A beginners guide to Burman I – by Joe Rayner

Part 1.

An Oilyrag guide to the strip down and rebuild of the Burman Heavyweight Gearbox.

There is nothing new in such a guide, other than it is an attempt to provide a detailed step by step 'manual' , accompanied by photographs, to help a newcomer approach the dismantling and rebuilding of the gearbox with a degree of confidence.

If the gearbox is still on the bike it may be easier to remove the drive sprocket prior to removing the gearbox.

If you have a bike with a swinging arm where it is a far more involved task to remove the gearbox, it is possible to carry out the same rebuild tasks, apart from renewing the mainshaft and layshaft inner bearings , by leaving the mainshaft and entire clutch assembly in situ. However it is more limited and this method suits dealing with problems such as gear selection, broken kickstart spring and oil leaks, rather than reconditioning.

Terminology

I may well use the incorrect terms at times, and experienced engineers may wince, but I'm sure you'll get the gist. For those new to gearboxes there are 3 main 'lumps' inside the gearbox. The selector assembly which translates the movement of you foot into engaging and disengaging gears. The mainshaft, which has a set of gears, and the layshaft that has a matching set of gears. Power into the gearbox comes via the clutch which is attached to the exposed end of the mainshaft. The power is passed through the gear sets and exits the gearbox at the rear chain drive sprocket. Different size gear sets provide the 4 ratios.

Tools required

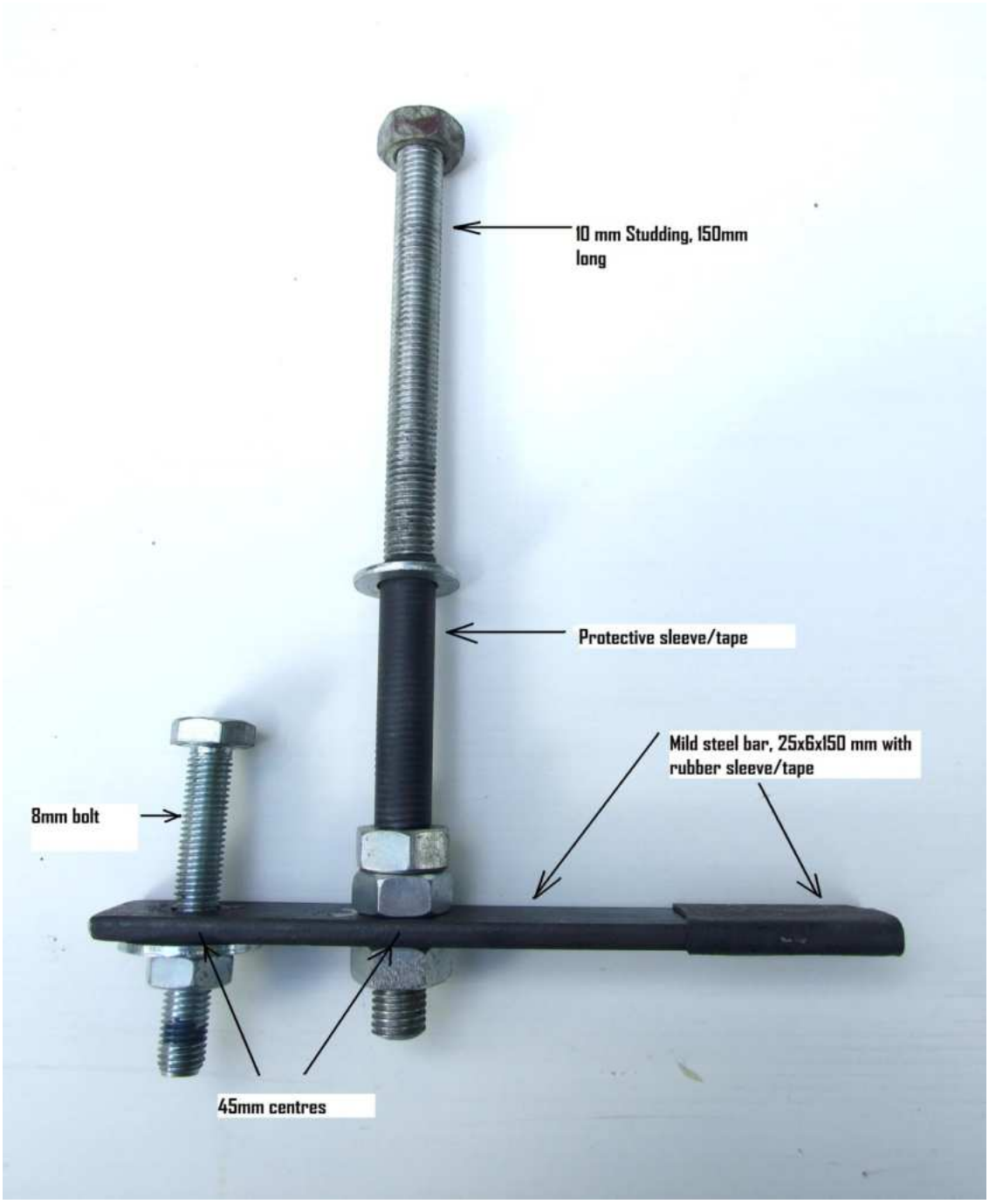
A small selection of Whitworth spanners, a large flat bladed screwdriver, mole grips, Stanley knife blades, circlip pliers, and a stepped drift if you have the means to make one. A camera will also be useful, along with a (!).. hammer. Loctite & gasket sealant may be required.

The gearbox weighs around 30lbs, and will cause considerable damage to you and itself, if it falls from the bench. Your hands and the casing will become oily and the risk of it sliding onto the floor is high! It is possible to clamp the lower mount in a bench vice, or workmate.

Instead, I made up a simple jig in order to make it easier to take the photographs, but it also made taking the gearbox apart a pleasure. The jig took around 10 minutes to make from scrap, and allows working on the gearbox in a vertical position, again using a vice. A light over the top means you can see into the gloomy depths. The ten minutes is saved time over.

A small drip tray or an old towel will catch the remaining dribbles from the mainshaft – it pays to drain the gearbox via the clutch lever inspection cap by leaving the box upside down for a day, and clean the outside of the gearbox with White Spirit prior to strip down.

The jig



Dimensions as shown, with a piece of shrink sleeving over the 10mm studding and a piece of inner tube over the metal strip, both to protect the aluminium casing – tape would do the same job. Once dismantled the main casing can also be worked on upside down on the jig.

Check the outside of the Gearbox prior to dismantling.

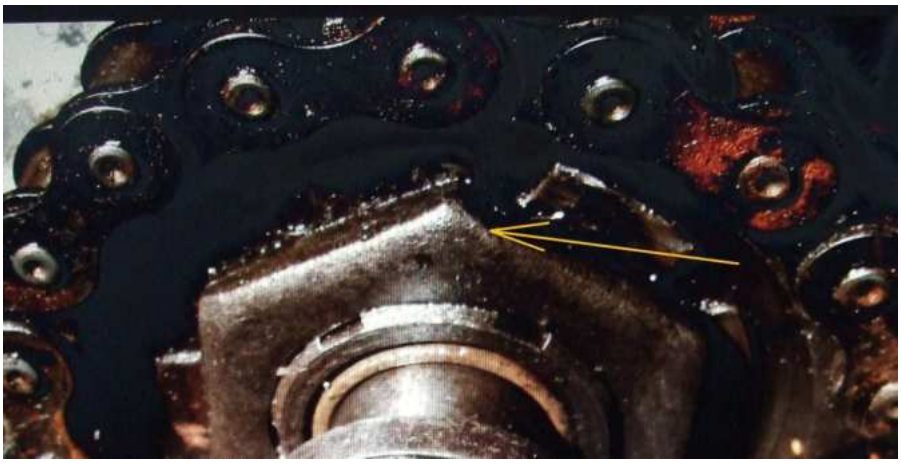
You are looking for casing damage, cracks, galled nuts & screws, chewed inspection cap, mushroomed or stripped lower mount bolts. The next time you'll handle these parts will be on final assembly, so start your shopping list for any parts required.

You can also check the casing stamps which will have the month/year shown – look in the POC library for these, and the many Burman listings on the web. This gearbox appears to have a main casing from 1957, but the middle 'layer' appears to be from 1952!

Removing the Drive Sprocket Nut

This gearbox was already out of the bike and had no drive sprocket fitted, but removal is as below.

Tap the tabs of the lock washer back fully. Wrap a chain around the sprocket (if not on the bike) and trap the chain in a Workmate or vice. Spanners to fit the large nut will not be easy to find and you'll probably need to resort to using a medium size cold chisel or drift on one or more of the nut faces, a 1/8" or so from the nut hex. tops. Realistically, with the chain in the way, you are hitting at about a 45 degree angle. A solid blow from a hammer will jar the nut free and there may be next to no damage to the nut.



However if the nut looks decidedly second-hand (maybe even before you start!) then budget for a new one, and certainly a new lock washer from POC spares. Heating for a few minutes with a hot air stripper may help, especially if you suspect Loctite. Pull the sprocket off.

Removing the gearbox outer cover

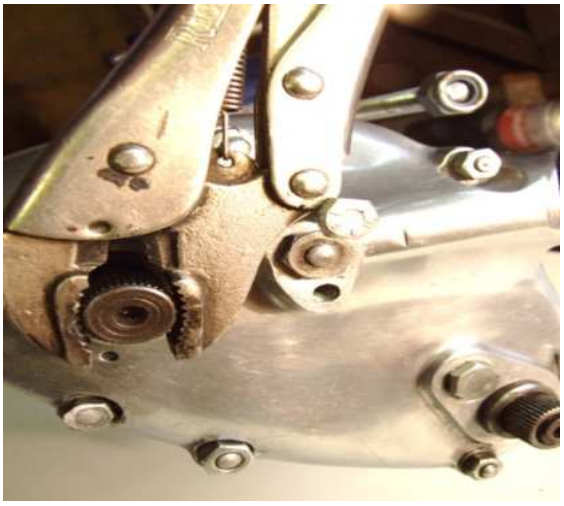
Mounted on the outer cover you'll find the gear indicator pointer, internal clutch lever adjuster casting , splined kickstart shaft and splined gear shift shaft. There are 3 x ¼" and 2

x 3/16th Whitworth nuts, a couple of which have limited access to get a spanner onto. Find spanners with the best fit and avoid rounding corners off. Remove all, plus any washers. Undoing a nut may bring the stud with it – this is not a problem.

Do not attempt to remove the larger 5/16th bolt located to the rear of the gearshift shaft.

Undo the two screws that hold the small alloy casting that covers the clutch adjuster and take the casting off. Leave the rest of the adjuster in place.

Find a Whitworth bolt around 1 ½" long and screw into one of the above screw holes. This will be used as a temporary 'stop' for the kickstart. Clamp your Mole Grips to the kickstart shaft and rotate the splined shaft (anti-clock) to take up some spring pressure and hook the grips behind the bolt, with the grips now under spring pressure, and resting against the bolt.



Find a screwdriver – (a Philips will fit well), and push it into the threaded hole that is in the centre of the gear shift shaft. This will be used to hold the shift assembly in place whilst you remove the cover – the whole splined gear shift shaft passes through the cover, and is left in place as the cover comes off, whereas the complete kick start assembly, held by the Mole Grips, comes off with the cover.

Everything undone, but it's still firmly there!

The original manual said that at this point the cover will come away, but since the discovery of silicone sealants, it may still be firmly stuck. This outer cover was assembled without gaskets, but with some very strong instant gasket and was reluctant to move. Hitting it will not help, nor will bashing an old screwdriver blade between you pristine castings. The following method works for both silicone and gaskets, and relies on using a narrow wedge over a relatively large surface area. If done carefully the cases will not be damaged. You'll

need a couple of new Stanley Knife blades. Remember that by this point your fingers will be nice and soft from the oil that you've been dipping them into, and will cut very easily!

The place where the sealant has most likely to have been used sparingly is at the top, near the inspection hole. Hold a blade at 90 degrees to the casing and tap it gently with a small hammer - it will stretch the sealant. Tap it until the blade chamfer only is fully in, about 3mm. Start another blade nearby and the wedging/cutting effect will start to separate the covers .

Work steadily around the cases, rotating the blades around the studs, until the whole outer cover has moved away from the inner. Find a couple of flat pieces of scrap to gently lever the cover upwards – I used 2 brass Rally Plates here, and increase the gap to a few mm. until you are sure that the sealant has been cut through. Remove all blades / plates

Cover off!

With the Mole Grips still braced against the bolt, and screwdriver in gear shift shaft, push down on the screwdriver and lift the cover away. The 'spring box' may have come off with the cover, or stayed put, so flip the cover, inside upwards, so that it doesn't then fall onto the floor. What you should see, apart from some grease, should be something like this ..

Inside ... with spring box almost ready to fall off.

And, inside the front cover, the clutch lever assembly and, still coiled, the kickstart spring

Dismantling the outer cover components

Firstly you don't need to remove the steel plate with the hole/peg in it on the left of the picture unless it has been damaged or worn. The kickstart spring is still under tension and is attached to a peg in the casing directly behind the quadrant in this picture. To release the tension (gradually!) wrap a rag or piece of leather around the plain inboard end of the

kickstart shaft and clamp it in the vice. Hold the casing firmly (it will try to rotate!!) and take the spring tension off the mole grips, remove the temporary bolt, then the mole grips.

With both hands rotate the outer casing a couple of times to release all tension (in the spring, not you). Remove from the vice and draw the kickstart through the back of the casing and unhook the spring from the casing locating pin. Check the position of the other end of the spring relative to the quadrant– unless you are replacing the spring, leave it there. The quadrant can be removed from the kickstart shaft if replacement is required, otherwise leave alone.

If you are thinking of replacing the outer cover kick start and gearshift bushes make sure that you can obtain them. They are a tight fit in the case, which must be heated evenly to 270C+ and a stepped drift or hydraulic press with suitable fitting used to remove and replace them. The case must be fully supported to avoid risk of distortion or cracking.

Remove the clutch lever assembly, shown here with its outer cast adjuster, bolts, and clutch push rod clevis.

Keep all of the outer cover components together for cleaning and inspection.

What you see inside when the outer cover is off

Firstly recover the spring box and its tin plate, and put aside for cleaning.

The centre section of the gearbox is now exposed, and the main parts now visible are :

The spring loaded kickstart ratchet assembly, attached by the gearbox mainshaft nut, mainshaft bearing, washer & circlip beneath. Shown with the short clutch clevis pin in situ, and pin removed in the second picture. It may have a loose ¼" ball bearing stuck to it.

The gear selector assembly, with corresponding index marks. This assembly lifts away.

It leaves exposed the toothed selector shaft , beneath which can be seen the loose rollers that act as a bearing, sitting captive in a groove in the selector shaft.

Also to be seen is the end of the layshaft and its Oilite bearing.

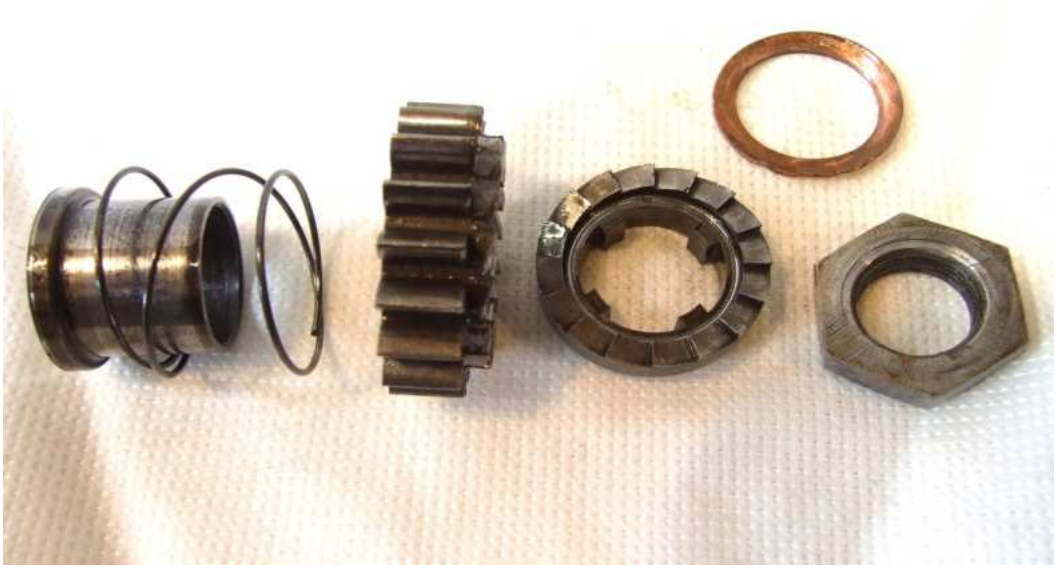
Back on the outside of the main gearbox casing , you'll find a large screw, and this holds a spring which pushes on a peg that relates to the various gear positions. Remove the screw and spring – a magnet may help.

Removing the middle layer of the gearbox.

First task is to remove the nut holding the kickstart ratchet. It is attached to the mainshaft that passes through the gearbox and at its splined end it carries the clutch centre. To undo it means holding the clutch end stationary and one way to do this is to wrap a piece of leather around the splined part and grip it tightly in a vice, ensuring that no damage occurs to it. The nut on this gearbox was slightly suspicious – it had a copper washer that shouldn't have been there and also signs of Loctite. To melt the Loctite a hot air stripper was used – it has to heat the component to 275 C + - when it's bubbling, it's soft.

Use a 9/16 Whitworth socket and remove the (hot!) nut, followed by all parts of the kickstart assembly. Once the nut has been removed the shaft will be free and could be withdrawn from the clutch end of the box (mind it doesn't drop out) , but leave it there. Put just the (cold) nut back on for now, by a couple of threads.

The kickstart ratchet components, including ‘extra’ copper washer, which shouldn’t be there.



Using a 3/16 Whitworth socket (insufficient clearance for a ring spanner), <u>almost</u> remove the 3 nuts that hold the middle of the gearbox to the main shell. This box had washers under the nuts, but manual says none. If washers are present take them off and put the nuts back on by one thread.

The middle layer is ready to remove, apart from the fact that this one was also glued, so out with the Stanley Knife blades again. Once the joint is free the casing can be raised by pushing your thumb on the selector shaft and lifting the cover with your fingers, but once it

is up about half an inch the very small selector shaft rollers will try to drop out, hence leaving the 3 nuts on. You may be able to catch the rollers on a magnet if the gearbox is vertical, otherwise they'll head for the floor. You're looking for 12 of those. Once they have been sorted out (if they drop into the box remember to find them later), fully remove the 3 nuts and wedge the cover upwards with something soft like a hammer handle. When you feel resistance you've topped out on the mainshaft nut, which can then be removed, and the casing drawn off the remaining 2 long studs. Put the casing aside, as it will be dismantled later.

The final frontier – the Main Casing and Gear Assemblies

The gears can now be seen, with the larger mainshaft set to the left and layshaft gears to the right and selector shaft to the top in this photograph.

If you rotate the selector shaft a little either way you'll see the gear dogs lift & fall to engage/disengage gear sets. To the right of the selector shaft is the (silver) detent peg , operated by the spring that you earlier removed, which matches the various gear selector positions. It is held in place by a small nut and this should not be disturbed unless replacement is necessary.

To make access easier, remove the 2 long studs, ideally with a stud remover , or lock 2 nuts on the stud thread. Alternatively a piece of leather and mole grips.

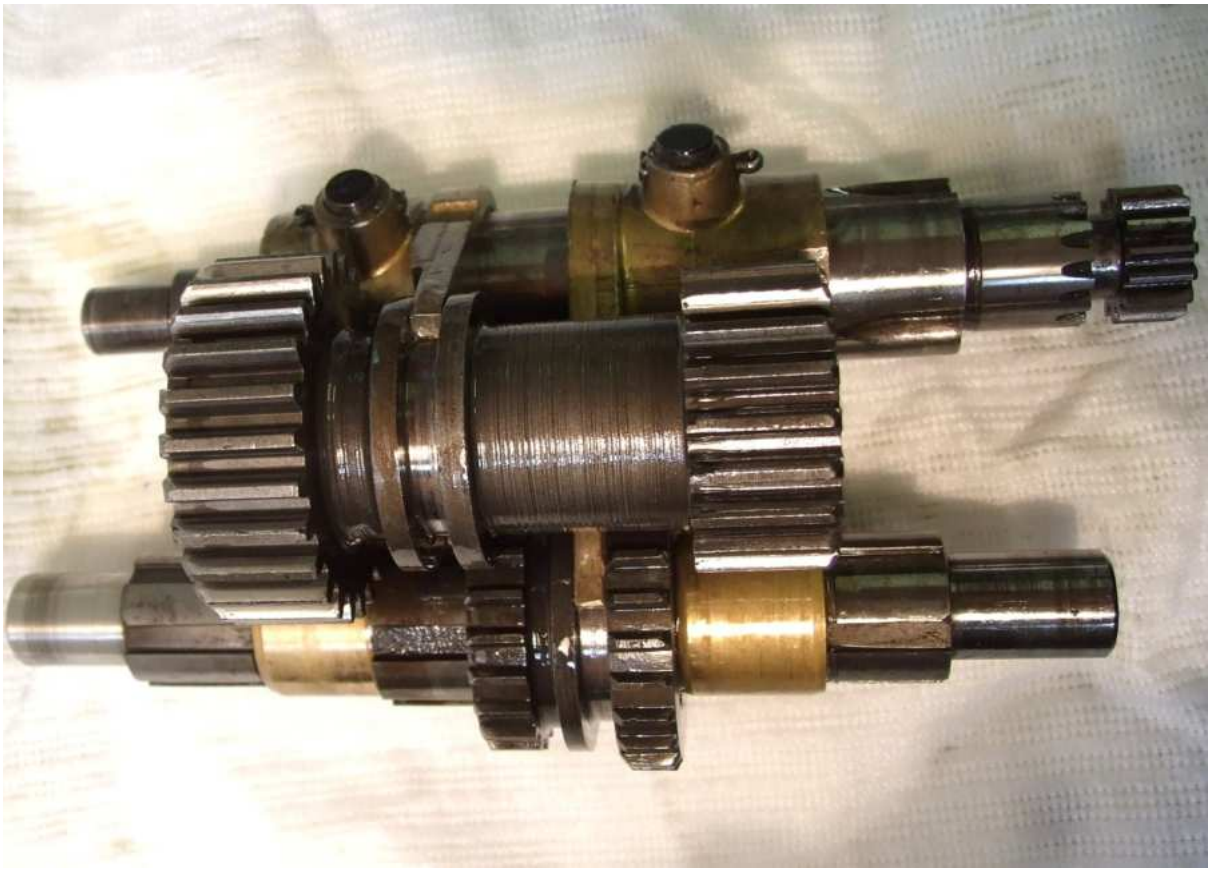
Remove the mainshaft nut, still leaving the shaft in place.

The gears shown are all number stamped – make a note/photo of yours as they are removed. Although the gears will all only fit in one place, it takes any out guesswork on reassembly. Also note which way up they are (& is number on top or bottom?)

Removing the contents of the shell

Remove the gears in turn until you reach the point where all of the loose ones are out of the gearbox, and the remainder are held in place by the selector forks. Remove the mainshaft from the bottom of the gearbox. Holding the cluster of gears, still attached to the selector forks, lift the whole group, including shafts, out of the gearbox shell.

The gear cluster – this is how it goes back in on reassembly. It’simpler to do than it looks.

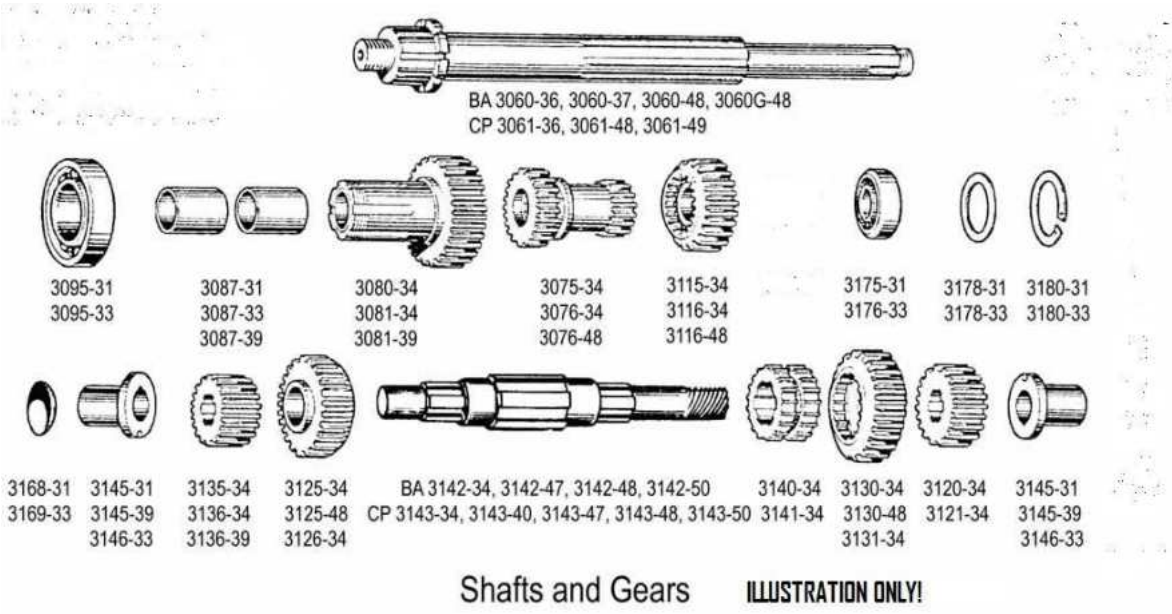


Still inside the gearbox is the large mainshaft drive gear to the left in picture and 2 loose layshaft gears to the right (a smaller one is out of sight here). Remove the layshaft pair first. The mainshaft gear has a sleeve which passes through the centre of the large mainshaft bearing located in the casing. Draw the gear upwards and recover the loose outside metal sleeve, which will either fall out or sit in the centre of the outer oil seal.

The same 2 gears removed below , mainshaft gear turned over to show splined drive sprocket sleeve plus 2 layshaft gears.

To find them on the diagram they appear (L-R) as 3080-34, 3135-34 and 3125-34 . Inside 3080-34 are the 2 larger Oilite bushes, 3087-31 x 2.

Diagram of gear train – ignore the part numbers, general illustration only.



The almost empty shell

You'll suddenly enjoy handling the very light gearbox casing and it now only holds in its depths the small selector shaft bush (steel), layshaft bush (Oilite type), mainshaft bearing and oil seal.

The selector shaft bush is hardened and should show little sign of wear, so unless it is suspect, then leave it where it is. This one was removed as it was slightly loose and moved back and forth, and will be refitted with Loctite. This steel bush is driven into the gearbox from outside for removal, and this can be done when the casing is heated to remove main bearing & Layshaft bush.

To remove the above selector bush or the layshaft Oilite bush you'll need to tap out, **from inside**, the metal caps that act as oil seals. Find a long drift (not screwdriver!!) that passes through the bushes from inside and lightly tap out the thin caps. No money was wasted by Burman on those. Also shown in picture the removed selector shaft bush. Top hat rim goes to the inside of the casing.

The mainshaft bearing and oil seal

Before removing the bearing rotate it and feel for any roughness or play. If it is at all suspect then renewal is recommended – you have to do a lot of pulling apart to reach it if you change your mind later. The bearing in this particular gearbox was as new, along with the oil seal, and it was reused.

Removal of the bearing starts from outside of the gearbox, with removal of the large circlip and oil sealing ring. Push down hard on the circlip pliers and free the whole ring before trying to lift it out – avoid prising the circlip up with screwdrivers as the groove is narrow and damage inevitable to the groove and the circlip. The seal has a broad hardened steel ring and careful use of a broad screwdriver beneath this ring, avoiding catching the oil seal lip, will raise the ring. Work around the ring, rather than levering from one point.

Once the (huge!) bearing has been exposed it is wise to thoroughly clean out the whole casing to remove oil residues, before heating it to as much as 270C+ in your oven. You may get away with lower temp., but not if Loctite has been used. The bearing may well fall out in the oven, so make sure that the casing is supported so that this can happen. If the bearing doesn't fall out, then you may well do so with your wife for doing this in her kitchen! Ovens self-clean at these temperatures, so smoke alarms will alert the neighbours and they'll tell your wife what you have done.

If the bearing doesn't fall out of its own accord support the very hot casing on wooden blocks and tap the bearing evenly from inside the casing, either with a long, large diameter drift, or tapping at the 4 points of the compass in turn on the bearing centre with a brass drift or similar.

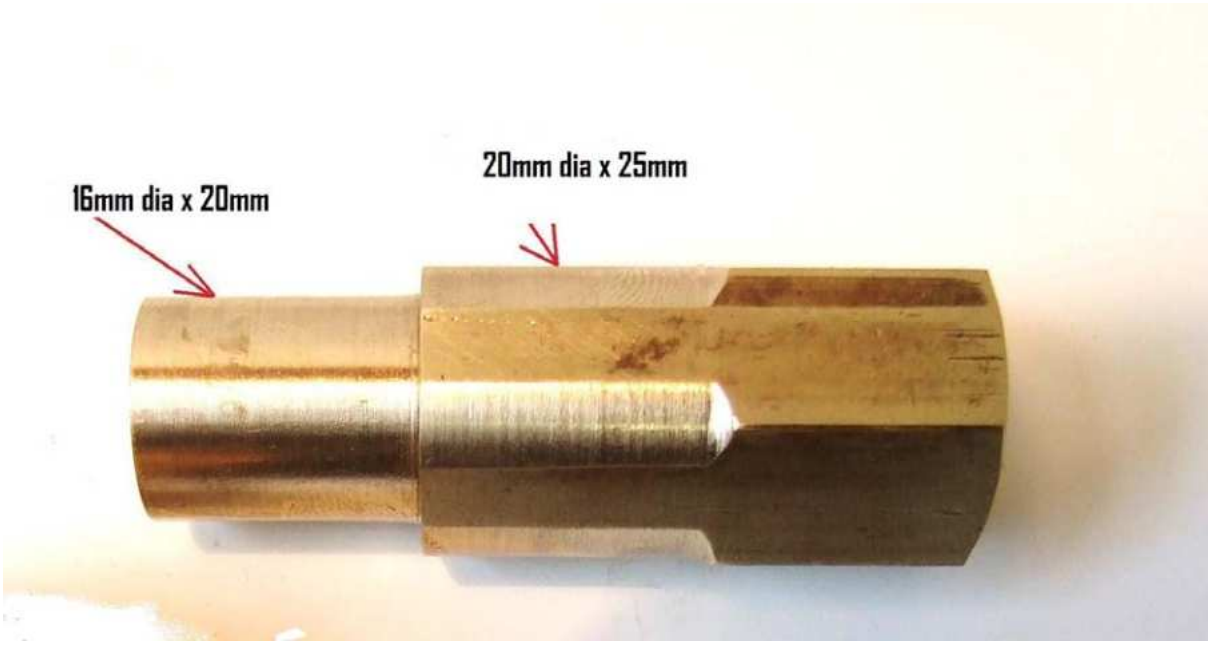
Trying to get the bearing out from a **cold case**, even with a hydraulic press, will pull some aluminium from the bearing housing, running the risk of a loose new bearing on reassembly.

It will also drag alloy into the circlip groove and make that difficult to fit – **so don't try this!**

Removing the layshaft bush from the main casing.

If you are well prepared then this can be done at the same time as the main bearing, with the case hot. From the outside of the gearbox you will see a small hole near the tin plug for the layshaft. Use a flat ended pin punch to drive the metal locating pin out of the casing and through the Oilite bearing. Retain this pin.

Working from outside, using a drift (ideally stepped, dimensions as shown) push/tap the Oilite bush into the hot casing until it drops out. The same drift is used in replacement.



Oilite is quite weak and porous, and damages/distorts easily – it's the metal equivalent of Weetabix. You won't be able to re-use this removed bearing, so be certain that it does need replacing before knocking it out. Keep the old bush as a reference as the POC ones need reducing in length. Any replaced Oilites will need reaming to size– it's not a difficult nor expensive job and shouldn't put you off replacing them- all shown in the **Rebuild** section.

Dismantling the Middle Layer.

This will seem simple now you've tackled the main casing.

Remove the circlip using circlip pliers only and lift out the steel ring/washer that sits on the bearing. Drive the steel pin out of the layshaft Oilite bush.

The same technique & tools are used to remove the identical Oilite bush in the gearbox main casing, so this job can be done at the same time. You must heat the centre casing to remove both the Oilite bush and the ball bearing race, fully supporting the casting as you do this. Get your wooden blocks, large sockets and any other supports ready and in place, before starting to heat the casing. Anything other than a light tap to shift the bearing race means that the casing isn't hot enough and/or Loctite has been used, so more heat required.

If the kickstart stop pin (shown 11 o'clock above bearing race here) is bent / damaged /loose this can also be tapped out from behind.

Hopefully you have now completed the strip-down.

You now have a very large, but well organised (!) pile of parts. There are very few parts that can be put back incorrectly, but that's no excuse for not keeping things organised. Throw nothing away at this stage, and don't be tempted to leave the rebuild to a later date as all parts to mend it are available now, and it's all still fresh in your mind!

Photographs are a great memory jogger and can also be added to your bike's history file.

Now on to Wear and Tear....and the Shopping List Grows