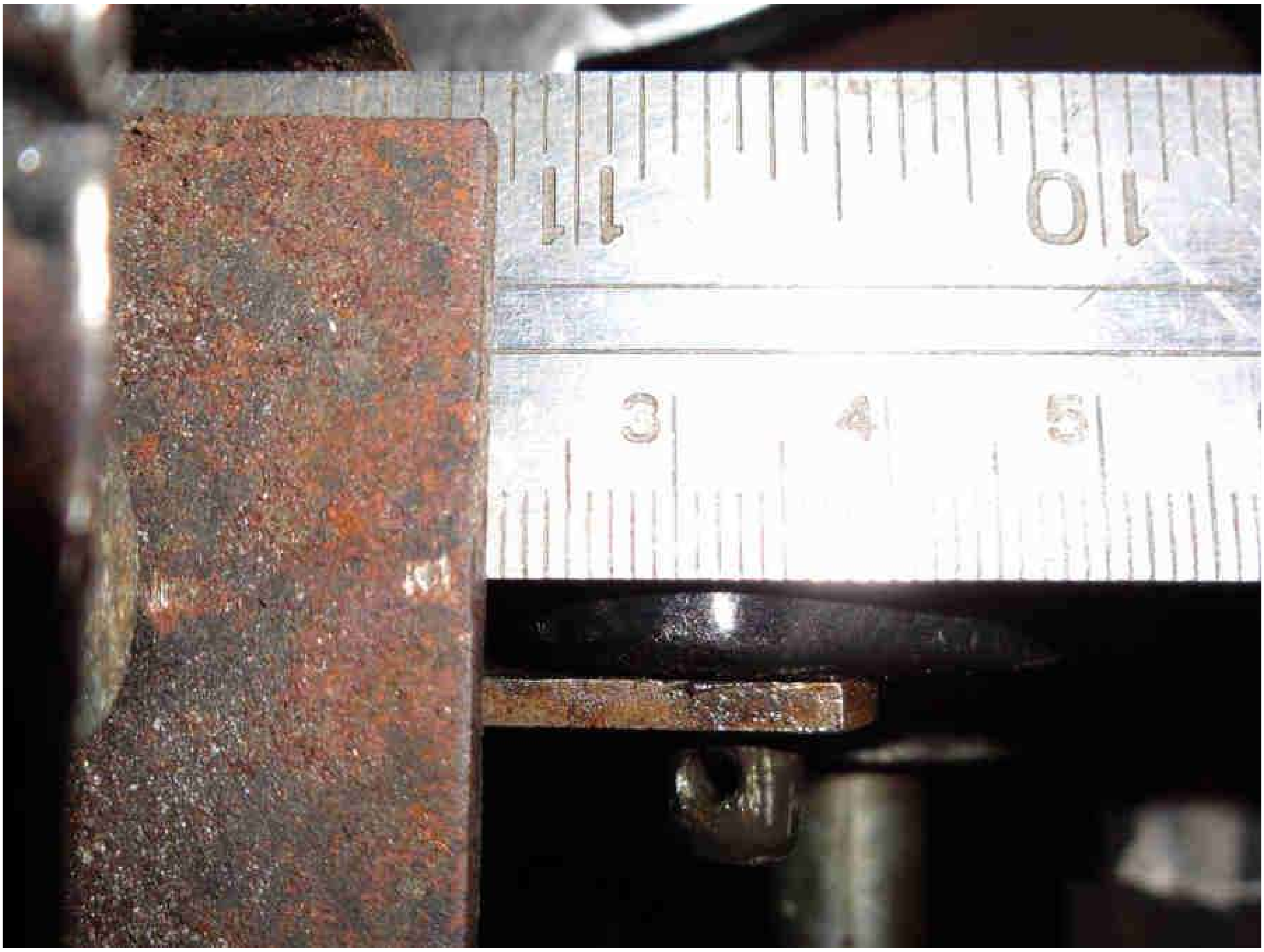
Clevis pin removed, the pedal can come back a further 5mm. Previously I had modified a pedal and push-rod in this manner to give more travel:



Clutch foot-pad now about 1" higher than the brake. One might imagine this would make things really awkward, but using one leg for the clutch and a different leg for the brake I drove it for a while like this with no problems, and the ZS 180 pedals are like that from the factory!

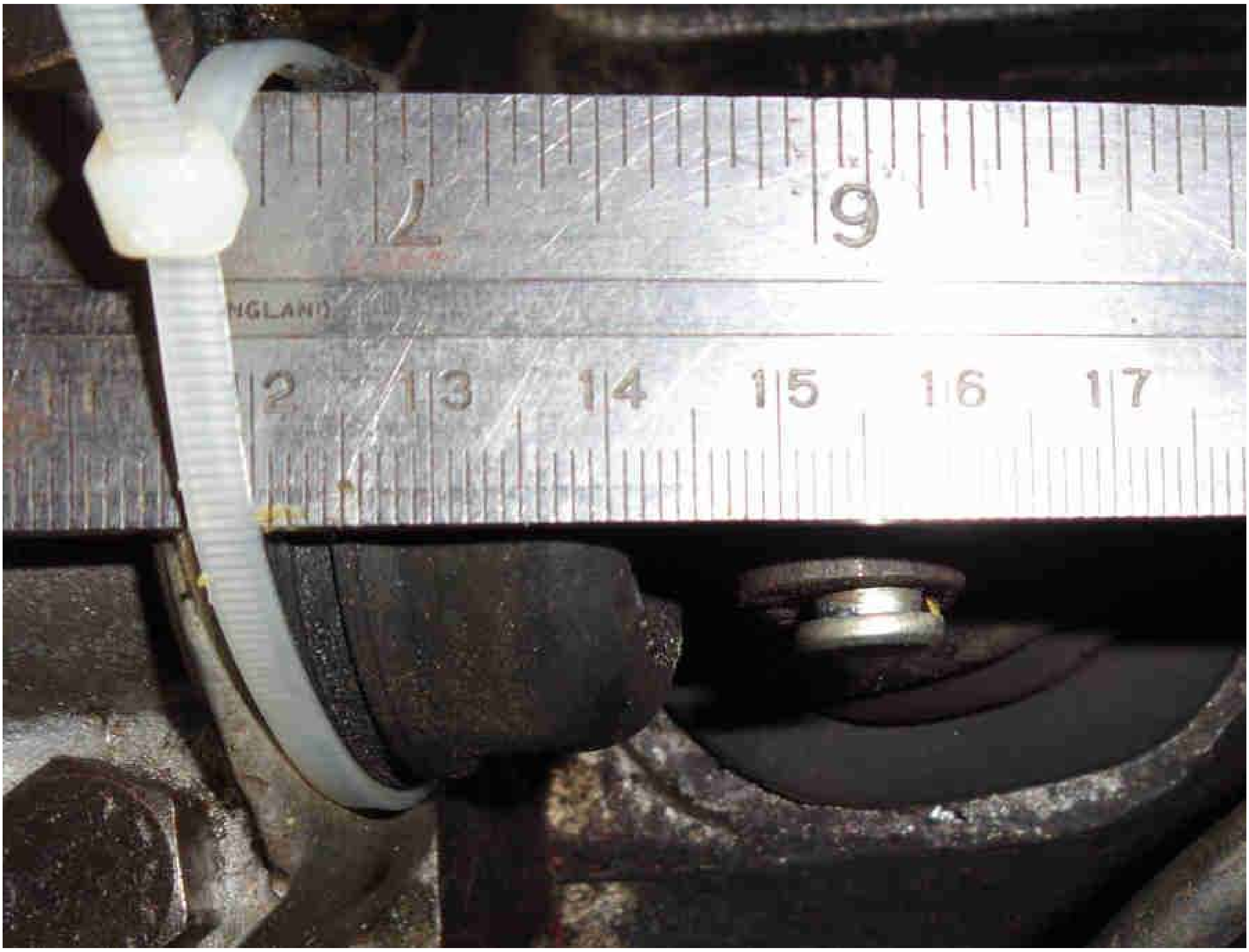


Clevis pin back in (minus split-pin at this point) and pedal jammed down to the carpet - centre-point of the clevis pin now at about 32mm, therefore giving about 33mm of master piston travel:

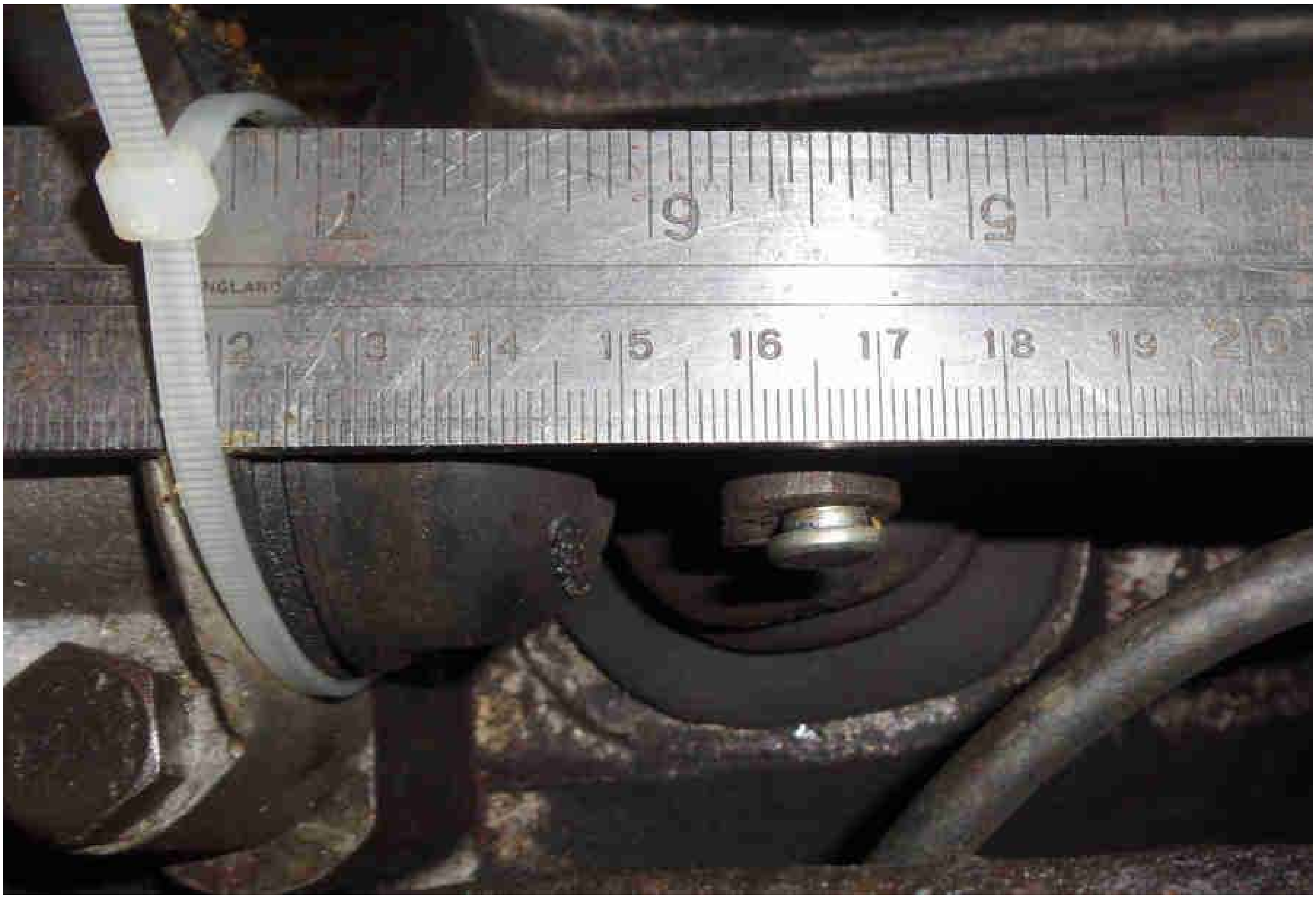


Clutch pedal fully depressed, push-rod fork still about 3/4mm from the dust cover. With the modified pedal and push-rod it was hard up against the dust cover:

Slave cylinder, pedal released, convenient mark on the push-rod fork at an again arbitrary 154.5mm:



Pedal fully operated, mark now at 166mm. This means there has been 11.5mm of slave push-rod travel, or 0.453". That's between 7/16" and 15/32", so as near as dammit 1/2", and makes the biting point slightly higher than I would like so no shortage of travel there.



I've just noticed that the two pictures of the slave are 'upside down' to how they are on the car, but the camera flash gave a clearer picture that way up, and I didn't think to reverse the ruler. I could flip it over but then the numbers would be upside down.

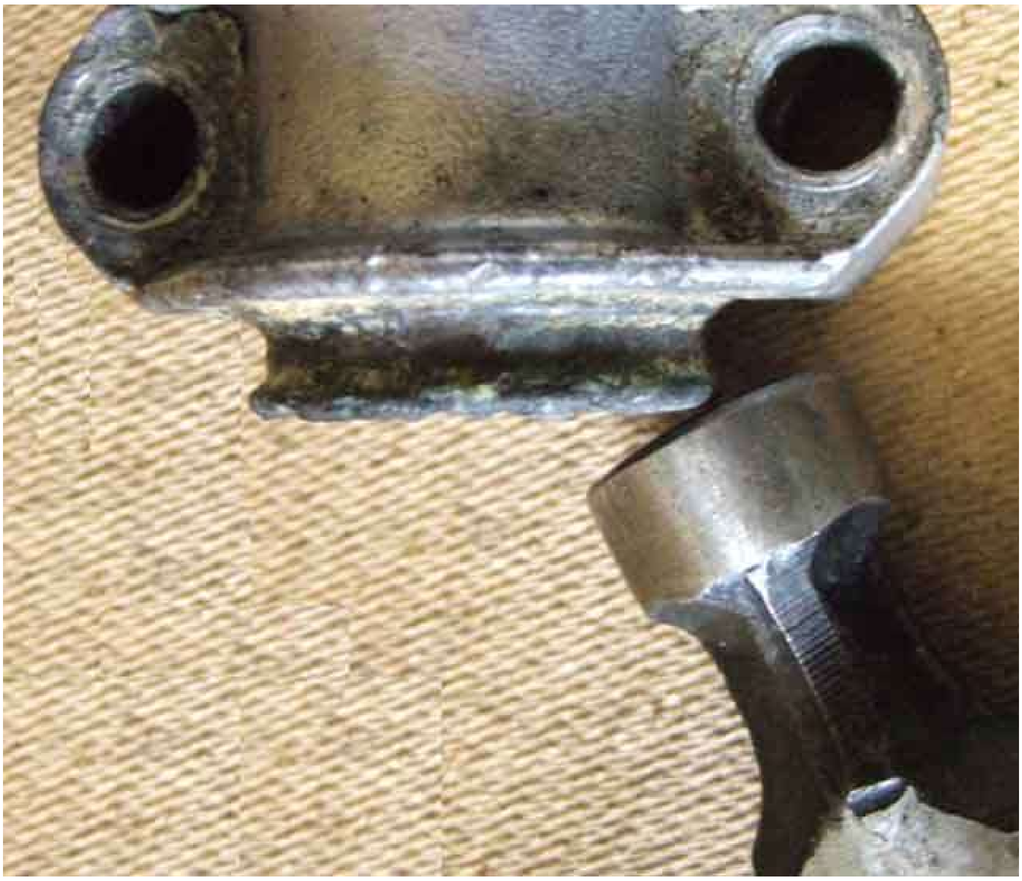
Clutch Slave

4-cylinder V8

4-cylinder
The muck and gunge both inside and outside

Cleaned, seal positioning disc separated from the spring, and the external boot turned inside-out and its clamping ring removed. This also shows the correct position for the bleed nipple and hence the hose.

Tap the edge of the cylinder at an angle to dislodge the piston. This and the chamfer on the inside of the cylinder prevents a lip being created which will trap the piston.



Showing the very close fit between piston and cylinder wall. I have read one claim where so much wear had taken place that the piston got 'cocked' in the bore and jammed. I can't really see this, the seal would have become so loose it wouldn't seal at all long before that, more likely an under-sized piston had been used.

The fluid-side of the seal.

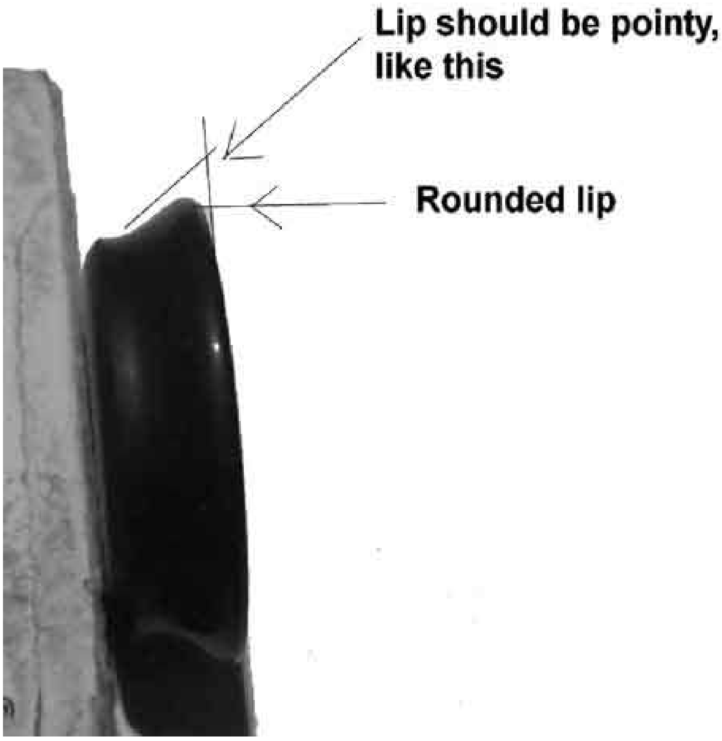
The outer boot with the larger diameter turned 'inside-out' to show the small inner ring that gives a seals the boot to the push-rod as well as the large outer ring that seals it to the cylinder.

The plastic disc that butts up to the fluid side of the seal, showing the three holes.

Not terribly clear, but the pale patch is significant erosion of the cylinder wall, the reddish area lighter corrosion.

Showing the bleed hole (circled) drilled along the line of the join of the cylinder wall to the back wall, in an arc at the top of the cylinder, normally at the highest point of the cylinder when the car is on its wheels or has the front raised.

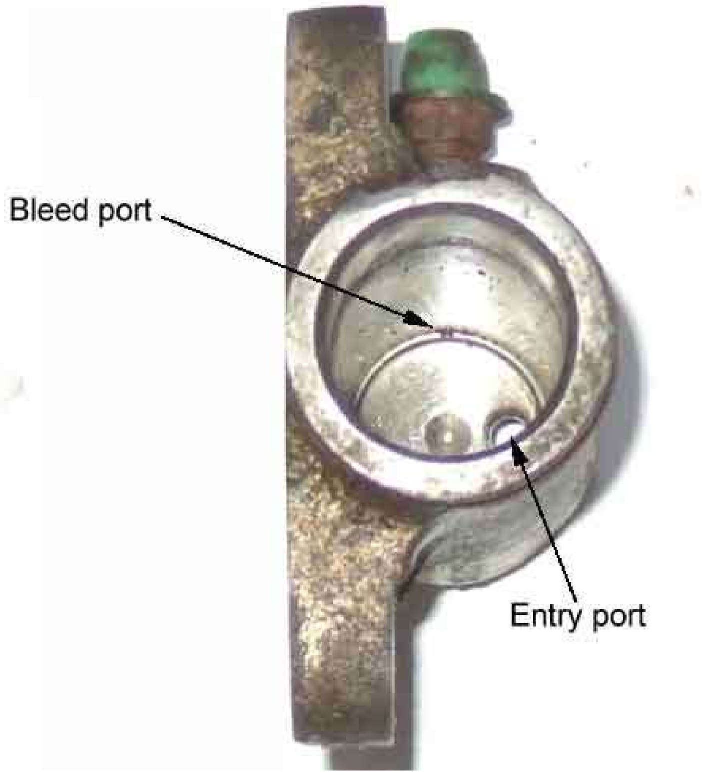
Herb Adler's clutch slave seal, was sucking air in:



V8:
Vee's replaced because of a leak - significantly different. Instead of a 'loose' seal and piston as on the 4-cylinder the pressure seal here is a ring-seal that has to be stretched over the end of the piston and dropped into the groove, similar to brake slaves. Hence the longer piston, and longer slave overall. Also has the 'push out' spring confirming it's not solely used to spread the seal on the 4-cylinder type. Like Bee's brake slave I changed earlier this year the seal is only slightly wider than the piston, so doesn't bear very firmly onto the cylinder wall.

An alternative view of the boot, piston and seal. The end of the push-rod just rests in the large recess in this end of the piston

Internal of the cylinder showing the fluid entry and bleed ports. The walls are very clean apart from a ring of something at the extremity of movement of the seal, although this is the top half.



The lower half, showing a larger area of corrosion where water may have been laying. The problem is that as the clutch wears down the seal will move out bit by bit to take up the wear. The further it moves, the more it encroaches onto areas that have never been used. If any dampness has got into the boot, the risk of rusting and seal moving more and more onto it increases. Not only is this rough making for a poor seal, but it can also damage the rubber.

Clutch Linkage Wear

When I did Bee's clutch pedal I only had a very basic digital camera and the pictures I took were poor. In January 2021 Steve Livesley had the same problem and his pictures show the problem much better than mine did so I show his here. The clutch pedal hole very ovalled, as was Bee's master cylinder push-rod but not Steve's - maybe a replacement master at some point:

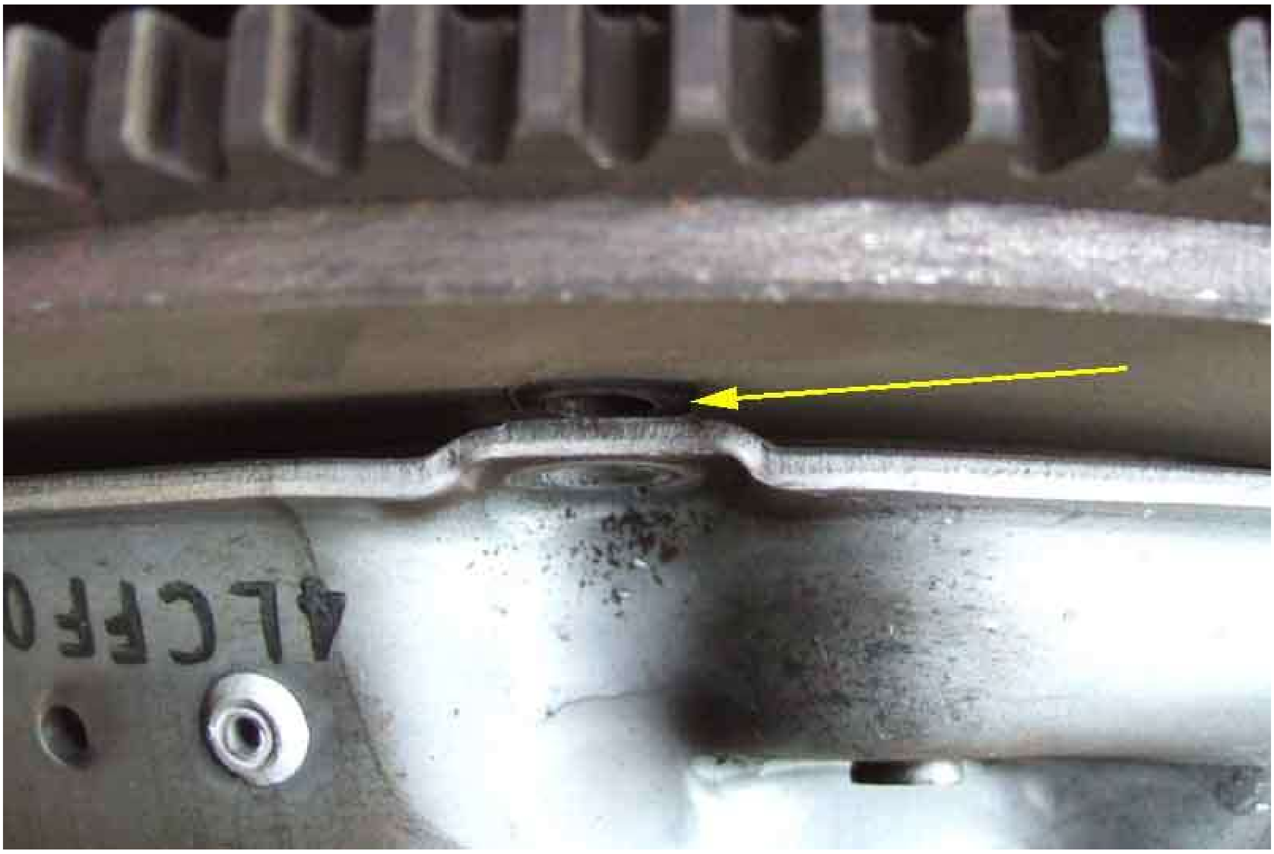
Steve's clevis pin as badly worn as Bee's was:

But looking at Steve's pedal I realised that all the wear is to the right, which means originally the hole would have been considerably off-centre, whereas I remember Bee's (with the wear removed) and two spare unworn pedals were central. This is one of the unworn spares showing that, but it also shows that the left-hand side of the hole is about the same distance from the left-hand edge of the pedal in both cases, so Steve's pedal must be much wider than mine at that point. Not only that, but this hole is nearer the top than Steve's is, which if the pedals have the same distance from the pivot to the top means that Steve's will have less leverage and hence less 'throw' than mine:

Clutch Change 2013

This was opportunistic on another pal's car while the engine was out to replace a faulty overdrive unit. First thing noticed was that the interior of the bell-housing was almost identical to that in 2008, i.e. gungy and shiny with sticky oil, but no dripping. The release bearing was slightly worn compared to the new one, plenty of life left in it, but not worth considering reuse unless one was really desperate. The release arm needs a bit of work as the clevis pin is seized in the arm. No big deal as the slave push-rod is free on the clevis pin, but easier to deal with off-car than on. Michael has a spare complete with rubber boot and push-rod off another gearbox which we thought of using complete, but the boot is a different shape so we have to use the original which fortunately is in good condition, and decide to use the original push-rod as well in case of dimensional differences. That arm is sloppier in the bell-housing than the original, so reject that as well in favour of the original, pressing out the seized clevis pin in a vice using a socket that just fits over the head, then drifting it out, and using just the clevis pin off the spare release arm.

However on slackening the cover plate bolts the cover plate was pushed off a significant amount by the diaphragm spring compared to the RB in 2008, i.e. indicating plenty of life in the friction plate.



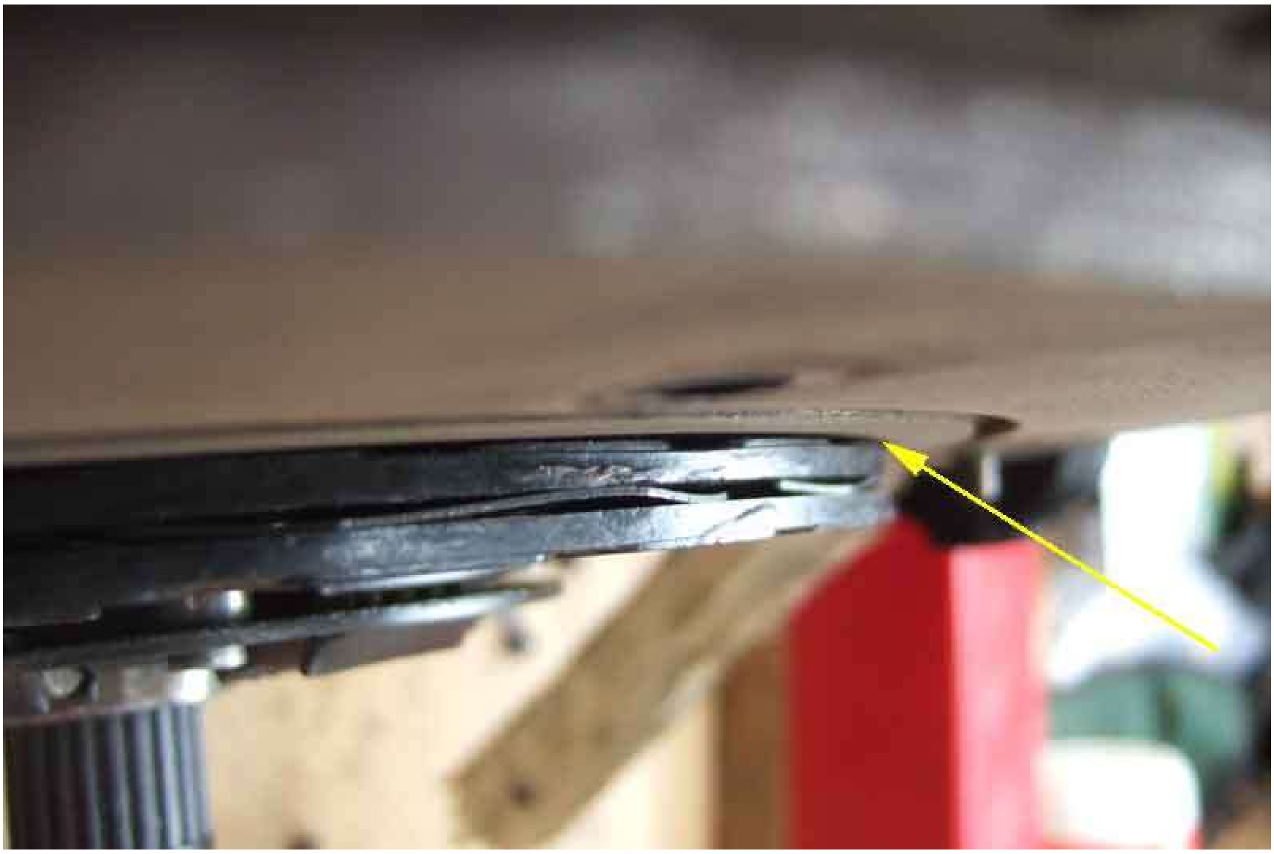
When removed the wear was negligible, so that and the cover plate will be kept for another day.

Witness marks as the rivets pass by, but no grooves on the flywheel, which could have happened with any previously worn-out clutch

New cover plate

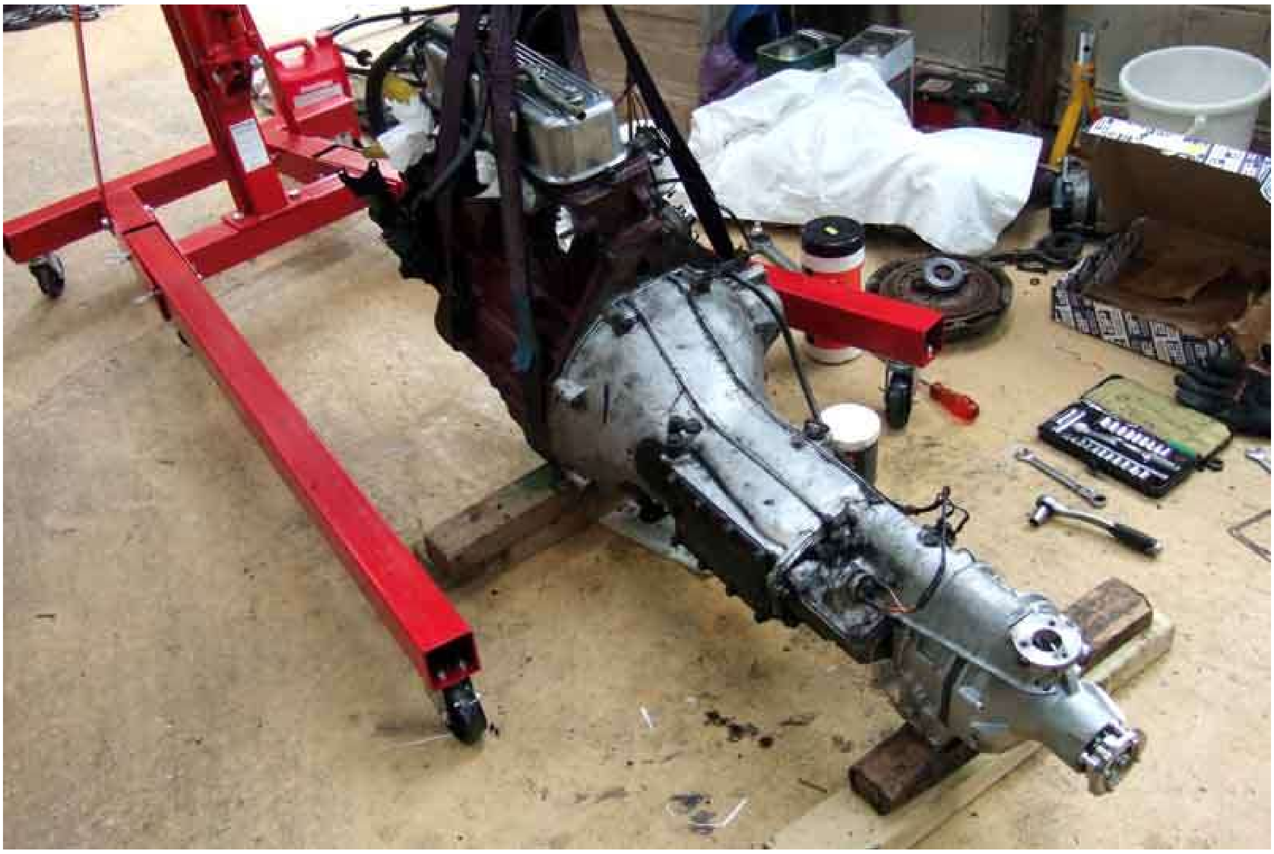
No marking on the friction plate as to which way it goes round, but offering it up to the flywheel both ways clearly shows which is the right way, as the wrong way the metal parts in the middle hold the friction area well clear of the flywheel.

Fitted correctly, no gap



Forgot to trial fit the friction plate to the gearbox shaft before fitting the cover plate, so decided to remove it again to make sure.

A bit of a struggle refitting the gearbox to the engine, trying to keep it square in four orientations while turning the OD output shaft (gearbox in gear) to align the splines. Confirmation that it is **much** easier splitting and joining the two while the gearbox is still in the car, so much so that I would probably do it that way even I wanted to ultimately remove the gearbox. Refitted the gearbox harness to the switches, solenoid and mounting points while it was still on the floor - **much** easier than trying to do it once installed! Note that the harness should go under the remote extension between the two switches, not over as here.



Clutch Change 2008

Last updated 22-Dec-2023

About a year ago a friend bought a 'barn find' (actually garaged for four years) 78 GT for a song which only took pump points cleaning and clutch bleeding to get going, even passed its MOT. However the clutch seemed to be slipping a bit although only in 4th and had a high biting-point, so that was obviously on the way out. 12 months on it is much worse, slipping in all gears now, and I was game for the challenge. Bought a B&B clutch kit, checking that the release bearing was of the bonded type and not the pinned type.

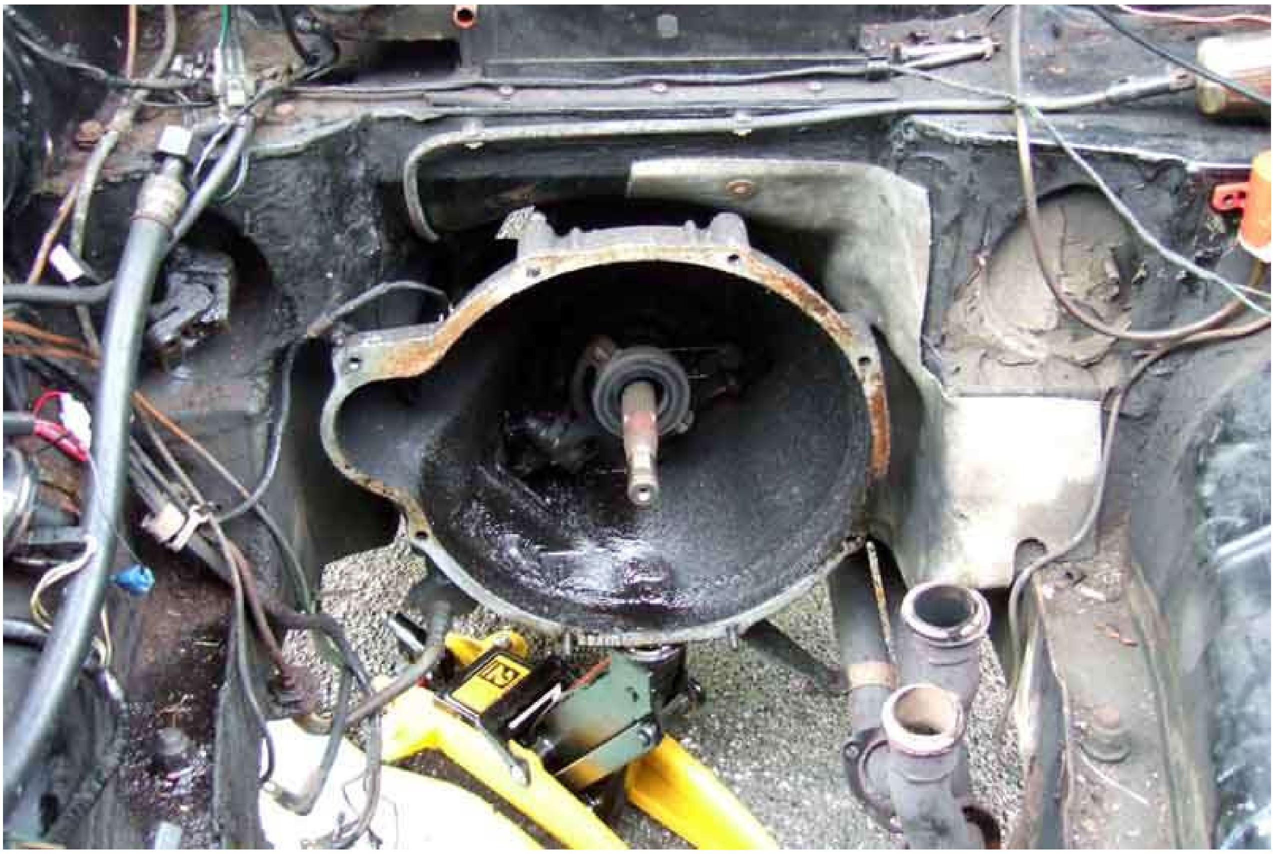
Dismantling was straight-forward enough - until it came to the nuts holding the rubber mounts to the chassis rails! I left the carbs and alternator on the engine but removed the air-cleaners and put paper bungs in the cab throats. I removed the distributor which enabled me to remove the starter from above (although possibly only the top bolt into the bell-housing needs to be removed, the bottom bolt could be left in and the motor left attached to the engine). Note these two bolts have different threads, one coarse as it screws into alloy and the other fine as it screws into steel. Whilst removing the solenoid operate connector the spade broke off the solenoid - repair number one. And when removing the servo hose (which needed replacing) I had to cut through its servo hose clamp as it had seized solid. The oil-cooler pipes were a pain - why is it that it is the adapter that always comes loose from the block first and not the pipe union? It means you have to get another big spanner or something (I wedged a screwdriver between the flats and the back-plate for the rear pipe) to undo the pipe union. Taped up the block fitting to stop debris falling in. Wrap some paper round the oil filter and head to stop oil dripping out, and prop the ends of the hoses up high for the same reason. I left the oil-cooler in-situ (and hence that end of the pipes) as it was underslung like a V8, also the diaphragm, but removed the radiator. This isn't strictly necessary with a late model with the forward-mounted radiator as there is more than enough room to get the engine forward to clear the first-motion shaft, and if you are worried about hitting it you can put a board in front of it. But it had been fitted on the wrong side of the diaphragm and I wanted to correct that, and in the event I would have had to remove it anyway as will become clear. Only one of the studs on the exhaust manifold sheared, but I had bought a full set as a precaution. Decided to pull the rack as it was going to be hard enough to get at the engine mounting bolt that side anyway. Easy-peasy with the track-rod end taper cracking scissors, although the clamp bolt in the UJ and the rack shaft needed a bit of persuasion.

But those mounting nuts! They fought us every inch of the way, despite releasing fluid, WD40, undoing them a bit then working them back and fore and so on. Space is **very** restricted, you can only turn them half a flat at a time. Fortunately I had a slim ring-spanner that I could get on, an open-ended would never have done it. They were so tight I was having to bash the other end of the spanner with a lump hammer to get them to move at all, which lying on my back under the car and working above me was extremely hard work. Keith (the owner) could only be there occasionally due to work commitments, but fortunately one of his free periods coincided with this so he was able to help by pulling on a rope running under the car (forwards for the one side, rearwards for the other) tied to the free end of the spanner while I lay underneath moving the spanner half a flat at a time. We got the first one off but the 2nd was even harder! It was so stiff after a while the rubber part of the mount was twisting, which meant the nut didn't undo so much, sprung back when he released the rope, and I couldn't get the spanner on the next half-flat. Eventually I drilled a small hole through the edge of the bottom metal plate of the mount and the chassis bracket with the intention of putting a pin in the hole to stop the mount twisting, but in the event the drill snapped as it broke through and did the job anyway. After that it was relatively straight-forward (but still a lot of pulling on the rope) to get the nut the rest of the way off. I did loosen the two front nuts and bolts that hold the mount bracket to the engine front plate, but there is another bolt underneath that and there is no way of getting to that until you remove the mount from the bracket, which I didn't think I could do with the engine in the car (unlike the V8). The only other way I could see of releasing the engine was to lift the engine to 'stretch' the mounts, then cut through the rubber or chisel it of the plates to release the engine, then grind the bottom plate of the mount off the chassis brackets. Fortunately we didn't have to go that far, as it would have meant another trip to Leacy for new mounts (but see below). Just to get that far took half a day, and as it was getting on for tea-time we decided to leave it there, with the engine ready to do a 'Playtex' i.e. lift and separate next day.

Next morning I was on my own again. Assembled the hoist, wheeled it up to the front of the car, only to find that even with the arm at it's fullest extent it didn't even reach the front of the engine! I didn't think removing the front bumper would have given me enough movement even though the rubber bumpers are pretty thick, so I had to push the hoist in from the side, and even then it only just reached over the rocker cover with about an inch to spare (thick cloths over the wing to prevent damage from the pump which was also in the way!). Slung a tow-rope through the eye in the hoist, down between the alternator and the block behind the front mount brackets and in front of the sump, up and through the eye again, then down the back of the engine and under the back behind the sump, and tie off. Started jacking up and tested the 'twang' of the front and rear parts of the rope - it's important to lift the engine so that it will be as square as possible to the bell-housing as they are parted to avoid damage to the first-motion shaft, and it seemed fine. Before jacking up any more I removed the top two bell-housing bolts while I still had the space, there was another one a bit lower down on the left, but a space below that where it seemed like there should have been another, and another space on the right below the starter. These were undone using a combination ring/open-ended spanner, the ring is at a slight angle, and I fitted it to the bolts the 'wrong' way round so the arm of the spanner was angled forwards instead of backwards. That left just the two bottom bolts which I had checked were free but retightened, so that as I jacked the engine up to clear the mounts from the chassis rails it lifted the gearbox with it and they remained together, the bottom bolts holding the bottom of the joint together, and the forces pressing the top of the joint together even though the bolts were out. You need to jack it until the bell-housing reaches the tunnel, or nearly so, which is why the top bolts are best undone first. Once up far enough a trolley jack under the forward part of the bell-housing jacked up a little bit more just so as it is taking the weight of the gearbox, then you can undo the bottom bolts. A bit of a pull and the joint parted, staying nice and square so confirming the engine was correctly balanced.

Now came another tricky bit - because the hoist was in from the side, and the front wheels at least only go back and fore and don't pivot, I couldn't easily pull the engine clear of the first motion shaft. I had to tie a rope to the engine and pull it back (i.e. towards the front of the car) as far as I could, tie it off on to the bonnet slam-panel (hence removal of the radiator required anyway), then get under the car and drag the wheels of the hoist sideways a bit, then pull on the rope a bit more, drag the wheels a bit more and so-on until the clutch cover-plate was free of the first motion shaft, then I could jack the engine the rest of the way up to clear the top of the wing, and pull it backwards away from the side of the car. Once clear of the car I lowered it onto a saw-bench for some stability but still left the hoist taking most of the weight. Phew! Not bad going, but still took a couple of hours to get that far.

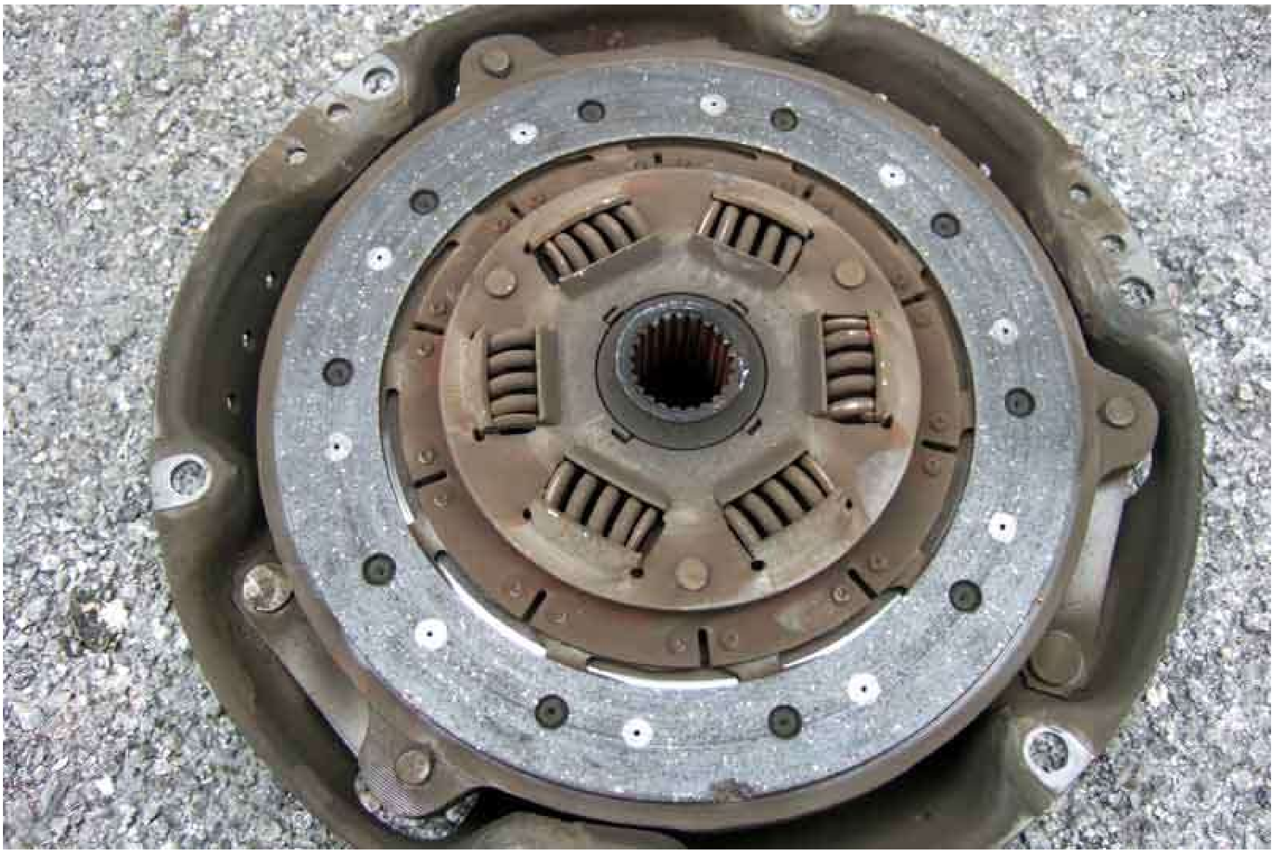
Gunky oil in the bell-housing, around the release arm rather than straight down from the first-motion shaft and cleaner oil if it had been the oil seal. I would very strongly advise freeing-up the connection between the clutch hydraulic pipe and the end of the hose, and the locknut securing the hose to the bracket on the chassis rail while the engine is out even if you don't think you will be removing it later. It's an absolute pig when the engine is in.



No visible seepage from the seal itself, so just checked the nuts on the seal plate for tightness. Check the release arm does not wobble on its pivot, but still moves freely. If the arm wobbles the release bearing can be off-set to the cover plate which causes premature failure. Also note that the release arm fork is pretty-well concentric with the first motion shaft, which wasn't the case on Bee in July 2016.

Undid the cover-plate bolts, but it stayed where it was, the diaphragm spring pressure should have pushed it off at least part of the way, but I had to lever it off the dowels. It wasn't jammed, it was just that it was so badly worn there was virtually no spring pressure left on the friction plate! The cover plate was badly scored, the friction plate being down to the rivets that side, but fortunately not quite as worn the other side although the raised pads had vanished from that side as well. No blueing or cracking from excessive heat from slipping, a very slight but even wear mark the full width of the flywheel, and even though at first sight there did seem to be a ring where the rivets had been it was only a polish mark and not a groove. Some good news, at least.

Friction-plate down to the rivets, fortunately only on the cover-plate side (facing upwards here).



Flywheel fortunately sound. Only a very slight depression across the full width, what looks like a groove from rivets is actually only a polish mark as can be seen by the reflection of the screwdriver. No blueing from the slipping or sign of oil from the crank seal.

Old and new friction plates - the old has the pads completely worn away both sides plus about half the base material on the cover-plate side. Quite a difference in thickness between old and new, together with the wear on the cover plate it's not surprising it was slipping and the springs wouldn't push the cover-plate off the dowels. Note the centre section containing the damper springs and splined boss projects much further from the face of the friction surface on one side than the other, uppermost on both these. This side faces the cover plate, if incorrectly fitted it prevents the friction surface from reaching the flywheel. So offer up the new one first to double-check, and triple check any 'flywheel side' legend on the new friction plate.

New (left) and old (right) release bearings - plenty of meat left on the old, perhaps only 1/3rd worn, as in theory the boss on the cover plate can go right down inside the release bearing casting. However the release bearing would need to be exactly concentric with the cover-plate boss, and in practice it seems there can be significant misalignment between the two which would mean that as soon as the graphite has worn flush with the bearing casting, you get metal on metal and very rapid wear on both, to be followed by catastrophic failure of the bearing casting. Under those circumstances, this bearing is just about worn out.

A useful set of instructions with the clutch describing things to check (like same size etc. as the old parts), clean (like the greasy film off the rubbing surface of the cover plate), and most importantly that the new friction plate fits over the splines on the first-motion shaft! Cleaned all the old friction material dust off the flywheel, slotted the friction plate onto location tool, and the plate and tool to the flywheel. Offered up the new cover plate and fitted the bolts, this time there was probably about 1/4" gap left to the flywheel when the bolts started taking up spring pressure. Mindful of people having fitted the friction plate the wrong way round (the flywheel side should be marked as such) I took the cover-plate off again and doubled checked. But note that the central section on the friction plate containing the damper springs and splined boss projects much further from the friction material surface on one side than the other, this side faces the cover plate. Fit the friction plate with your alignment tool to the crankshaft and check it is reaching the flywheel before fitting the cover plate. If you get it the wrong way round the damper springs will be resting on the flywheel instead of the friction surface, and the cover plate will be much further away when you start to tighten the bolts. I wasn't able to fully torque them up (25-30 ft lb) as I needed to stop the flywheel turning and decided it would be easier to wait until Keith came by again than rig up something myself (rope fed through a plug hole to stop the piston reaching TDC is one method I have read of). Unhooked the spring clips holding the release-bearing to the fork, carbon still visible above the edge of casting so still plenty of life left, but certainly not worth leaving. There was quite a bit of really thick black grease/oil at the bottom of the bell-housing, but with the bearing off I could see there wasn't a leak from the oil-seal, so just checked the bolts on the plate the seal sits in for tightness. The clutch kit includes a little tube of grease so smear some on the pins of the release bearing and fit that to the fork and refit the springs.

Time to get the carbs and exhaust manifold off to drill and retap for a new stud. Used a small drill first to check it was in the centre of the old stud at both ends - a little bit of side drilling required to square it up, then through with the correct size, taper tap, plug tap, screw in stud with double nuts and job done. When I came to refit it with a new gasket I found the same thing had happened as to the tubular V8 manifolds in that it had warped, and the outer holes on the manifold were closer together than the holes in the head. I fitted one, then tapped a screwdriver down between the centre branch and its adjacent stud to spring that a little bit, then between the outer branch and its stud to spring that as well, and got the other outer bolt in. Smears of Hermetite red on one face of each joint for the intake (there are no less than eight joints!) and bolt them up. The HIF are convenient in that the link pipe that feeds fuel from the front carb to the rear helps to keep them together and all the linkages in place. Cleaned up the studs on the mounts as best I could and worked a nut up and down each one with copper grease until they turned relatively easily.

Keith arrived again, just in time to hold the flywheel while I finished torquing up the cover-plate bolts. More clutch grease on the nose and splines of the first-motion shaft and the splines of the friction plate, then hoist the engine to clear the wing, push it over the engine compartment following the tracks made in the drive when pulling it out, and lowered it to be in line with the first-motion shaft. Tied off the engine again while we kicked the legs of the hoist sideways, then gradually released the rope and fiddled with the height to line it up. One very useful tip is just before the end of the shaft enters the hole in the cover plate feel with a finger to check the clearance is the same all round, and when you start moving the engine onto the shaft check the teeth on the flywheel are square with the bell-housing when viewed diagonally downwards from each side. Get the same alignment of flywheel to bell-housing all the way round and the engine **has** to be square to it as well as at the correct height and sideways alignment. I don't know whether we were particularly lucky, but just turning the crank pulley nut while pushing the engine forward, then giving it another push, and it went right on! I did see a recommendation that if you jack one rear wheel, put it in gear, you can use the rear wheel to turn the first-motion shaft into alignment. Personally I think it is easier to turn the crank pulley - put it in gear as before but this time make sure the rear wheels aren't going to turn i.e. lock the first-motion shaft in place, while you turn the crankshaft into alignment. We didn't put it in gear i.e. the shaft was free to turn, maybe we were just lucky, or maybe the grease on the nose and splines of the shaft helped. Bolted up the bottom of the bell-housing, lowered the jack, and lowered the hoist to get the mounting studs into the slots. This was a bit tricky as they were about 1/2" too far back. I probably should have disconnected or slackened the engine restraint tube on these models, but with a bit of pulling and levering we got them in. Fitted the locating plates, washers and nuts under the chassis mounting brackets - another fiddle as you can only get a couple of fingers up from below and one in from the side, and they did up a lot easier than they undid. Then it was a matter of refitting things that needed two pairs of hands while Keith was still around like the exhaust (new sealing rings, metal side down as that was how they came off), I had to disconnect the front restraint strap as it was holding the exhaust in the wrong place. The rack needed a bit of persuasion again to get the splines inserted, check the notch in the shaft is aligned correctly with the split in the UJ i.e. there are the same number of splines each side. We chocked the back of the UJ against the firewall while tapping the rack casing with a hammer and block of wood, and it went in easier than it came out. With the starter I tried soldering another spade to the stub of the broken one but the rest of it broke away as well, what it is made of goodness knows. Fortunately the ends of the solenoid wire were sticking up a bit so I was able to wrap a short piece of wire round that with a male spade soldered to the end. Refitted the starter with me underneath supporting it while Keith got the top bolt in, then the bottom. End of day 2.

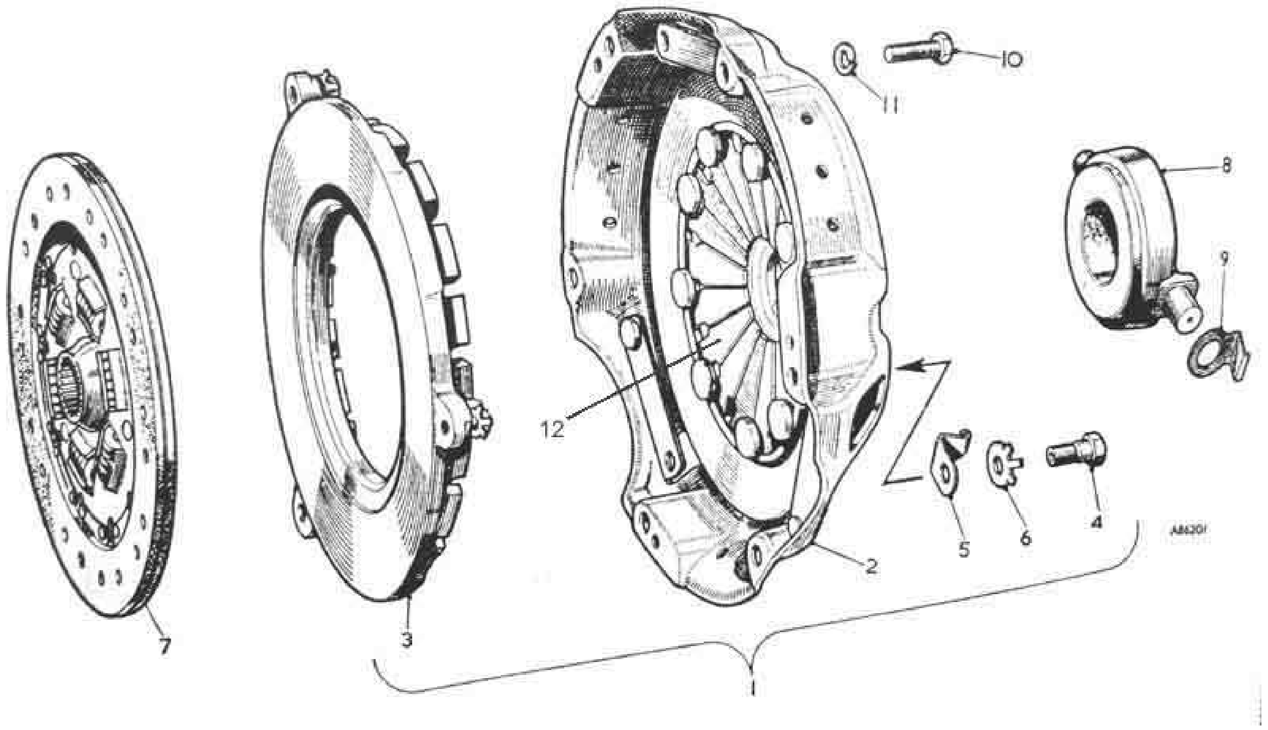
Then it was a matter of fitting oil cooler and gauge pipes, wiring and plugs to starter and alternator, carb throttle and choke cables and fuel pipe, heater tap control cable, and hoses. Both the bottom hose clips would only tighten up so far 'before jumping a tooth', as it were, no spares to hand, so they would need replacement. Cut the new servo hose to length and fitted that, with a spare clip that I **did** happen to have to hand to replace the broken one. Refitted the distributor, removed No.1 plug and turned the engine with my thumb over the hole to find TDC of the compression stroke, and see where the rotor was pointing. It was in the correct place (about 2 o'clock) so on went the cap and leads. Reconnected the battery and tried cranking, OK so the starter repair is good for the time being at least. Tried starting it and it was trying to go, but wouldn't catch. Wandered round to the front of the engine to ponder why and I noticed I had left the paper bungs in the throat carbs! Removed those and it fired up nicely, ran it for just a few seconds as I hadn't put any water in yet because of the hose clips.

Nothing for it now but to bite the bullet and test the clutch! So light it obviously wasn't doing anything, but as I was on my own I couldn't operate it and look at the slave push-rod at the same time. I'd had the slave off at one time while I removed the starter, and even though I put it back once the engine was out the spring inside the master would have pushed the piston out quite a way moving the release arm with it. Couldn't see why it would need bleeding as I hadn't opened the hydraulics, but nothing else to be done. Tried from the top down first of all using a Gunson's EeziBleed on the master - no change. Next I tried reverse bleeding with the Gunsons connected to the slave (having first removed some fluid from the master to prevent overflow) - again no go. Then I tried removing the slave and reverse bleeding it while hanging off the hose i.e. air at the highest point by the hose connection but again no-go. Then I tried manually pushing and releasing the piston. Lots of gurgling from the master so I thought 'Ah-ha' but it did it every time I pushed the piston back, so I guessed it must be sucking in air past the seals as the spring pushed the piston back out rather than drawing it down from the master. Then the slave started dripping fluid, so that was it another trip to Leacy's and more of Keith's money spent, also got a new flex hose. On my return I couldn't shift either the nut holding the pipe on the chassis end of the old flex hose, nor shift the hose or its locking nut on the chassis bracket. Keith said to leave it and we would deal with it when we had to. The problem is that the hose ports were tapped differently old to new (and yes I did move the bleed nipple from its shipping place to the correct place) so when the hose was tightened the only way the slave would sit on the bell-housing was by twisting the flex hose. Fortunately by fiddling about with various copper washers I was able to line it up. Tried reverse bleeding with a pipe connected between it's nipple and the right-hand caliper nipple while Keith pumped but there still didn't seem to be any pressure on the pedal. Next took the slave off the bell-housing and tried again this time with it hanging on the pipe. This time when I pushed the piston back I could feel the pressure from the fluid as I forced it back into the master, but again once attached Keith said he still couldn't feel any back-pressure. However when he pumped it I could see the push-rod moving, but only by about 3/8" and not the 1/2" or so I have seen before. So I tried, and it was indeed very light, but I thought I could feel some back pressure. Nothing for it to start the engine and tentatively try selecting reverse - and it went in as quiet as a mouse! Not only that the biting point was where I would expect it, so it seemed to be working properly (thank goodness!), just very light!

After that it was just a matter of finishing off the hoses, fill with water, retime, and take it for a test drive - perfect, very light and as smooth as silk. The top hose seemed to be dripping by the thermostat housing, so we removed it, spotted what looked like a pin-hole just on the hose side of the clip, so cut that bit off and refitted as there is room to do that with that hose. One of the heater hoses was also leaking at the heater even though the clip was tight (I'd put some Waxoyl on the worm 'threads' which usually helps old clips but not in this case), I had a new clip that size so replaced it and solved that. 15 minutes to replace the clutch, 2 1/2 days dismantling and reassembly!

The Clutch - How It Works

A typical 4-cylinder clutch kit: *(Image: Leyland Workshop Manual)*



Consisting of:

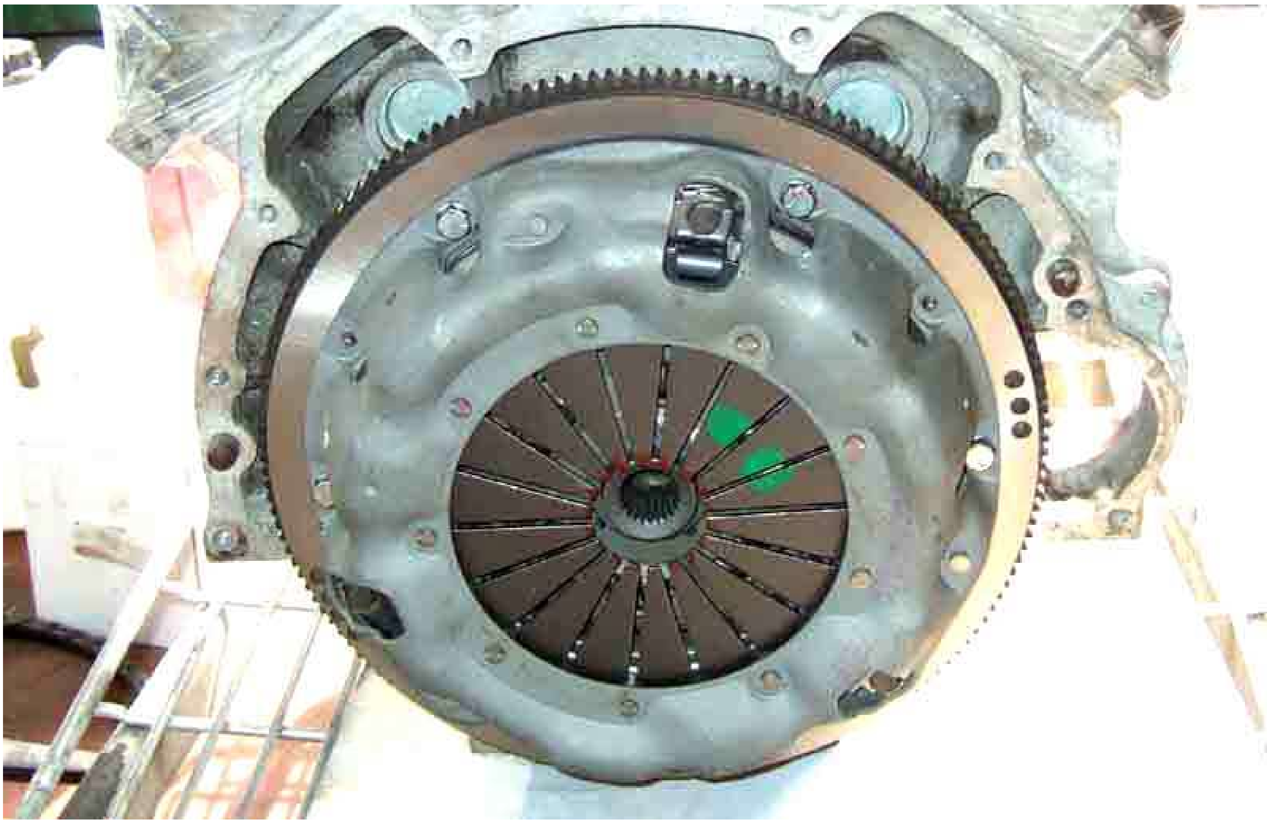
'1' the cover plate assembly, comprising:

'2' the cover plate
'3' the pressure plate
'4', '5' and '6' attach the pressure plate to the cover plate

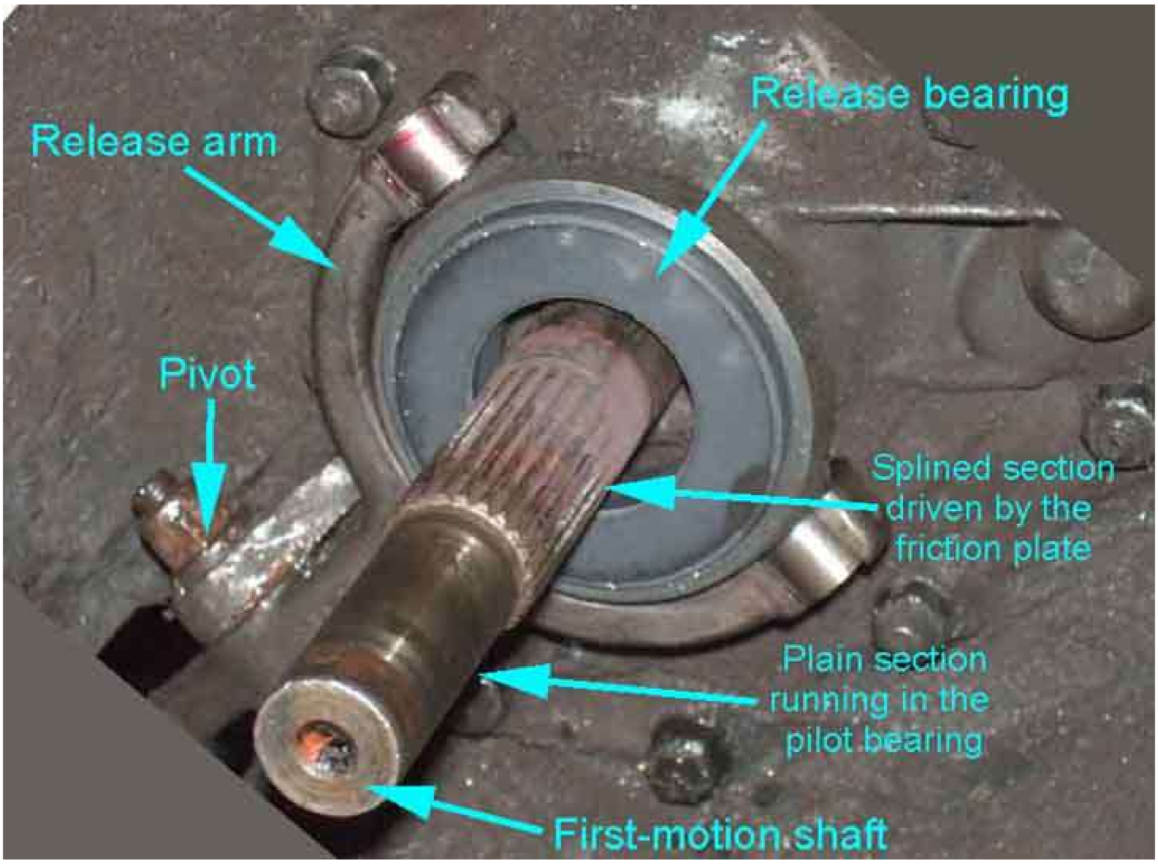
'7' the friction plate
'8' the release bearing
'9' the spring clips that fasten the release bearing pivots to the release arm (not shown)
'10' and '11' fasten the cover plate to the flywheel (not shown).
'12' are the diaphragm spring fingers that press the pressure plate against the friction plate a flywheel to transmit rotation from the crankshaft to the gearbox first-motion shaft.

The cover plate has a 'release ring' (13) attached to the diaphragm spring fingers (12) and the graphite release bearing presses against this to release the clutch.

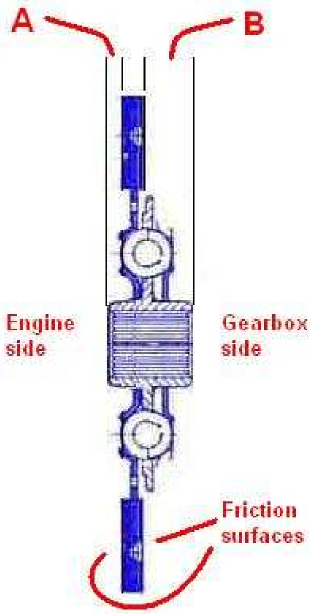
By contrast the V8 (and Midget 1500) clutch does not have this release ring as they use a roller-bearing release bearing, and the face of that rotates with the cover plate so does not need the smoother surface the release ring provides.



The 4-cylinder graphite release bearing with the gearbox first motion shaft protruding, showing the splined section that engages with the splines in the friction plate and the plain section that runs in the pilot bearing in the crankshaft. The release bearing is attached to the release arm and can move towards and away from the flywheel, but does not rotate. Note that with the clutch pedal released the first-motion shaft is rotating with the pilot bearing and crankshaft, but with the pedal depressed the first-motion shaft rotates independently of the crankshaft, and the plain section of the shaft is running in the pilot bearing.

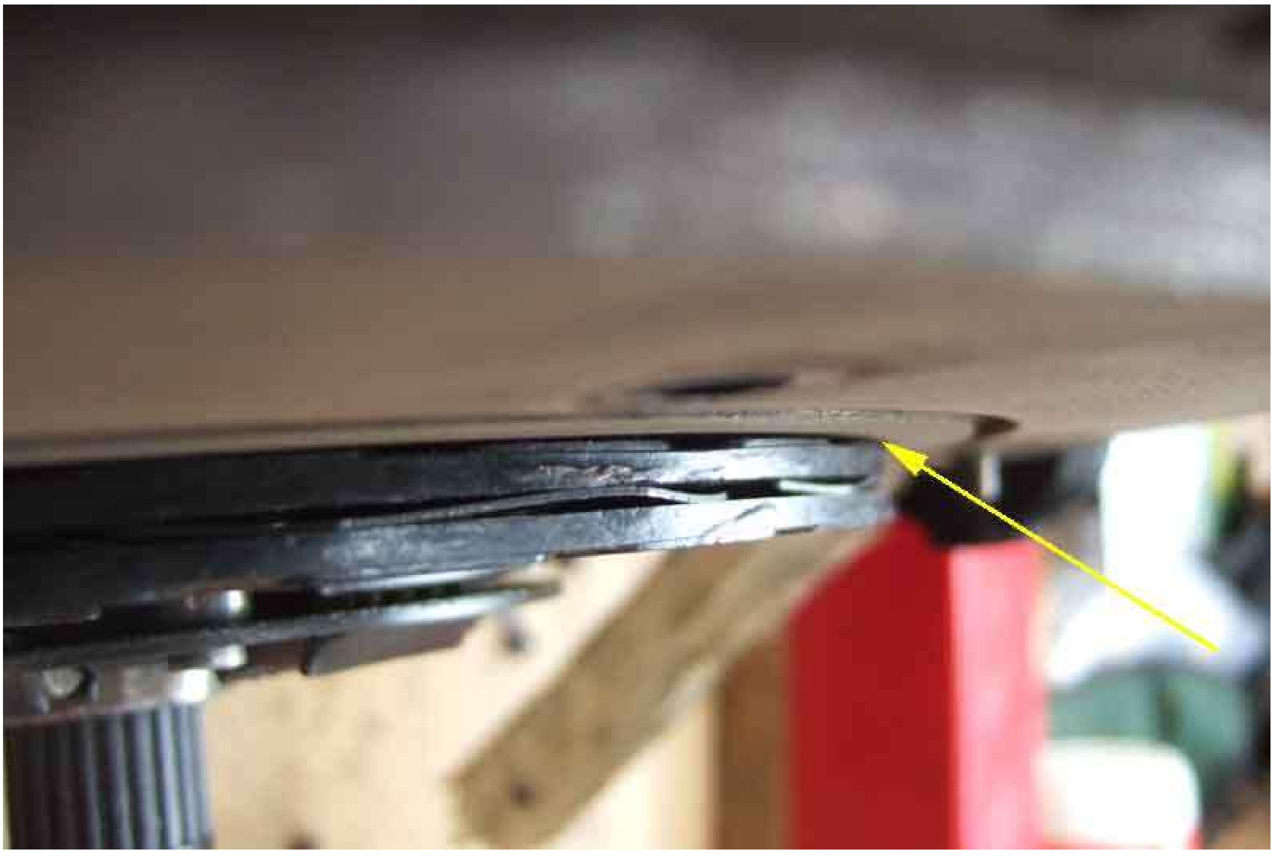


Which way round does the friction plate go? It's often not marked, but there are two ways to tell. The first is that the splined boss sticks out much further on one side (B) than the other (A), and this side faces the gearbox:

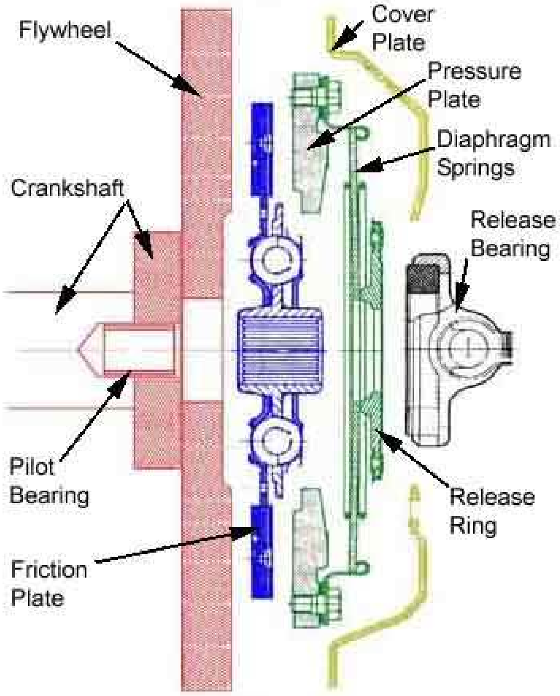


The second way is to offer it up on the alignment tool, and if it is the wrong way round there will be a large gap between the friction surfaces and the flywheel:

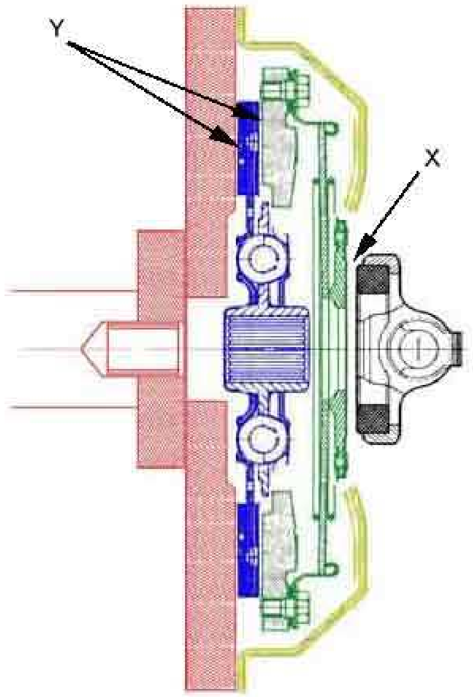
The correct way round there is no gap:



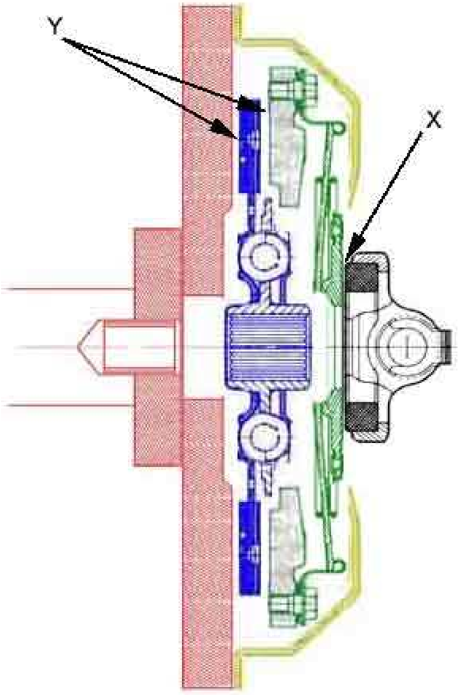
A simplified and exploded view of the component parts. The gearbox first-motion shaft passes freely through the release bearing, cover plate and pressure plate. The splined section is engaged with the splines in the friction plate, and the plain section is inserted in the pilot bearing in the crankshaft.



Clutch engaged: With the cover plate bolted up to the flywheel diaphragm springs push the pressure plate against friction plate which slides on the splines of the gearbox first-motion shaft and is pushed against the flywheel (pressure at points 'Y'). All three rotate as a unit, and drive is transmitted from the engine to the gearbox. The plain section of the shaft is rotating together with the pilot bearing. A clearance is shown at point 'X' simply to show the release bearing is not pushing against the release ring at this time. However in practice this will not be the case as a spring inside the clutch slave cylinder will be gently pushing all the release components together to take up any free play.



Clutch disengaged: Now the release bearing is pushing the release ring towards the flywheel (pressure at point 'X') which moves the inner ends of the diaphragm spring fingers towards the flywheel, hence the outer ends of the fingers away from the flywheel, which pulls the pressure plate away from the friction plate. This allows the friction plate to move away from the flywheel (clearance at points 'Y'), so the flywheel, pressure plate and cover plate can now rotate independently of the friction plate and hence the gearbox first-motion shaft. The plain end of the shaft is now rotating independently of the pilot bearing.


Y
X

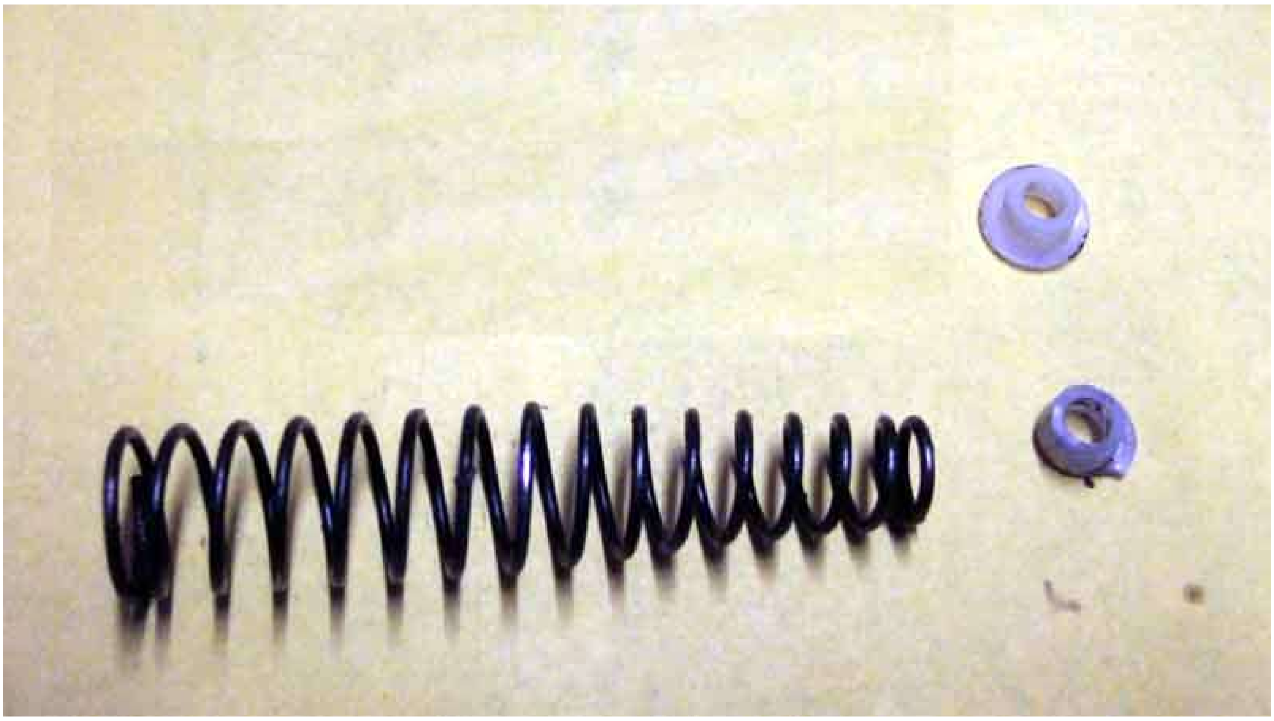
Clutch Master Seal

About 150 miles into a 520 miler for the Pendine Run I became aware the clutch pedal was occasionally lighter than normal, and I was getting baulking and grinding in reverse. As it was intermittent I reckoned it was the main seal occasionally leaking back, i.e. no fluid loss, and a check showed the level was normal. We completed the trip with no further drama, but I protected the clutch as much as I could by only changing gear when I had to, and if I had to come to a stop I only depressed the clutch pedal and engaged a gear when I was ready to move off.

On return home I investigated repair kits and replacements. The original style metal reservoir type are available again after plastic reservoirs having been the only type available for some years, but as previous master replacements had shown the bores with no visible scoring or corrosion, I decided to try a kit. That took quite a bit of sorting out as there are two types of internals, originally with different external markings, but the later internals are supplied as a kit for the earlier masters. This makes it effectively a conversion kit, but it isn't described as such, and means the original seals are no longer suitable. So with a car of unknown history you have to take out the piston to see what type of seals you have. Various suppliers reference this but I don't think they explain it clearly enough, and note that **the ring-type seal repair kit GRK3004 contains the brake master restrictor valve as the kit is common to both brake and clutch but the restrictor must not be fitted to the clutch**.

Despite being a 1973 model Bee's master does not have the later markings, and even though the clutch master hadn't been tampered with in my ownership of 26 years (and I suspect it was original to the car) I drained the system by opening the bleed nipple and pumping with the pedal and removed the piston and seals before ordering spares so I could check the bore. A long screwdriver is needed to get at the one cover fixing screw tucked down beside the inner wing, but a driver that takes hex bits with a couple of adapters and a 1/4" drive extension reached that OK, the others are easier. Cover twists out across the front of the masters towards the engine, with just the water bottle removed from its cradle to give a bit of slack on the tubing which normally sits over the flange of the cover. Split-pin and clevis pin removed, dust-cover pulled forwards, circlip pliers and a wiggle and pull removes the push-rod. The internal return spring pushes the end of the piston with the secondary seal out, pulled that the rest of the way out with my fingers, leaving the primary seal etc. still in the bore. Extra-long nosed pliers (from my BT days) tip the seal over so it can be gripped and pulled out. Peering into the bore I can see the plastic 'spreader' that sits between the end of the return spring and the fluid face of the seal has half a flange broken away so it had been at an angle on the spring and setting the seal at an angle. I can also see a broken piece of the spreader sitting in the bore. The seal itself it quite distorted, so must have been like that for a considerable time, amazing it kept going as long as it has. Fish the bit out and the spring with the remains of the spreader.

The broken seal spreader that came out (bottom) and a good one from an old cylinder (top):



The distorted seal. The vertical line runs through the centre of the pip that is at the bottom of the cup and sits in the hole in the spreader. That should be central, but is clearly displaced to the right because of the broken spreader.

Wrap some hand-wipe cloth round a chop-stick (!) and use that to wipe round the bore, which looks perfect. Because Bee's biting point has been rather low for as long I can remember, and I did modify the push-rod some years ago to give more 'throw' (which only improved things slightly), I decided to order both kits - the original at £4 and the conversion kit at £11. New spreaders not available, but having kept the guts of Bee's brake master and both masters off Vee changed some years ago, and out of those three two had the old-style seals with the same spreaders, so I had two spares!

Shiny bore full length and all the way round:

Parts arrived from Moss next morning, and with the low biting point in mind and wondering if I would be able to improve it, I compared the lengths of the five pistons I now had - three previous replacements one with ring seals and the other two with cup, Bee's clutch with cup seal, and the new conversion kit with ring seal. They vary in length quite a bit, except that the new conversion piston is the exactly the same length as the previous replacement that has a ring seal, and Bee's piston is exactly the same as one of the old cup seal pistons. The remaining cup seal piston is slightly longer, and is my first though to fit, but when I check the diameter it is fractionally smaller than Bee's. That must be from the V8 clutch, which has a slightly smaller bore than the 4-cylinder, so not a good idea to use. All the secondary seals are ring-type, but do vary in size.

Unlike the 4-cylinder the V8 clutch master did not change at any time, so it would be reasonable to expect that to have the cup seal as V8 production started before the 4-cylinder seal changed. Why the V8 didn't change in 1973 as Clausager estimates for the 4-cylinder is a bit of a mystery as the V8 still had a couple of years of production left. Maybe the change occurred after the end of V8 production. The other oddity is that of the other two previously removed pistons one is a cup seal the same length as Bee's, and the other is a ring seal the same length as the new conversion piston. One must have come from Vee's brake master, and the other from Bee's brake master, but (purely from an interest point of view) which came from which car? If the cup seal came from Bee, making both pistons and seals identical, then Vee must have had a ring-seal piston in the brake with a cup-type in the clutch. The Parts Catalogue has the same info about a change in brake master to one with two concentric rings as for the clutch, but is similarly vague about the date. And both Vee's brake and clutch masters only have one concentric ring, not two, Bee's having none. The brake master was always the same for the V8 and the equivalent era 4-cylinder. The implication is that one of the brake masters had already been modified with a conversion kit, but before my time. This is all rather by-the-by, and really only leaves me with two options - the new original cup-type seal with Bee's piston, or the new conversion kit, and I go for the former.

A selection of pistons and seals: A is the new piston from the conversion kit; B an identical item from a previously changed cylinder; C is from the V8 clutch; D is probably from the roadster brake master and identical to the one from the clutch master:

The shim (arrowed) that fits between the seal and the piston, on both cup and ring-type seals.

The cup-type seal removed from Bee's clutch (A) significantly longer than a similar seal from another cylinder (B). If the replacement seal is like B, that would explain why the biting point is now lower.

I coat the new secondary (ring-type) seal and the push-rod end of the piston with brake fluid, and ease the seal on easy enough. However there is a thin flange that projects forwards of the main part of the seal and sits flush against the piston body, that flange is partly tucked under the rest of the seal, and needs careful easing forwards with a small blunt screwdriver. After that one of my 'old' seal spreaders is fitted to Bee's spring and inserted into the bore, and the new main seal coated with fluid and manually pushed in. There is a curved thin steel shim that sits between the face of the piston and the back of the seal, which may push the seal away from the piston to open up the three holes in the face of the piston, which are perhaps there to aid fluid flow when bleeding. Insert the shim and the piston, and refit the pushrod with its thick integral washer and circlip. **Note!** If you are fitting a new dust cover to the push-rod do so from the piston end before refitting to the master cylinder, the sharp edges and large size of the clevis pin fork can rip the seal.

For filling and bleeding I decide to try yet another variant of the reverse system I have used with complete success on Vee and a pals car. I connect a tube between the caliper and clutch nipples as before when I used the brake pedal and master to fill an empty clutch system, but this time I connected the Gunson's EeziBleed to the brake master. The same low pressure of about 15psi on the front off-side wheel I had removed to give me better access to the clutch slave, opened the clutch bleed nipple, then the brake, and fluid from the caliper fills the tube and starts going into the clutch system. Peer into the clutch master until I see fluid rising, then close the brake nipple. Test the clutch ... and absolutely no back-pressure at all, and peering underneath only a trace of movement of the push-rod. I'm pretty gobsmacked, as this method of reverse filling had worked perfectly the previous twice I had used it.

I tried operating the pedal slowly, some gurgling, but no change. So I wedged the pedal fully down over lunch, then slowly released it, no change. Someone recently said they pumped the pedal like mad, which also made no difference, except to obviously aerate the fluid in the master and make it milky. Next I wedged the pedal down, then opened the slave nipple, and quite a bit of air came out. Did that several times till no more air. I can feel some pressure now, but only about 3/8" of push-rod movement and it grinds if I try to put it into reverse. More pumping, still no better. So now I put the Gunsons on the clutch master and bleed normally, and loads of air and milky fluid comes out again. More pressure, but it still feels soft at the top and its still grinding. So I leave it wedged down overnight, hoping that the air bubbles coalesce, and can be pulled back into the master when I release it in the morning. That makes the feel much better, it now engages reverse without grinding, although the biting point is very low at probably not much more than 1/4" off the floor.

Although the hydraulic system automatically compensates for all the expected wear at the clutch end i.e. in the release bearing (of which mine is a ball bearing anyway) and push-rod/clevis pin/release arm, I do wonder whether wear in the release arm pivot has allowed the arm to move outwards, so increasing the ratio of the arm, which would need more movement of the slave push-rod to get the correct movement of the release bearing. So I ease the push-rod into the slave a little to take the pressure off the release arm, and test for any wear in and out or up and down, but there is none.

I then start pondering all sorts of ways to get more throw on the pedal. Removing the (pretty thin) carpet from under the pedal makes no difference. So I modify one of my old push-rods to move the clevis pin hole as far as way from the master as possible. This moves the clutch pedal pad up from the brake pedal so does give more throw, but I'm surprised to find there is little change to the biting point. My dander is up now, so I also modify the pedal. I notice that the hole in the clutch pedal is about 1/8" lower than in the brake, so giving it a higher ratio. So as well as moving the clevis pin hole closer to the master, I also move it upwards, to lower the ratio and get more travel that way. I end up with the clutch foot-pad almost an inch higher than the brake, but still no damned improvement in the biting point! But when I check, I find that when the pedal when fully depressed it's about 1/2" off the carpet - because the clevis pin bracket on the push-rod is now pressed hard up against the dust-cover on the cylinder. The clutch is also very stiff, which surprises me as I wouldn't have thought changing the ratio would have affected it that much, but I discover that because I have moved the clevis pin upwards, the push-rod is now angled upwards instead of horizontal, and as the push rod moves in to the cylinder it also moves upwards, and is binding on its spacer behind the circlip in the cylinder. I then realise that the reason the clevis pin is that 1/8" lower on the clutch pedal, is because the clutch master is 1/8" lower in the mounting frame than the brake master is. This must have been done deliberately to get the right amount of movement of the slave push-rod, taking into account the relative dimensions of slave and master bore, without making the pedal pressure too high on the one hand (high ratio) or the pedal movement too long on the other (low ratio).
So that means I have to move the hole back down on the pedal to correct the angle of the push-rod, as well as move it away from the master a bit as there is no point in having the pedal pad so high that the master stops it way before it reaches the floor. But why is my biting point still so low? I take some comparative measurements with the V8, and whilst the V8 has more free play in the clevis pin linkage, it obviously starts to build pressure earlier than Bee. I then look again at the seal I removed from Bee, in conjunction with the older piston and seal, and realise that the seal I have just taken out is a good 1.8" deeper than an older cup seal. I didn't note the depth of the new seal that is now fitted, but if it is shorter than the one I have taken out then the seal will have to move further before it closes off the bypass port from the reservoir, which it has to do before it starts building pressure.

Piston and cup-type seal from Bee's clutch (A) significantly longer than the piston and ring-type seal of the conversion kit.

I could take the piston and seals out again, and perhaps fit the conversion kit, but that is also about 1/8" shorter than a piston with the original seal so isn't going to be any better. And after the problems with bleeding I'm not keen on having to go through it all over again. If I could put a spacer between the push-rod and the piston, then with the pedal fully released the piston would already be part operated, and if I could arrange for that position to be just short of closing the bypass port I would have maximum travel to pressurise the fluid.

There is a ball in the end of the push-rod that sits in a recess on the piston, presumably to avoid sideways forces on the piston as the angle of the push-rod changes slightly through its travel. I could wrap a spacer around the ball, but if that went behind the ball it would prevent the push-rod going fully back - reducing effective travel - as the back of the ball sits in a recess in the large washer. I could build up the ball with weld, but it would need to be carefully shaped back to a ball again, I don't have a Dremel, and I can't spin the push-rod so as to make sure it was circular. Which leaves a spacer disc of some kind that sits between the two halves.

But first I really need to find how far the piston needs to travel before it closes off the bypass hole. If my washer is too thick fluid expansion from heat won't be able to escape into the reservoir as it should, and I won't be able to bleed conventionally. By laying a ruler on top of the clevis pin bracket of the push-rod, and butted up against the open end of the cylinder, I see that the back of the bracket is 4.9mm (from memory) from the cylinder. Then I cut a fine wedge from a piece if hard board and fit it between the front of the pedal and the back of the hole in the bulkhead shelf that it passes through, so I can hold the pedal and hence the piston at various positions into the cylinder. Fully released I can push the slave push-rod and piston into the cylinder easily, and it moves out easily from the effects of its internal spring. 2mm of movement of the piston is the same, but 3mm makes it much harder to push in, and slower to come back out, so at 3mm the seal has partially closed off the bypass port. I settle for a 2mm spacer to allow for piston expansion when that gets hot, and find a washer that is slightly smaller than the cylinder bore, with a small hole in the middle, and a couple of mm thick. Clamping that in a vice between one of the old pistons and push-rods forms it nicely into a shape to fit between ball and socket. A trial fit in the cylinder does raise the biting point a little, not as much as I was hoping, but it seems to be the best I can get. It's effectively loose in the cylinder, so could get dislodged, but I realise that by putting a blob of weld in the hole in the middle of the washer onto the ball of the push-rod, and carefully filing smooth, overcomes the problem of getting the right shape as well as retaining it.

With that fitted the pedal feels much better, very little play at the pedal clevis, and it firms up sooner than before, but although the biting point has improved it is still lower than prior to the seal change. Maybe some air still in the system? I try wedging the pedal partially operated so it just closes the bypass hole, then using a big screwdriver in the release arm hole try to lever it forwards and push the piston into the cylinder but it doesn't budge. So I try another tip which is to push the slave push-rod and piston fully into the cylinder (pedal released now) and tie it there, initially as another way of seeing if there is air in the system, but also prior to another attempt at conventional bleeding. The pedal gets hard very quickly, no sponginess and I can see the release arm trying to move against the restraint of a cable-tie, so very unlikely to be significant air still in there. I reconnect the Gunson's to the clutch master again, open the bleed nipple and maybe a little does come out. Close and try twice more, maybe a couple of tiny bubbles. Once more and nothing. Once more for luck ... and disaster - the Gunson's bottle has emptied and pushed all the fluid out of the reservoir! If it hadn't been for that once more for luck

I'd have got away with it. I'm running low on fresh fluid but put what I have in the Gunsons and fill and bleed again, the air bubbles are only reducing slowly, so it's down to Halfords for more supplies, and several more goes - keeping a close eye on the bottle! - before it's bubble free.

Try the clutch in reverse and really it's no better than its best previously. Wedging the pedal fully down and using dial calipers to measure the travel of the push-rod at 0.44", which I would have expected to be enough, especially as some have claimed theirs is only 3/8" (0.375") and fine. However with all the work I have done to increase the throw I would have expected it to be more than 'normal', which does indicate there is still a problem with the master ... or maybe the slave .. or maybe the bleeding. So it's still a mystery. Maybe it's something to do with the release bearing, but unless it is reducing in length as the clutch is disengaged, and I can't really see that happening. Maybe the friction plate is slightly warped, which means the pressure plate has to move further to completely release it. Possible, but I'm never one for engaging the clutch at high revs for a quick getaway, preferring to get it all in as soon as possible at little more than idle then using the torque to accelerate. That's something that will have to wait until the engine comes out, and would still happen even I had more slave piston travel than 'normal'. I could try the conversion kit, but going by the length of the piston from socket to seal lip that will be no better. It could be something to do with wear by the bypass hole meaning the seal has to move further to fully close it off, which would be corrected by a replacement master. For the time being I'm going to run with it, and see if I can live with it or not.

July 2016: Eventually I'm forced by release bearing problems to pull the engine and change the clutch, and after that I find the biting point uncomfortably high, even though the slave push-rod travel is fractionally less than before. I found that because of an alignment issue the release bearing is offset to the cover-plate by a significant amount, which basically means it has been pressing on one side harder than the other, which probably meant that the pressure plate wasn't moving away from the flywheel as much one side as the other, hence had to move further overall (lowering the biting point) to fully release the friction plate. So with the new clutch fitted I have to undo all the work I did to improve the biting point!

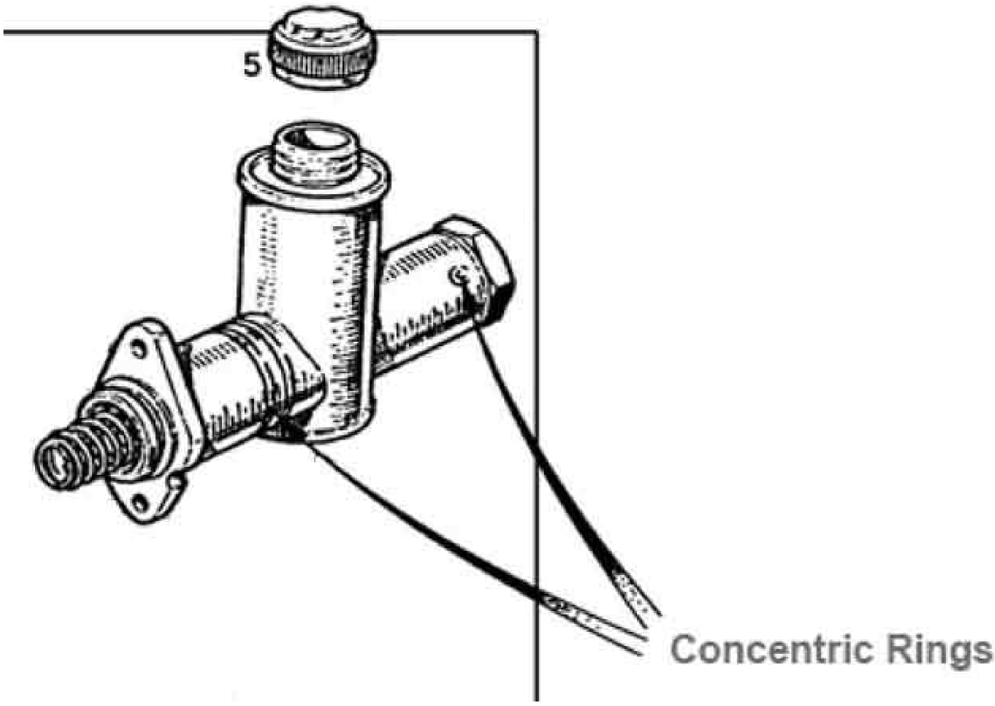
Clutch Master

The canted over Mk2 version BHA 4667, not needed with the single-circuit brake master ...

... or the later dual-circuit master: (Steve Shoyer)

... but definitely was with the early North American dual-circuit: (Dave's Cars)

AAU7152 with the two concentric rings indicated on the cylinder body on the mounting flange side. The other arrow is indicating another mark like a letter 'O', which seems to be an alternative identifier, not additional. The internals of this type are different to the previous two, something you need to be aware of when buying repair kits: (*Moss Europe*).



GMC 1007 which at one time was the only 4-cylinder replacement. Several vendors show this plastic reservoir type: (Sussex Classic Cars)

But as of August 2015 both Motaclan/Leacy and Brown & Gammons have confirmed that they have the recently remanufactured original metal can reservoir type (not far short of double the price of the plastic reservoir type):

Is this the one that causes problems with the unboosted dual-circuit master? Whilst the main casting and the diameter of the reservoir seem to be much the same as for GMC1007, the cap is obviously much bigger: (Image from Victoria British)

This cylinder had a leak from between the reservoir and the casting which could have the upper wire clip above the casting and so tending to distort the plastic reservoir rather than seal it: (*Richard Massey*)

A previously failed master showing the position of an O-ring seal in relation to the top of the casting. Not much scope to get the upper wire above the O-ring but still on the casting: (*Richard Massey*)

This one from Rimmers seems to have both clip wires in the right place:

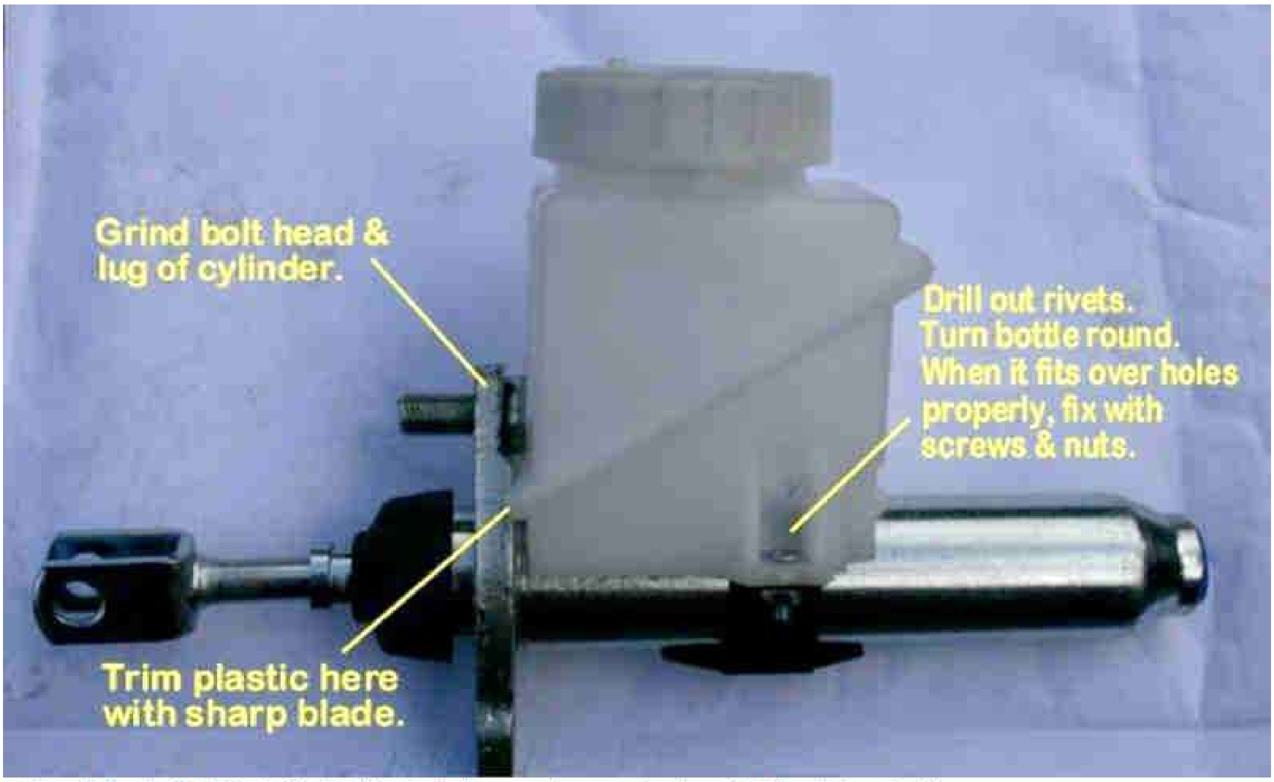
But this one from MSC seems to have the upper wire very close to the top and the lower wire may not even be on the plastic reservoir:

Yet another variant, this time with a fully cast body but a large plastic cap, pictured by several vendors. It's interesting to note that the cap states "Use only DOT3 fluid"! (Image from URO Parts ('Euro', geddit?))

Original GMC 1011 for the factory V8 and also some Midgets as pictured by Motaclan/Leacy but no longer available. Note the single groove round the cylinder near the mounting flange as on both V8 masters, not the two in the Moss Europe drawing above:

Current-stock GMC 1011 for the factory V8 and also some Midgets from Brown & Gammons:

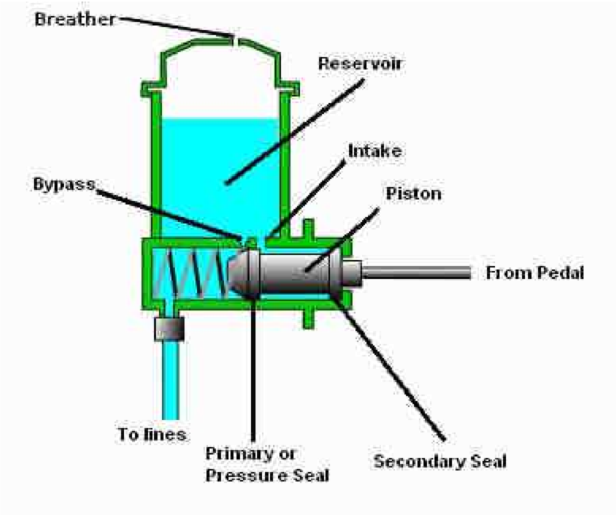
Modification to turn the reservoir round and make the cap more accessible, but not trivial: (V8 Register)



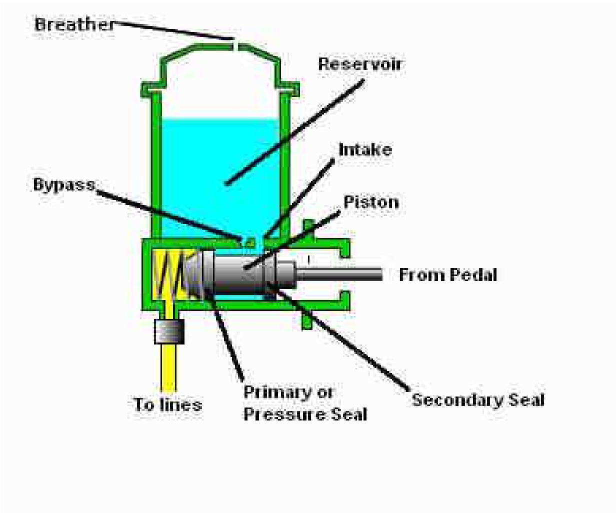
Modified GMC 1011 V8 clutch master cylinder (Mike Howlett)

GMC1011 installed on Hans Duinhoven's MGB, although it's a 4-cylinder so should have the GMC1007. Hans says there is enough room to access the cap even though it is an LHD where there should be less clearance to the bulkhead for the clutch master cap than it would have on an RHD. Originally the V8 master was 1.2mm smaller bore than the 4-cylinder, which with a 4-cylinder slave would give a slightly lighter pedal but less throw, i.e. the biting point would be a bit nearer the floor if the remainder of the mechanical linkage at the master remains the same:

Showing how at rest fluid can flow from the reservoir into the cylinder in front of the pressure seal and from there down to the slave, and into the space between the two seals via the Intake port. When operating the pedal the primary seal has to move past the bypass port before any pressure is applied to the fluid. It also shows that at rest the primary seal has to come back past the bypass port to allow fluid expansion and contraction to pass in and out of the reservoir during temperature changes. If this doesn't happen and the fluid expands, pressure will be applied to the release bearing which could cause the clutch to slip and will definitely accelerate wear, as well as rendering it impossible to bleed:



Showing how fluid fills the space between the two seals when the pedal is operated. If the secondary seal (nearest the pedal fulcrum) leaks you will get fluid running down the pedal, but the clutch otherwise operates normally (until all the fluid is lost!):



The Intake and Bypass ports, the brake master has the same arrangement:

The Bypass port is tiny:

Girling Clutch Master by Crispin Allen (*my edits*)

When I tried to bleed the clutch on my MGB, I would open the bleed on the slave, press the pedal down. Result: the fluid comes out, the pedal stays down, so no pumping is possible (I always detach the pedal return spring, during bleeding, as it may give the false impression that the master cylinder piston has returned, where in fact it is just the pedal that has returned) it seems like the return spring inside the master is not strong enough to push back the piston. First thought: has the master return spring failed? No, on removal it is working properly.

> *The mechanical linkage between the pedal and the master cylinder piston means that the pedal return spring is helping to pull the piston back during pedal bleeding as well as confirming that it has pulled back. To remove the pedal return spring is counter-productive.*

I had spent several hours trying to bleed the clutch without success, so I looked on the internet and was comforted to see that it is a nightmare job for everyone including professional garages. While planning my next attempt, I thought I would bleed the clutch on my Triumph GT6. I filled up the master cylinder, opened the bleed. Fluid came out, pumped the pedal a few times, checked for bubbles, tightened bleed. Job completed in about 10 minutes.

Why were the two tasks so different?

This bit of information found at: mgparts.co.nz: The lack of a return valve means the air in the pipe and slave cylinder is not isolated from the master cylinder so the suction generated by the master cylinder piston stroke, is dissipated right through the system rather than confined to the master cylinder. The amount of suction remaining is not enough to draw new fluid in.

> *There is no 'return valve' in the Lockheed clutch master cylinder, although there is in the brake master which delays the return of fluid to allow 'pumping up' in the event of a long pedal. If there was one in the clutch m/c in either brand it would delay engagement of the clutch after the pedal was released, which seems very unlikely. When the pedal returns during pedal bleeding then the m/c piston has also returned from the action of the internal spring if nothing else. If the bleed nipple has been closed for the return stroke (as it has to be otherwise fluid and air would simply go back and fore) the lowering of pressure that occurs in the m/c bore sucks fresh fluid from behind the pressure seal and the reservoir to replace the fluid and air that has been expelled from the bleed nipple on the down-stroke of the pedal. This is how pedal bleeding works. The ease of bleeding for the Girling must be down to differences in the design of the bores and pistons.*

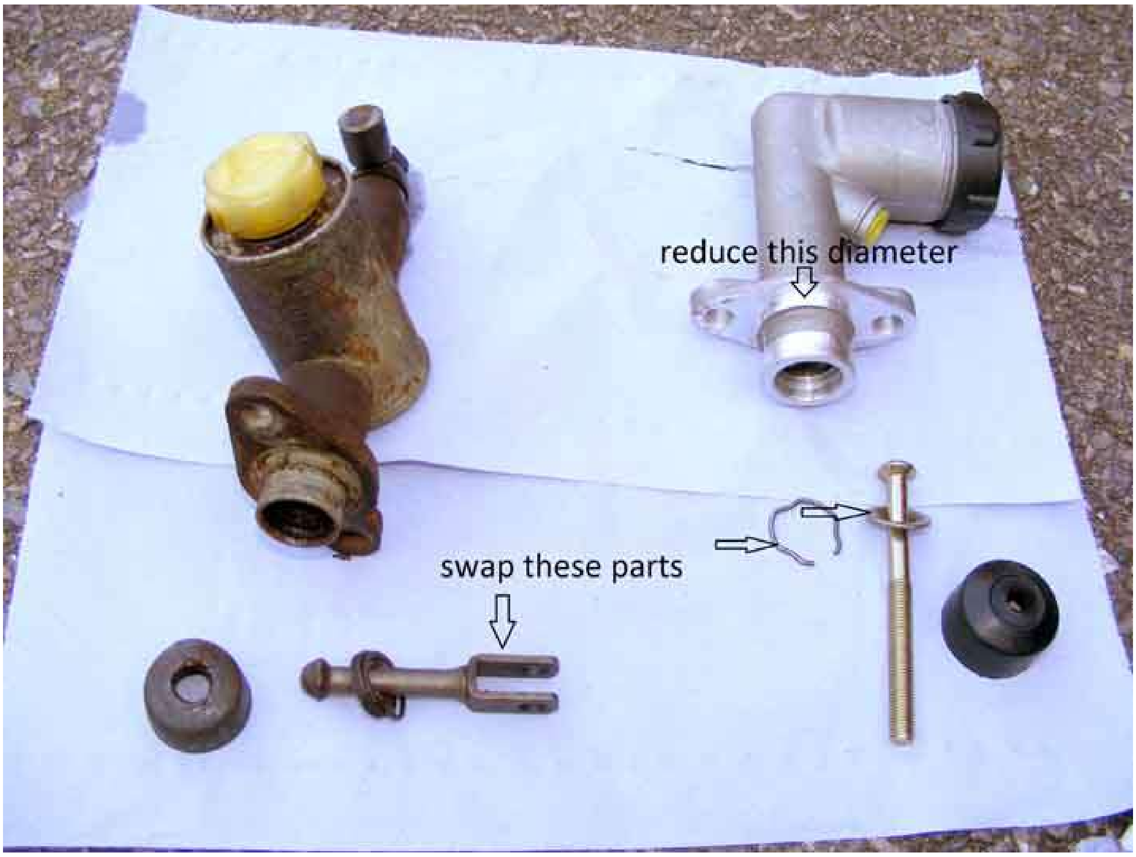
Clearly the problem lies with the master cylinder design. Taking a close look at the master cylinders in the early MGBs, there is very little room in the pedal box, the brake master cylinder takes up most of the room. It looks like MG had to use the thinnest reservoir clutch master available, and even then, they couldn't mount it straight (see the slanted mounting flange). On later cars with servo there is more room, but they kept with the Lockheed cylinder.

> *The canted-over clutch master was rendered necessary by the North American Mk2 dual brake master, and fitted to all cars for simplicity. Before that they were upright.*

MGBs with the brake servo, have more room to install a different master cylinder. As the Girling Master cylinder works well on a Triumph, why not try that?

The Girling master cylinder was installed in most Triumphs, Land Rovers and the MGC. There are various bores available including 3/4inch (0.75") the same bore as the MGB. The pedal box mounting bolt holes match up perfectly, but unfortunately the centre hole is a few mm too small, but a few minutes with a hand file on the master cylinder solves this:

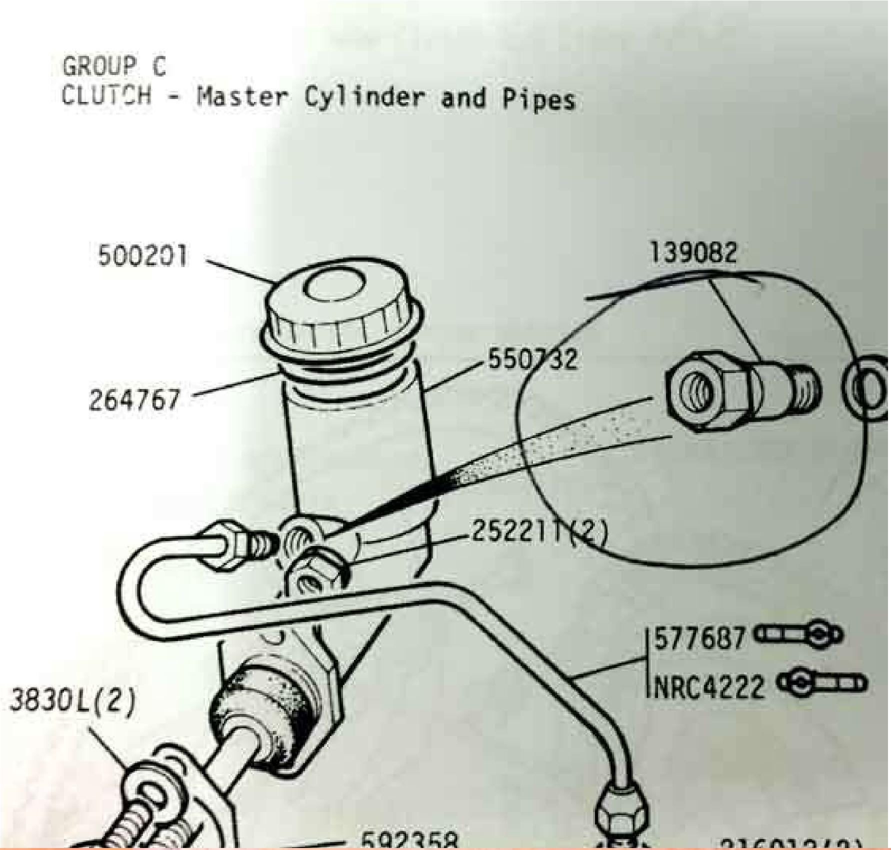
Just swap the push rod, circlip and the retaining washer (this needs to have a notch cut out to be fitted onto the push rod):



The MGB uses a larger diameter solid pipe, so the adaptor, (as used on Land Rovers) is required to convert 3/8 to 7/16:

I had considered replacing the whole solid pipe with smaller diameter pipe, however the slave cylinder are also the larger 7/16 union.

Gently bend the solid pipe to attach to the adaptor and master cylinder. Reconnect clevis pin etc.:



Bleed clutch in normal way (as you would do the brakes) now takes about 10 minutes instead of several days.

Land Rover Master cylinder: STC500100 & Adaptor: 139082

March 2021:

> Chris Silk is unable to completely remove the cap even though he has the same dual-circuit frame and plastic cap as Crispin. Nevertheless Chris had enough room the fill the reservoir with the cap just tilted back, and although during bleeding he inadvertently emptied the reservoir twice he still completed the bleeding in 20 minutes.

This Girling clutch master is original equipment on the MGC, which has a completely different pedal frame again, and this picture shows masses of clearance for the clutch - which is just as well given the height of the brake master. I'm wondering if the MGC frame positions the master cylinder mounting face forwards of both MGB positions, or is just lower:

Ray Leborgne's RHD installation, alongside the original single-circuit brake master. The clutch cap is pretty close to the brake master but otherwise clearance looks OK. Ray is contemplating using a Girling brake master as well, but as can be seen from the MGC installation above the MGC brake master almost certainly won't fit in an MGB pedal frame. That's maybe why a second clutch master has been mentioned as an alternative, but with significantly reduced fluid capacity:

The 'ink' is hardly dry on the above and Ray has fitted a Girling brake master:

He writes:

> It does have a few drawbacks.
>
> The top unscrews to fill it up, however the top cannot be removed, and it can only slide back. It just means I cannot use my Eezibleed, not the end of the world.
>
> Although I used the old push rod from the old MC (as the clutch instructions) what I did not see (until it was too late) was that the overall length from the pedal box to the pedal was very slightly longer, thus it locked the brakes on. This was overcome by grinding down the edge of the pedal and inserting spacers on the MC.

It may work better with a Mk1 pedal box as this looks like the MC fixings a lower which means more space between the cap and bulkhead.

I was hoping to replace the plastic cap of the clutch MC for the metal version, I purchased a cap which was stated as 44mm (the ID of the Girling MC) but alas it was too big, I suppose that what you get with aftermarket. So I'm reluctant to keep trying, the plastic will stay.

Subsequently Ray had further problems with the push-rod causing the brakes to lock on:

The problem that I did encounter was the brakes were locking on (again) but this time the problem was with the push rod.

I transferred the old push rod from the Lockheed (as per the clutch) and used the retaining washer from the Girling. But what was happening was as the pedal was on its return stroke the push rod was catching the retaining washer and not fully returning thus locking the brakes.

The reason (in my view) is twofold, the shape of the old push rod and the size of the hole in the retaining washer.

The Girling is on the left, Lockheed on the right. As the Lockheed is more pointed it would move around on the end of the cylinder's piston and because the retaining washer had a large hole the push rod would move to one side and catch the retaining washer on its return stroke. It's done this a number of times when driving, just flick the brake pedal and they would unlock.

So went back to the Girling push rod, made a new retaining washer (smaller hole) and adapted the old Clevis (drilled and tapped) to fit on the Girling push rod with locking nut. Having a locking nut (half nut) does not interfere with the overall travel of the push rod.

Converted the clutch to match.

Going by this picture of Mk1 and Mk2 single-circuit pedal boxes side by side from Dave O'Neil the Mk1 does seem to position the master cylinders lower. The covers also changed which tends to support that:

Note that the pedals also changed from Mk1 to single-circuit Mk2 and matching items may be necessary to maintain the geometry of the pedal, push-rod and master cylinder. The box (and cover) changed again for single-circuit rubber bumper, but the pedals didn't.

Mk2 Lockheed master cylinders for comparison:

Master Seal Kits (clutch and single circuit brake systems)

Clutch and brake master cylinder repair kits are confusing for several reasons:

- There were two different types of internals, changing "sometime in 1973" (Clausager), but any car could have either now:
- Early brake and clutch masters had one cup-type seal (the pressure seal) and one ring-type seal (the secondary seal).
- Later brake and clutch masters have two ring-type seals.

There are four repair kits: (*images from Moss Europe unless otherwise stated*)

GRK1026 for the early brake master with cup seal and restrictor, the washer goes between the piston and the back of the cup seal:

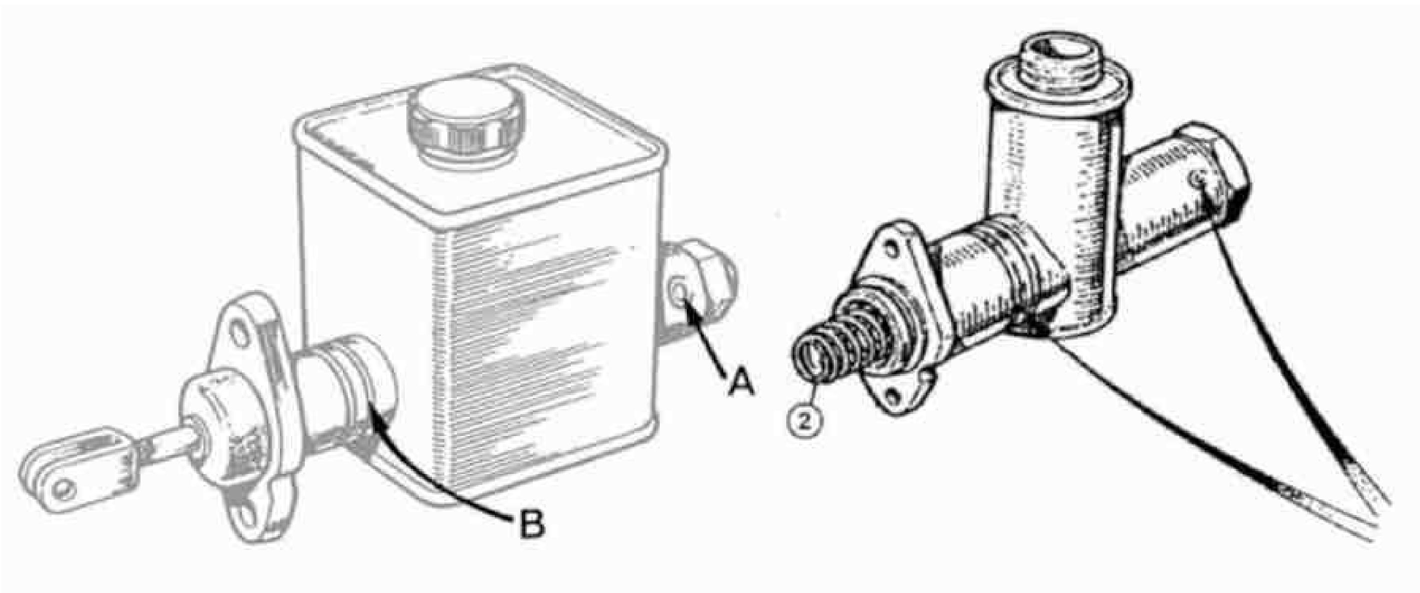
GRK3007Z for the early clutch master with one cup and one ring seal:

GRK3004Z for later brake **and** clutch masters with two ring seals. This includes a restrictor valve which MUST be fitted to the brake master, and must NOT be fitted to the clutch master:

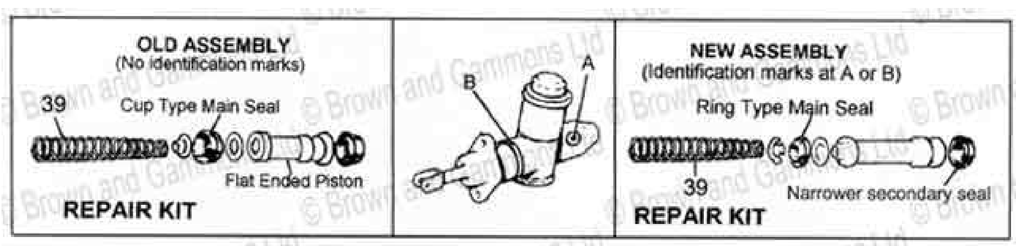
GRK3007 converts the earlier clutch internals to the later type and uses two ring-type seals, at about three times the price:

Not all suppliers show all four kits and some show GRK3007 i.e. without the 'Z' suffix as being the basic cup-type repair kit **not** the conversion kit to ring-type seal that most suppliers show.

There are identification marks on the later masters originally fitted with ring seals but supplier information is confusing if not incorrect as here from Moss. This shows two grooves around the bore by the flange and a smaller symbol (two concentric rings) by the banjo:

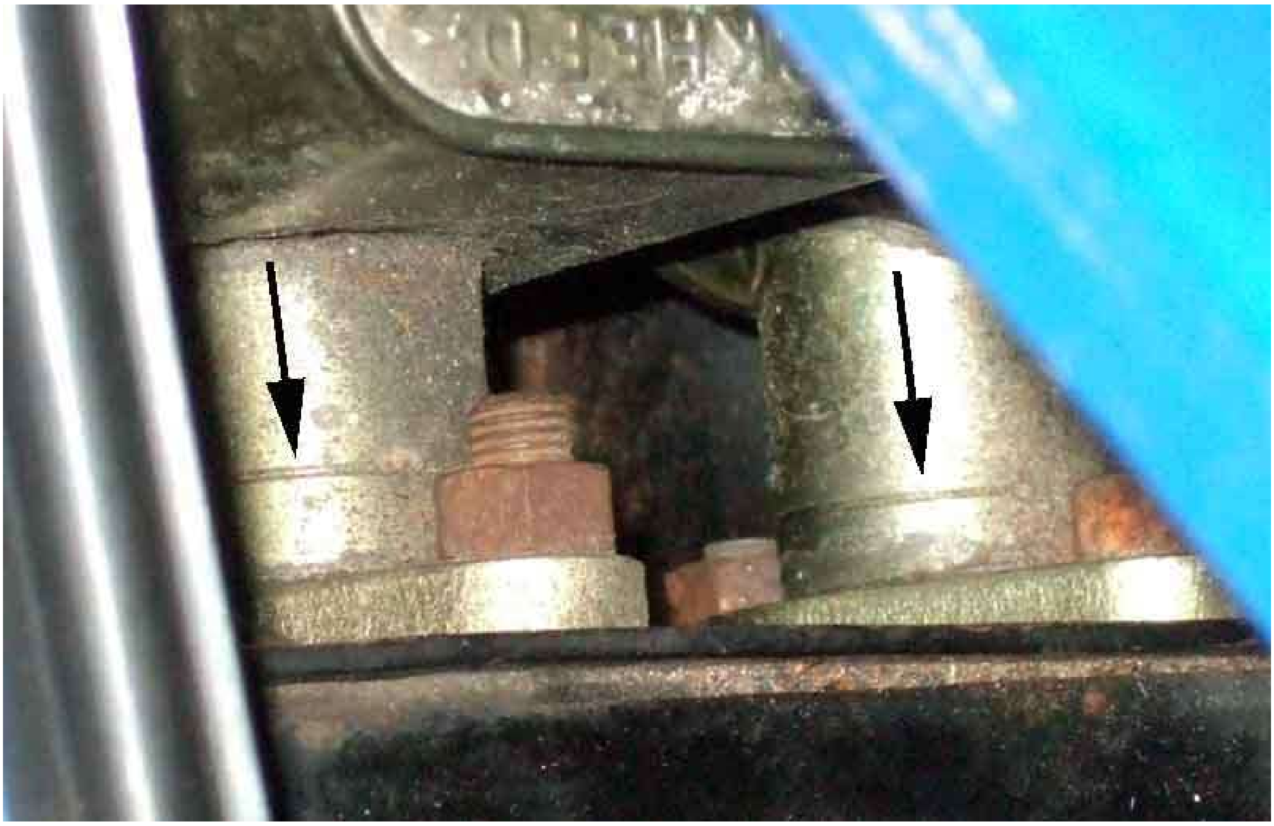


This from Brown & Gammons could be showing the same but isn't clear enough to see if there are one or two grooves by the flange:



I have never seen the type A symbol.

Both masters on my 75 V8 have a single groove by the mounting flange:



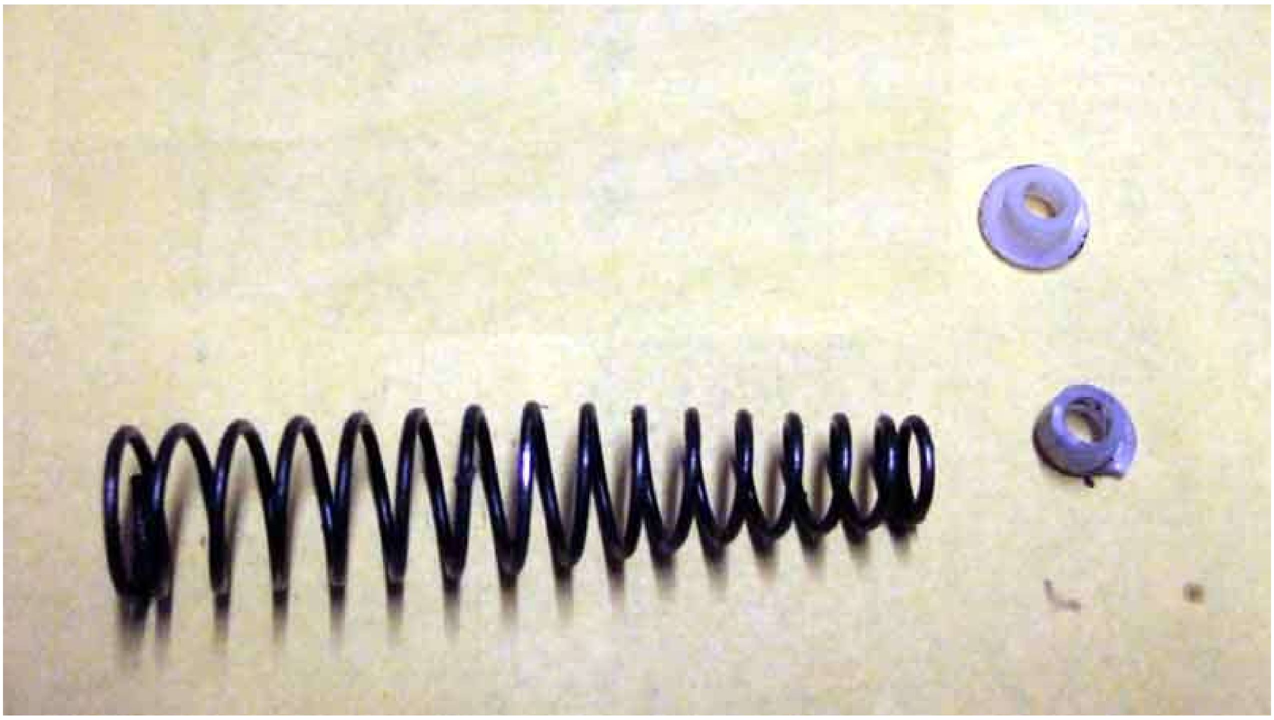
Groove barely visible on the replaced brake master on my 73, the clutch master is the earlier cup-seal type so no markings:

To get the correct seal kit for your master you would need to remove the existing piston first to see what seals are present, or you could go straight for the conversion kit albeit wasting money if you already have the later or already converted master.

But there is another factor and that concerns the [seal spreader inside the cup seal](), which none of the seal kits show. I had the clutch master seal leaking back on Bee so the clutch would slowly engage while I held the pedal down, and on removal of the piston and seal I could tell that the seal had been cocked to one side because the spreader had broken, but fortunately I had kept an old master and reused the spreader from that. Otherwise I'd would have to go for the conversion kit.

Cup-type seal internals: The shim (arrowed) goes between the seal and the piston, and on all pistons both primary and secondary seals face forwards. When fitting the dust cover to the push-rod do so from the piston end before assembly to the master cylinder, the sharp edges and large size of the clevis pin fork can rip the seal:

Bee's broken clutch seal spreader that came out (bottom) and a good one from an old cylinder (top):



The spreader does not appear to be available meaning if this is broken or lost the ring-seal conversion kit would have to be fitted.

The distorted seal. The vertical line runs through the centre of the pip that is at the bottom of the cup and sits in the hole in the spreader. That should be central, but is clearly displaced to the right because of the broken spreader:

A selection of pistons and seals: A is the new piston from the conversion kit, B an identical item from a previously changed cylinder. C is from the V8 clutch and has two parallel rings! D is probably from the roadster brake master and identical to the one from the clutch master:

The cup-type seal removed from Bee's clutch (A) significantly longer than a similar seal from another cylinder (B). If the replacement seal is like B, that would explain why the biting point is now lower. (It wasn't, that turned out to be a problem with the release arm and bearing alignment with the cover plate):

Piston and cup-type seal from Bee's clutch (A) significantly longer than the piston and ring-type seal of the conversion kit:

Three from Richard Massey on the MGOC forum - top from a 100 mile no-name plastic-bodied replacement that started leaking, middle from an older TRW plastic, bottom from a metal can. Slight differences in thickness of the flanges either side of the seals which is irrelevant as long as the seals are in the same position. Also slight differences in diameter of the flanges but only 3 thou max between any of them. Speculation that it was deliberate to give greater clearance to the bore, but I can't see that after all these decades, and it would allow for more lateral movement of the piston in the bore which could impact the sealing. Whilst my old pistons do show some polishing on the sides of the flanges there was no scratching or scoring in the bore which the 100 miler shows. What (to me) is more interesting is the long extension inside the spring of the no-name plastic. It shows how much free space there is at the bottom of the cylinder, and I can see it being needed in some applications to prevent the piston going too far and tangling up the spring, which then may not push the piston back as it should when the pedal is released. Neither do you want to push the secondary seal past the inlet port which will cause fluid to leak out:

Clutch Pedal Return Spring

The fracture well away from the marks showing the pivot-point.

V8 Clutch Release Bearing

GRB224 from Clive Wheatley, with an extra part at the bottom. When finally (2016) Vee's engine and gearbox was removed I found the bearing was like this one and nothing like the one from B&G below. However there seemed to be a set of plastic fingers at the roller bearing end of the tube on my bearing which looked like they might retain the basic bearing. But as I could see no way to get the new bearing off its tube, and may break some of the fingers on my carrier, I had no option but to reuse the old bearing as-is. Annoyingly I've had access to the gearbox for some weeks now, so could have discovered it earlier and done something about it, but foolishly I thought it would be obvious and simple - which it wasn't.

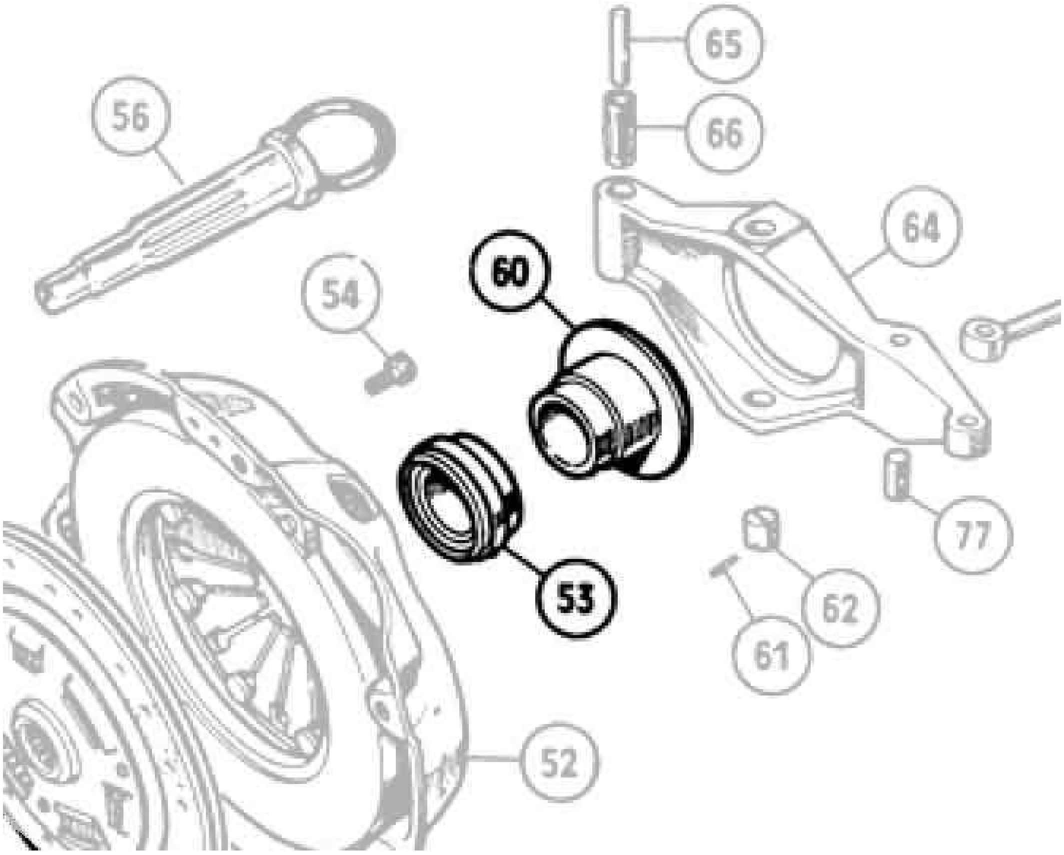
December 2019: Silver linings being what they are the gearbox has to come out again for repair, so at least I have the opportunity to replace the bearing.

'GRB224' as received from Brown & Gammons in 2011, but nothing like as drawn on their parts page:

GRB207 as depicted by Rimmer Bros, for the Midget 1500 and Triumph, completely different. However the V8 Register depicts this type of bearing as GRB224 for the V8 - obviously incorrect:

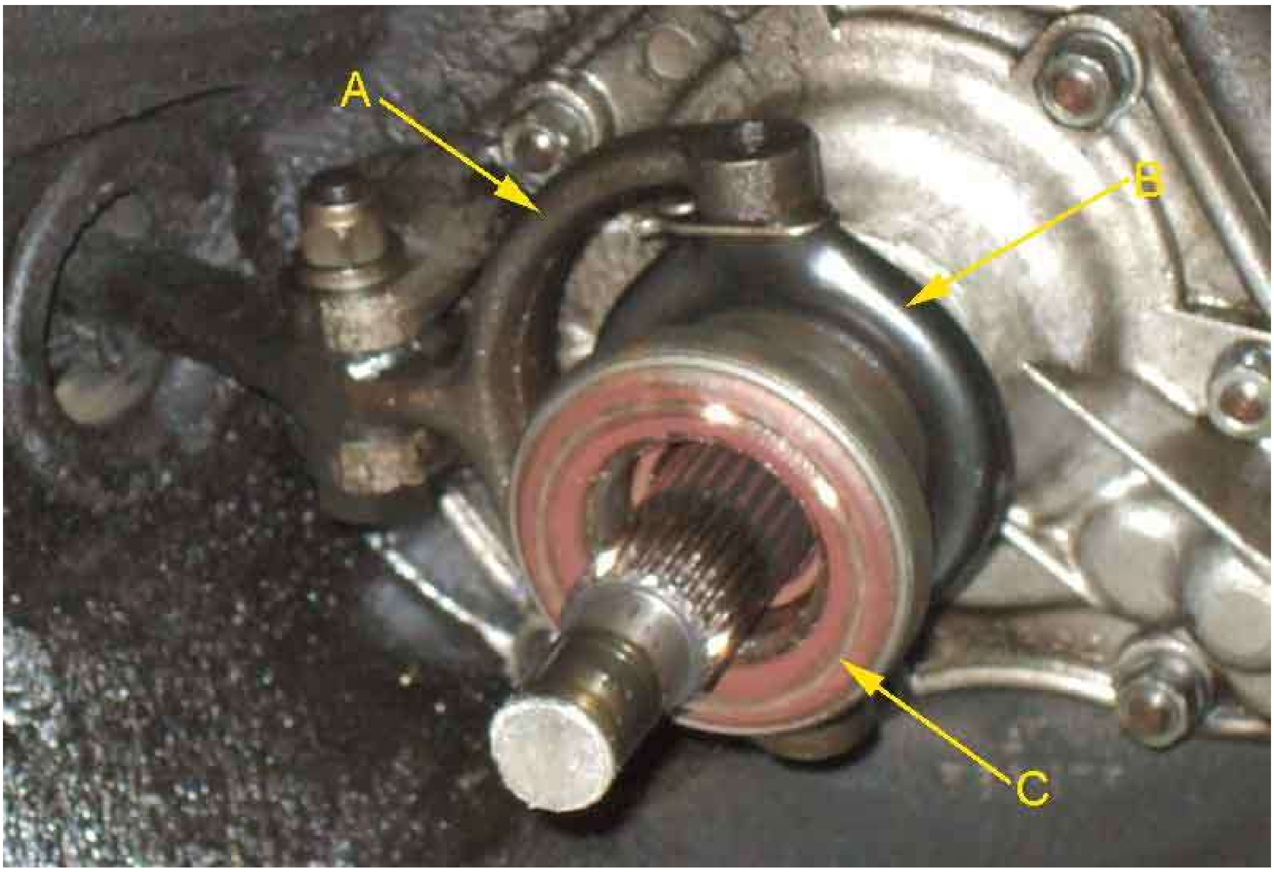
Clive Wheatley shows this for the LT77 or R380 gearbox with a separate carrier:

And Moss Europe depicts a very similar arrangement for the Midget 1500 (and Spitfire 1500) i.e. a separate bearing and carrier:

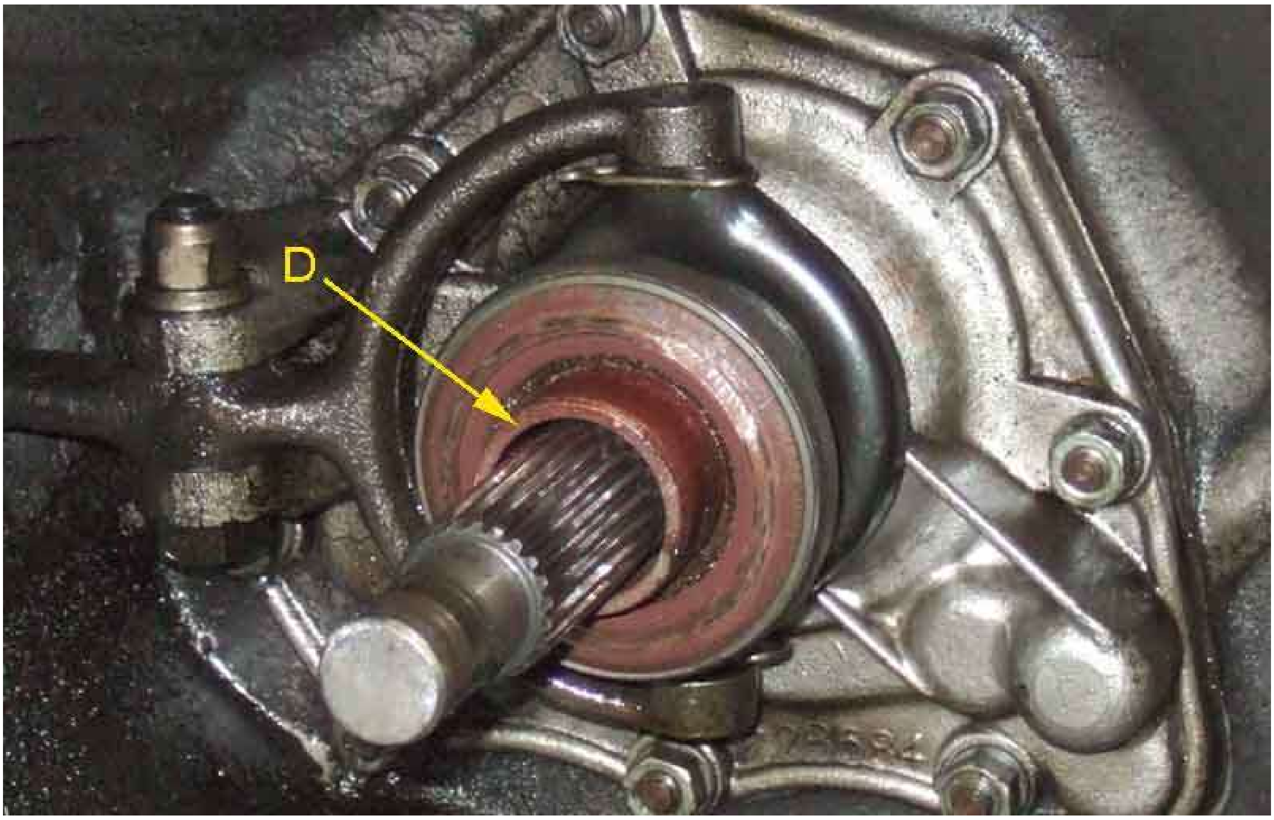


So the upshot is that whilst the Midget 1500 and V8 use the same principle of using a guide tube to keep the release bearing concentric with the first-motion shaft so a roller-bearing can be used, the components used are completely different. And the V8 Register item is not correct for the factory V8.

When Vee has her engine out for a rebuild I get the opportunity to see just what is there. 'A' is the release arm, 'B' the carrier, and 'C' the bearing. So the Rimmer image above shows the bearing plus the carrier. The red colour appears to be rust powder from the springs in the friction plate. Note the release arm pivot bolt is installed from underneath with the nut on top of the bracket, probably because the bolt can only be inserted from that end due to the design of the bell-housing:



Showing the release arm and bearing fully retracted, and the guide tube 'D' that keeps the bearing concentric with the shaft. The tube is part of the front cover, and apparently the whole assembly can be fitted to the 4-cylinder 4-synch gearbox - if you can find a V8 box that is beyond repair! There seems to be a very sticky substance on the nose of the first-motion shaft that fits in the pilot bearing, which may have been causing the dragging when not used for a bit. I'm hoping when that is cleaned off and out, and lubricated, the dragging will be a thing of the past. (It is - bliss!)



This is the correct item - GRB224: (*Rimmer Bros* have the clearest picture)

Release Arm Gaiter

Chrome-bumper 4-cylinder gaiter 22H 1337

Rubber-bumper 4-cylinder gaiter 22H 1693 (*Motaclan/Leacy*). Note that the information in the Leyland Parts Catalogue that states the earlier gaiter was used throughout production is incorrect.

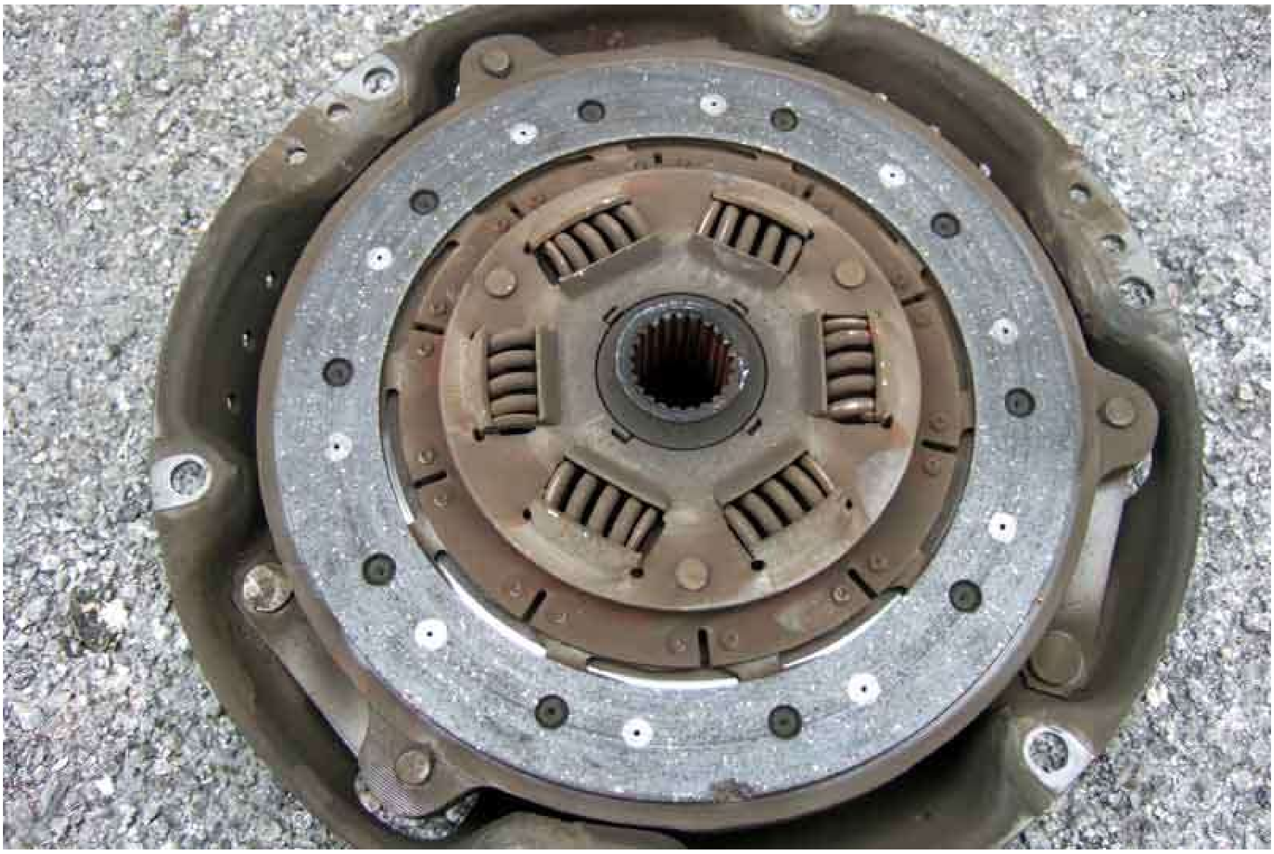
V8 and MGC gaiter 22B 450 (*Motaclan/Leacy*)

Clutch Change

Engine ready to lift out ...

Very badly scored friction surface on the cover-plate, a deep groove from the friction plate rivets as well as significant wear across the full width of the friction surface.

Friction-plate down to the rivets, fortunately only on the cover-plate side (facing upwards here)

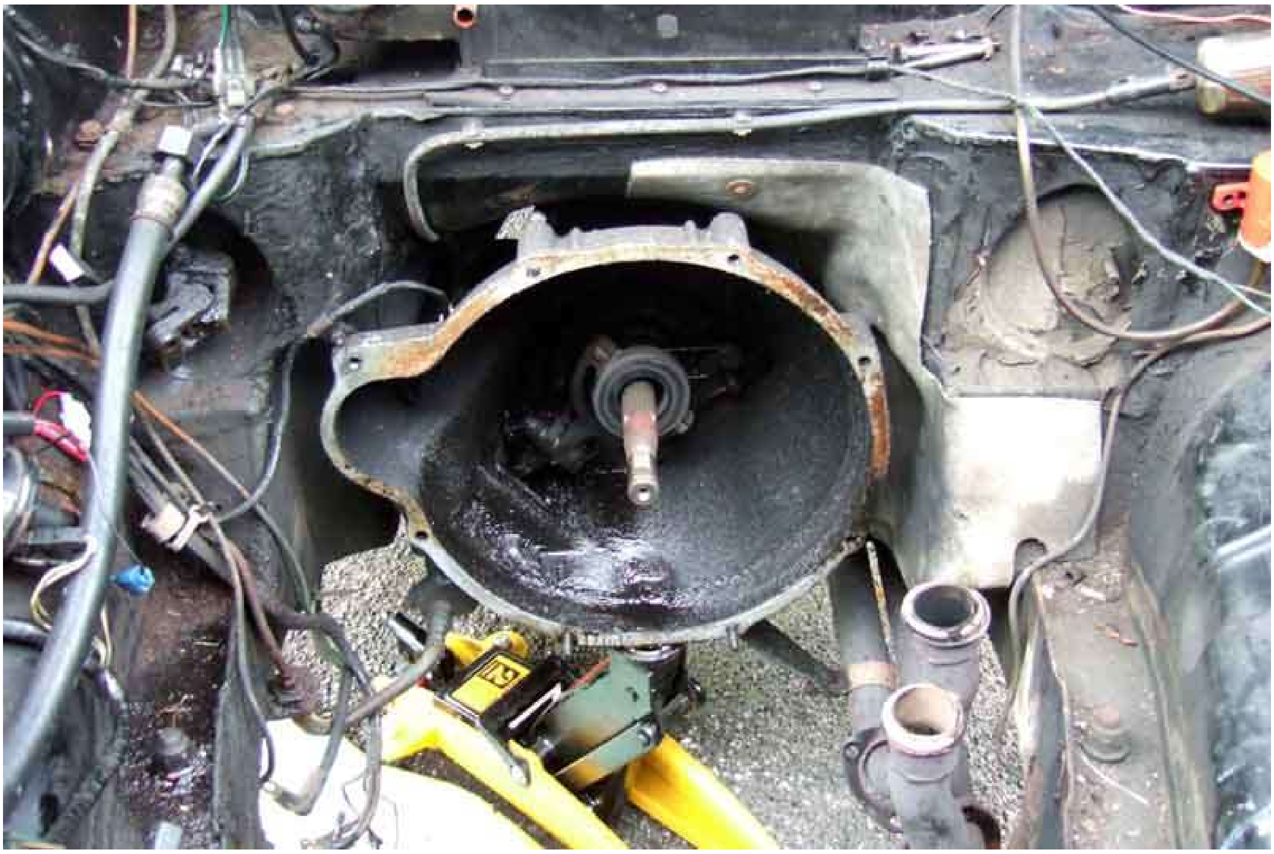


Flywheel fortunately sound. Only a very slight depression across the full width, what looks like a groove from rivets is actually only a polish mark as can be seen by the reflection of the screwdriver. No blueing from the slipping or sign of oil from the crank seal.

Old and new friction plates - the old has the pads completely worn away both sides plus about half the base material on the cover-plate side. Quite a difference in thickness between old and new, together with the wear on the cover plate it's not surprising it was slipping and the springs wouldn't push the cover-plate off the dowels. Note the centre section containing the damper springs and splined boss projects much further from the face of the friction surface on one side than the other, uppermost on both these. This side faces the cover plate, if incorrectly fitted it prevents the friction surface from reaching the flywheel. So offer up the new one first to double-check, and triple check any 'flywheel side' legend on the new friction plate.

New and old release bearings - plenty of meat left on the old, perhaps only 1/3rd worn, as the boss on the cover plate can go right down inside the release bearing casting.

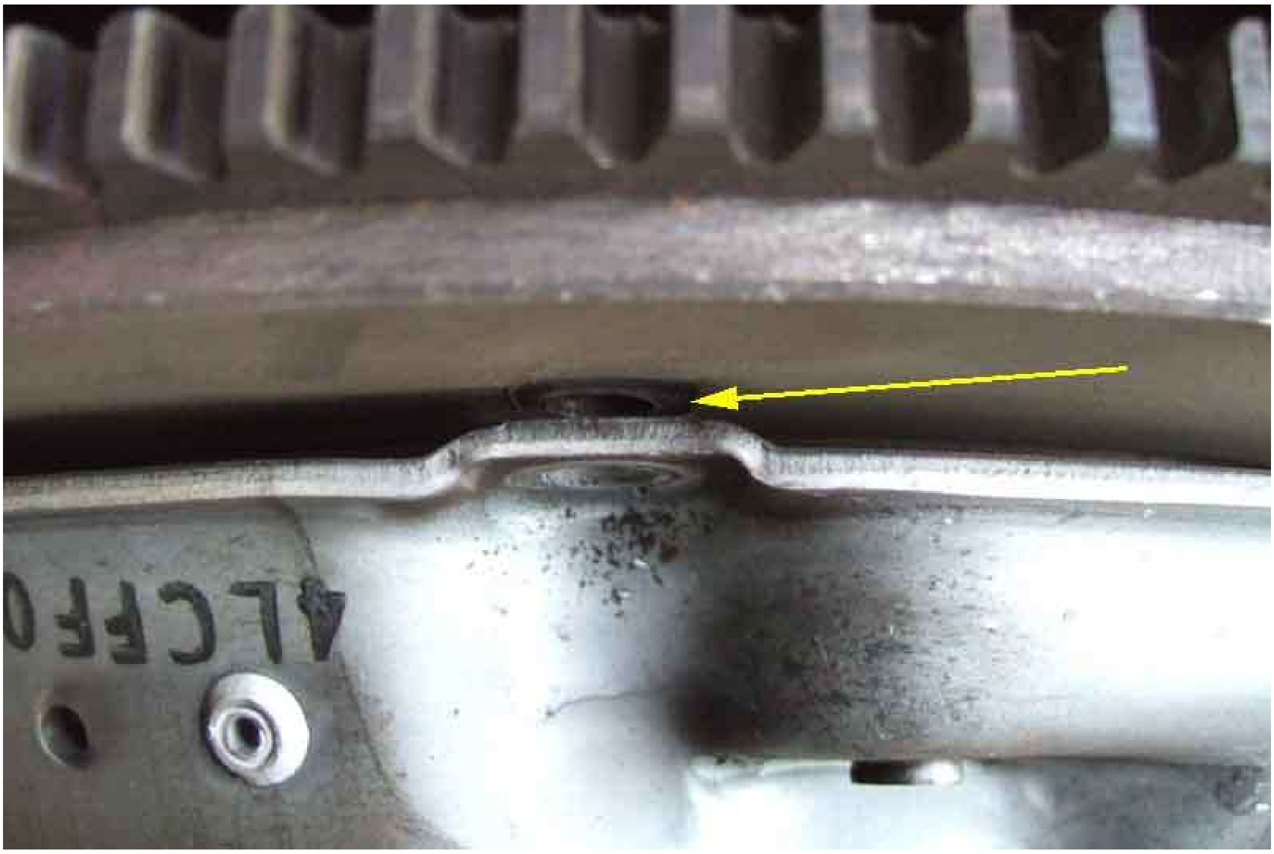
... and engine out (wish it were as easy as that). Gunky oil in the bell-housing, around the release arm rather than straight down from the first-motion shaft and cleaner oil if it had been the oil seal. I would very strongly advise freeing-up the connection between the clutch hydraulic pipe and the end of the hose, and the locknut securing the hose to the bracket on the chassis rail while the engine is out even if you don't think you will be removing it later. It's an absolute pig when the engine is in.



No visible seepage from the seal itself, so just checked the nuts on the seal plate for tightness. Check the release arm does not wobble on its pivot, but still moves freely. If the arm wobbles the release bearing can be off-set to the cover plate which causes premature failure.

Another clutch change *June 2013*

Cover plate pushed off by the diaphragm spring ...



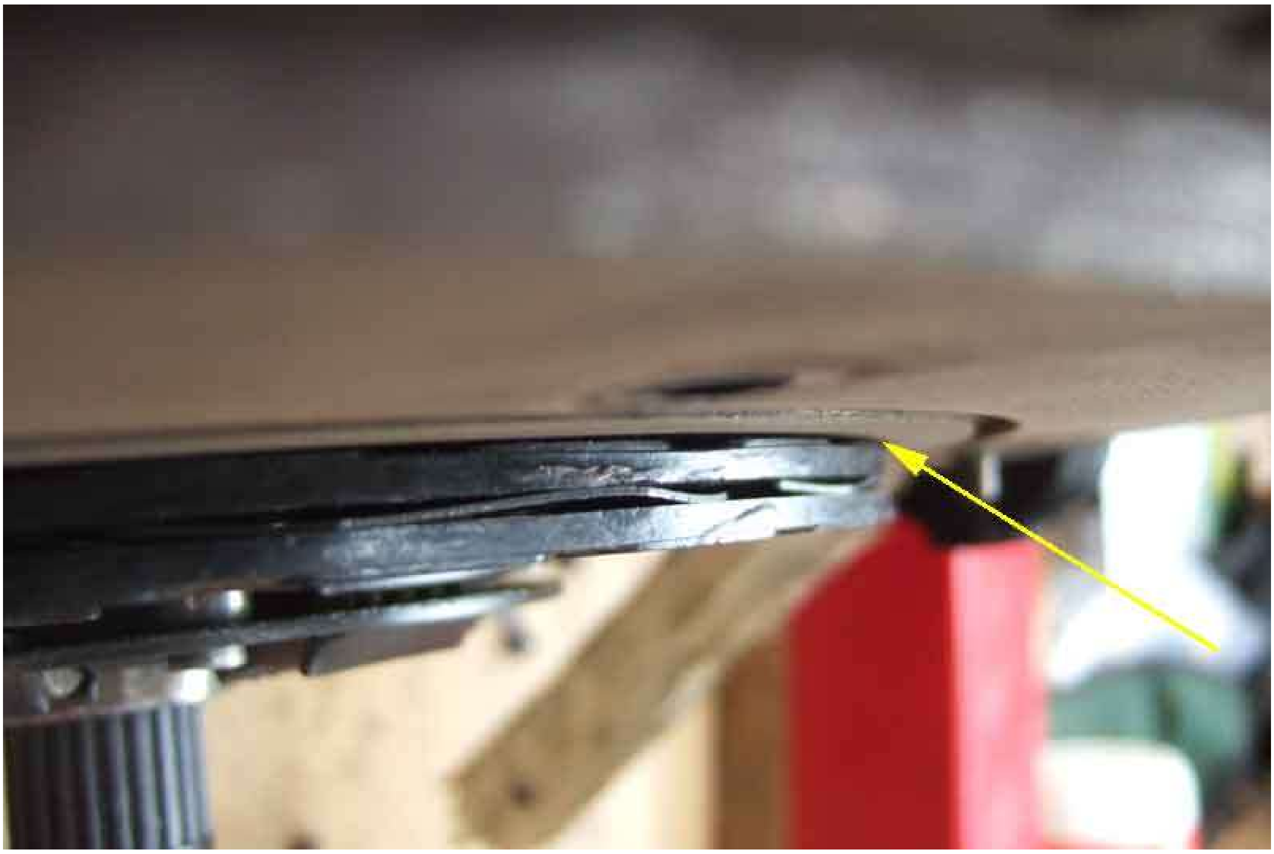
... indicating plenty of life in the friction plate

Witness marks as the rivets pass by, but no grooves on the flywheel, which could have happened with any previously worn-out clutch

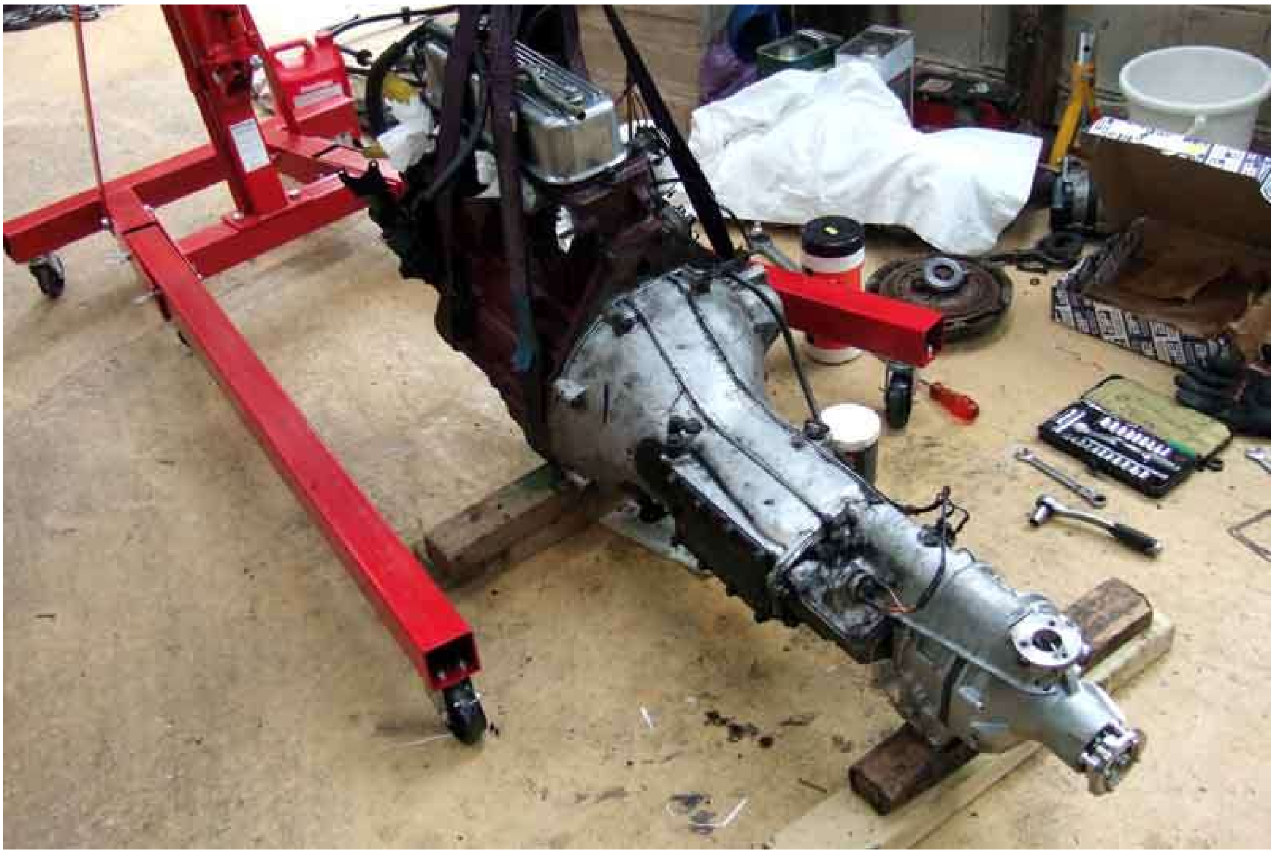
New cover plate

Friction plate fitted the wrong way round, miles away from the flywheel

Fitted correctly, no gap



Back together, gearbox harness fitted, ready to go back in. However the harness should go **under** the remote change housing from the reverse switch to the OD switch, not over as here.



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