A beginners guide to Burman III – by Joe Rayner

Part 3.

Burman Gearbox Reassembly

Preparing the 3 'layers' & main gear bushes.

The  symbol indicates the level of workshop tools required, not difficulty.

1. Assembling the outer cover. 

Jobs prior to re-fitting are :

Replacing kick start oil seal.

Refitting internal clutch lever.

Refitting kick start spring & tensioning.

Reassemble spring box/gear shift

1.1 Replacing the kick start oil seal

The kick start shaft and its two steel bushes take quite a bit of force and leaks are inevitable. Having previously tried on another box, without success, to fit a modern oil seal supplied by Draganfly, on this gearbox I've used 2 x O rings. One between the two steel bushes (2.5mm x 21mm ext dia), and a larger one in the cover outer face (4mm x 25mm ext dia).

To get to the outer seal seat, carefully punch, from inside the case, the retaining washer that is peened over. Position your punch at the 4 peening marks and tap the washer out. Clean the washer and dress it flat. Clean the 'groove' that the outer O ring will sit in and also put the smaller O ring into place between the 2 bushes. It's probably wishful thinking that it will do much to stop oil moving along the shaft, but hopefully the second one will.


Place the larger O ring in place and run a thin bead of Loctite around the washer seating and put the washer in place. It will be held up too high by the O ring. Use a piece of studding and pull the washer fully onto its seat, compressing the O ring. Leave the studding in place and peen over the casting in 4 new places to retain the washer, which, along with the cured Loctite will hold the O ring securely. Smear a small amount of grease onto both O rings and bushes.


1.2 Fitting the clutch lever is the reverse of removal – it will need further adjusting once the clutch cable has been re-fitted. Don't fit the small outer adjuster casting at this stage.

1.3 Kickstart quadrant and spring.

Reassemble the spring onto the quadrant, find the Whitworth bolt and mole grips that were used in dismantling. Hook the spring onto its retaining peg in the cover and wind the spring using the mole grips on the splined kickstart shaft. A couple of turns should suffice. (Before dismantling mine I used a spring balance on the end of the mole grips and it read 1.2Kg 'pull'

at the lever top position). Put the Whitworth bolt into place to hold the Mole grips/spring tension and put the assembled cover aside.

1.4 Spring Box

Reassembly is the reverse of dismantling, and is made easier by using a tie wrap or wire to hold the larger springs after they have been compressed in the vice, or at least make them easier to find if they fly across the shed. Use grease on the shaft & bushes and lightly coat the selector quadrant with grease. Do not fit the Spring Box assembly to the outer cover at this stage. Make sure that the steel peg is secure in the aluminium casting – Loctite if in doubt.

2. The Middle Layer of the Gearbox.

Jobs prior to refitting are :

Fitting the Layshaft Oilite bush & reaming

Fitting the mainshaft ballrace

Fitting the kickstart stop peg/cushion

2.1 Layshaft Oilite fitting & reaming 

The Layshaft Oilite bush, as supplied by POC, is too long and 2mm will need to be removed – either in a lathe, or by careful sawing /filing. Oilite crushes & distorts very easily, so clamp by its ends, rather than crushing the tubular part of the bush, and take the 2mm off in 2 half-round bites.

Heat the case and push the (frozen!) bush fully into place, with the top hat rim to the inside. Using a 3mm bit, drill from the front of the case through the rim of the bush. Open the hole up slightly in the bush rim with a needle file and, after cleaning, apply a small drop of Loctite to the hole. Tap in the 1/8” locating pin from the rim side, finishing with the pin just below the top hat rim. The rim may distort slightly outwards around the drilled hole, but this is not an issue.

The bush bore now needs to be reamed to match the diameter of the Layshaft – your Layshaft may have suffered wear in the past and been ground undersize – in fact the two ends may even differ in size, so make sure that you are matching to the correct outer end of the Layshaft when reaming. Mine were 2 thou different in diameter.

Having tried using the adjustable reamer 'freehand' it is not easy to keep the tool at precisely 90 degrees to the casing face in what is a short bearing – as you turn the tool by hand it is easy to apply more force at one particular point and end up with a bore that becomes bow-tie shaped.

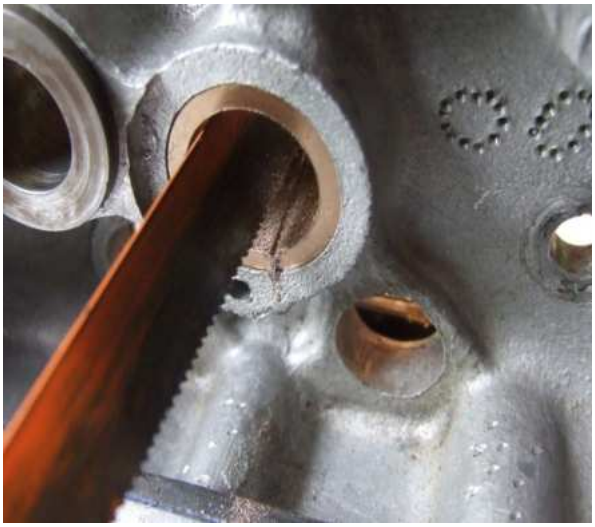
Instead I used a pillar drill, running at lowest speed, with small cuts and coolant/lubricant and this ensures that the bore of the 2 bushes are in line with the main casing faces. I did the main casing bush first, then put the mid casing in place on the main casing and then 'bored' this. The casing wasn't clamped to the table as the reamer self-centred quite happily.

Ream the bush when the casing is cold. Take very small bites with the reamer – slacken the nut closest to the squared drive a fraction (half turn for early cuts, to 1/8 turn for final cuts) and then tighten the bottom nut up to expand the blades for the next cut, then re-tighten the top nut – the nuts are thin walled and should not be forced. Have a practice on the old bushes when they are in situ – nothing to lose with those! White Spirit will help with the cut if you do not have cutting fluid, and is useful to wash away swarf.

Once you are happy that you have reamed the bush to size – free running with just discernible 'clearance' (see Oilite chart) , use a sharp wood chisel or bearing scraper to form a small chamfer at the bore edge on the thrust face of the bush– if your layshaft has been ground it may have a radius and the Oilite needs to be scraped back to clear this.

A very useful guide to clearances & press fit sizing, along with information on grooving can be found at https://www.oilite.com/PDFs/castBronze_designData.pdf

You can then cut an oil groove . The simple way to do this is to dismantle your hacksaw and pass the blade through the bush, and reassemble your saw. Firmly clamp the casing. I cut my grooves at the lowest point, hoping that oil might get into the groove more readily, but that is just wishful thinking, as it probably drains out more readily too.



Cut a 1mm deep line into the bush with the saw, remove the blade and use a coarse rat-tail file to open up a neat trough. Don't be tempted to run the reamer back through once the groove has been cut – it will chatter as a result of the groove. Thoroughly clean the casing of all swarf prior to fitting the ball race.

Once both Oilites have been finished & lubed, put the middle & main casing together, with just the layshaft in place and check that it fits and rotates – if it binds, add the dry gasket & see if it improves. If still tight, then very lightly ream the bushes until the shaft can just be rotated with your fingers, accessing through the mainshaft bearing race hole. Put a gear on the layshaft to make things easier. It will be quite heavy to turn with your fingertips, even when reamed correctly, so keep reaming to a minimum – clearance should be around 2 thou".

2.2 Mainshaft (small) ball race fitting

Fit new mainshaft bearing race first, followed by the steel spacer, then circlip, ensuring that the circlip has fully expanded into its groove. With a heated casing the bearing should go in quite easily, but ensure that the thin rear wall behind the bearing is fully supported if any additional force is required to seat the bearing, or it may crack. If you have to tap the bearing in do so on the outer race only, using the points of the compass, to ensure that the

bearing remains square in its bore. If you try using your old race to push the new bearing all the way in you run the risk of jamming the old one into the bore and it will be a so-and-so to get it out!

2.3 Kickstart stop peg & buffer 

Refit the kickstart stop peg, if it has been removed, again to a warmed casing , using Loctite. Make sure that it does not project beyond the front face of the casing , otherwise it will hold the two cases apart – the pin projects through the rear of the casing by a couple of mm. Fit a suitable 'buffer', either POC or alternatives mentioned in Wear & Tear section, once casing is cool. Here a piece of 16mm nylon bar has been used.

(Before fitting the kickstart spring to the outer casing test clearances by putting the outer case and mid section of the gearbox together to make sure that the cases are not being held apart at all. I found with this gearbox that the kickstart shaft could be felt to bind when the cases were pulled up together without a gasket, so clearly a gasket, rather than sealant, was the best option. I made a gasket from 0.5mm gasket paper, but they are available from POC.

3. Gearbox main casing

Jobs to do :

(NOTE : Any work on the lower mounting needs to be done first! See Wear and Tear section.)

Fit & ream Layshaft Oilite bush

Fit mainshaft ball race

Fit mainshaft oil seal

Dress and fit core plugs

3.1 Layshaft Oilite bush 

Fitting procedure for this is the same as that used for the 'middle' casing and should be done with the casing hot. Pin & then ream the bush to size, cut the oil groove and thoroughly clean the casing of all swarf before the next step. Ream this bush at the same time as the one in the middle casing. Once done, this will be your last chance to clean the inside of the casing thoroughly.

3.2 Mainshaft ballrace fitting 

The casing needs to be heated and the bearing pushed into place until it seats fully. Remember to use bearing locker if the old bearing came out very easily. Allow the case to cool. Thoroughly lubricate the bearing race.

Although there is an oil seal outboard of the bearing it only seals against a collar, and there is the possibility of oil creeping around the outer edge of the seal where the circlip locates. It may be beneficial to run a narrow bead of sealant around the rim of outer bearing race prior to fitting the steel ring/oil seal and circlip, and another bead once the circlip is in situ, sealing the whole channel.

3.3 Fitting the core plug caps

These domed tin discs seal the end of the selector bush and the Layshaft Oilite bush.

They have probably taken a battering but can be dressed back into a dome shape by using a ball pein hammer with the disc resting on the end of a suitable sized socket or an old bush. The disc may end up out of round by doing this, so test that it just enters the hole and file away any high spots from the disc edge.

Make sure the seatings for these are oil-free and apply a thin bead of sealant. Use a tubular drift such as a socket just and lightly tap the dics down, dome upwards, until they just contact the bushes.

Then, using a large diameter plain drift, tap the centre of the dome of the disc to spread it out – there is no need to flatten or batter the disc, just a couple of centrally placed light taps. Once in place, fill the remaining bore with sealant and smooth the outer face with a wet finger. Wipe any excess sealant from within the bearings.

The 3 gearbox casings are now complete and ready for gearbox reassembly.

4 Preparing the main gear Oilite bushes 

Jobs to do, if wear is excessive :

Remove old bushes.

Machine new Oilite bushing outer diameter on lathe.

Replace and ream the Oilite bushes to match the shaft.

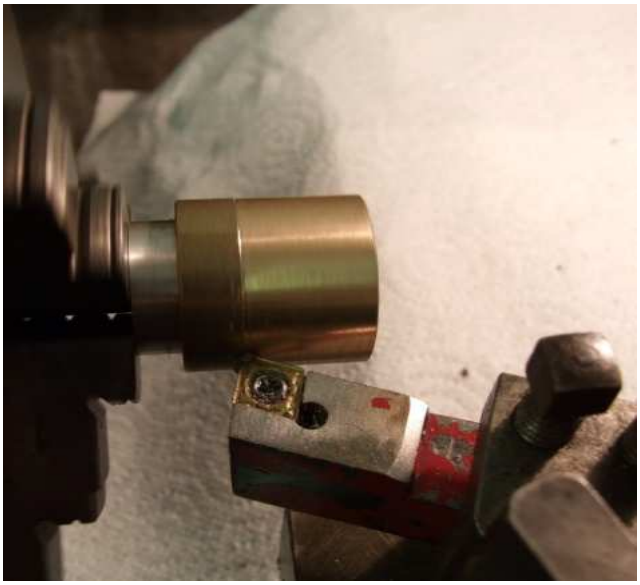
4.1 The Oilite bushes within the main gear bore are relatively thin-walled and straightforward to press out with a ¾" AF socket. Place the gear face down on wood blocks and, working from the drive sprocket end, use a ¾" socket or similar to knock the bush down into the bore. It will then connect with the second bush and both can be pushed out through the gear end. The reason for working from the drive sprocket end is that it is quite

possible that the steel ‘tube’ that the bush fits into may no longer be round – it has had a battering from the drive gear and the large lock nut. It is therefore recommended that the bush is pressed out of the opposite end, as shown, and new bushes also fitted from this end too.

The only new bushes available are oversize both in outside diameter and bore (28.6mm x22.1mm), whereas the ones that came out were smaller in outside diameter and larger in bore (27.75mm x 22.85mm (worn!)).

If you are at all uncertain about doing the next part of the job, then get it done professionally – you’ll have saved a lot of money by doing the rest yourself, and sometimes, if you do not have the correct equipment, there is no choice.

4.2 If you are building up the gearbox in your shed you’ll need to find a way of getting the outside of the 2 new large bushes outer faces turned down before pressing them into the bore. Either a pal with a lathe (even a model maker’s will do this job), or entrust it to an engineering shop, who can also fit & ream the bush bore to match your mainshaft.



If you do it yourself then turn the bush outer surface to the diameter of your gear bore plus around 3 thousanths of an inch, so that the bush will be a tight press fit in the main gear. You'll need to make up a simple mandrel for the bearing to sit on for machining– I used a piece of aluminium bar turned so that the bush just tapped over it, as in the photo. If you try to use the expanding chuck jaws the bush will distort, becoming triangular.

4.3 Ideally use a press to push the new bearing into the gear, or improvise with a large vice or heavy studding. It may be easier to fit the bush into a hot gear, with the bush having been in the freezer to shrink it, but it will warm up fast. Lubricate the bore first.

Remember to press the drive sprocket side Oilite bush all of the way through from the gear end using something like a socket, to avoid any distortion that may be present at the drive sprocket end, and then fit the gear end Oilite bush afterwards, leaving a gap between the 2 bushes.

I had all of the equipment both to reduce the bush and press it into place, but not a reamer that would do the job. Luckily I already had the correct adjustable reamer for the smaller bush, so had the choice to either get the main gear bushes reamed professionally, or buy the correct size adjustable reamer, an H10.

(I opted for the latter, and paid around £25 (from RDG Tools – a bit of a budget quality tool, only just 'adequate') – mainly for the satisfaction of doing it myself as the costs were likely to be similar. Cheaper reamers are available from India etc, and frankly they are probably no better or worse than the £25 one, which likely came from there in the first place.)

I did consider trying to use the lathe to bore out the new bushes to match the shaft, and had a try on the old bushes whilst they were still in the gear to see how well I could do this. Resulting accuracy was not great, mainly due to a combination of my lack of skill, getting the tool to bite consistently on the oil impregnated bush, and an old lathe, so the choice was reamer, which allows smaller, controlled cuts.

Note the thick wall of the new bush prior to reaming – there's quite a bit to come out, but it will allow you to practice! A spiral flute reamer would take out material more quickly, but with a straight blade, adjustable reamer, the cuts have to be much lighter as the tool will chatter otherwise. Ream through both bearings at the same time from the gear end, and have a pot of White Spirit to dip the reamer into after every pass, turning clockwise all the time, even on removal. If you do this by hand it will be a laborious process. I resorted to using the lathe as it has a gearbox that allows speeds down to 39 rpm. Even then only a relatively light cut was possible, with coolant/lubricant, but better than blisters!

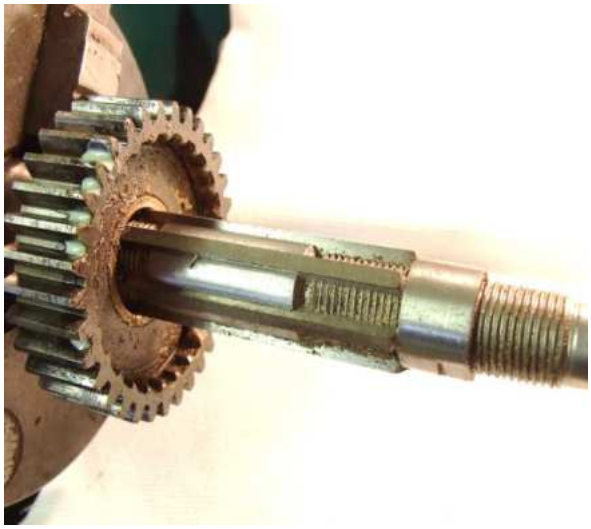
I think that a drill press would run too fast, even on lowest speed, in this size of bush.

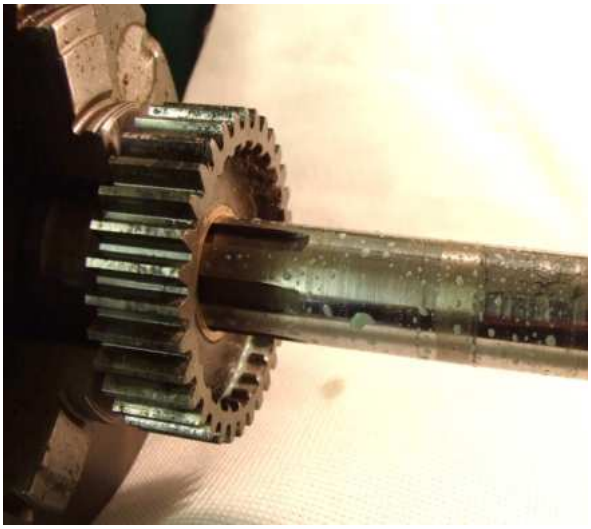
Both bushes fitted, shown prior to reaming together.

As my main shaft had 3 thou wear and the best I could achieve was to ream the bushes to match the original shaft diameter, plus a thou to let me get it onto the shaft, allowing the unworn part of the shaft to be a sliding fit through the bush.

I was then left with a 4 thou clearance at the bearing when in situ , which to me sounds OK, close to the Oilite chart clearance figure , and certainly a big improvement on what I had.

Photos show reamer in action, using lathe to reduce effort and get the bore concentric , and secondly , once reamed, final clearance fit of mainshaft.





Unless you can find out what Burman originally recommended and also have the means to accurately machine and measure to those tolerances, then 'free-running, with barely discernable play' could be the choice – Oilite bearings of the diameter found in this gearbox fall into the range of 2-3 thou" clearance. Remind yourself that this is a 60 year old gearbox and no Rolex wrist-watch!

At this point, with all repairs done and replacements fitted, it's time to hide your handiwork.

4 At Last – Reassembling the Gearbox.

Have your oil can at the ready to make sure all moving parts have an initial dose of lubricant, rather than assembling 'dry'. Oilite bushes usually come 'oil soaked', but if they appear dry then a liberal soaking of light machine oil will help. Lubricate all races thoroughly.

Also have some thick grease nearby to hold rollers in place, along with Hylomar or similar.

If you had removed the drain plug, re-fit it, with a couple of wraps of PTFE tape around the threads.

4.1 With the gearbox main casing on a jig, or firmly supported in your vice, put the main gear into the bottom of the casing, fully through the main shaft bearing.

Stack the two Layshaft gears, small one first, on top of the Layshaft bush in the bottom of the casing. (Look back at dismantling pictures).

4.2 Hold the cluster of Mainshaft gear, Layshaft gear and selectors together by putting your fingers into the two gear sets and feed the whole assembly into the gearbox, angling them past the detent pointer.

Set the selector shaft into its bush at the bottom of the gearbox, and then spread the gearsets apart, supported by the selector forks. Look down through the Layshaft gears and line them up with the Oilite bush that you'll be able to see in the bottom, and feed (and wriggle) the Layshaft fully into place. The Layshaft has splined ends and it's the longer spline that goes in first.

4.3 Place the remaining Layshaft gears onto the shaft, and stack the matching Mainshaft gears on top of those already in place. Set the mainshaft gears into a straight line by looking down through their bores. Feed the mainshaft up through from the bottom of the casing, collecting up the gears on the shaft – you'll need to wriggle & poke things around to get everything to match up with the shaft splines, but it is straightforward.

If you have used the vertical jig (assembly is very, very easy with it) then raise/adjust the main casing upwards and support the end of the mainshaft on the lower part of the jig, with all of the weight of the casing being taken on the vertical stud, and the mainshaft projecting around ¾" from the mainshaft sleeve.

4.4 Fill the groove in the selector shaft with thick grease and put the rollers in place – put some clean rag over the gears at this point in case you drop one of the loose rollers into the casing. Fit the detent spring and only tighten the screw until it is level with the casting.

This makes it easier to move the selector, as the spring pressure is reduced.

Put a thin smear of Hylomar type sealant on the main case, apply the gasket (my home-made gasket was 0.25mm thick), and use Hylomar on the inside face of the mid-section casing.

Give everything in the main casing a squirt of oil and lower the mid section into place – feeding the 3 shafts into their relevant bushes/bearing and take care not to disturb the selector shaft rollers.

Nip up the 3 nuts that retain the mid-casing, and fit the kickstart ratchet steel bush, spring and ratchet assembly onto the mainshaft . Thread the nut onto the mainshaft fully, but only nip up hand tight. This will now support the clutch end of the mainshaft and lift it away from the jig.

NOTE : There is no provision for adjusting end-float on this gearbox, so no shims.

Put a piece of leather over the small selector gear and rotate the gear with mole grips until the detent clicks into one of the selector grooves. Initially you won't know which gear you have selected, or possibly neutral. But once you have neutral it is easy to find first – one click anti-clockwise, and the other 3 gears clockwise from neutral – the degree of rotational movement required to select the gears varies from one gear to another. There is a positive stop at each end of the gear range, so the cog will not rotate a full 360 deg.

Rotate the mainshaft by holding the clutch end and check that everything turns smoothly. If you have selected a gear then the output part of the mainshaft will also rotate. If all feels good, then carry on as below. If something binds or jams then ease the middle casing upwards and find the cause. Once you are happy.....

4.5 Apply Loctite to the cleaned threads of the inner mainshaft nut and now tighten it firmly onto the mainshaft – holding the clutch end of the mainshaft in the vice, protected by a piece of leather or rubber whilst doing this.

Loctite & fully tighten the 3 nuts that hold the mid casing to the main casing. No washers are shown on the Burman diagram. Mine had split spring washers fitted, which had dug into the casing, and these were omitted on the rebuild. No torque figures are given for fixings, but clearly the mainshaft nut needs to be pretty tight, whereas aluminium castings need a lighter touch. Any wobbly or easily unscrewed studs need Loctite.

4.6 The gearbox assembly can be turned over and the loose oil seal steel ring fitted onto the output shaft, shown here without the central mainshaft in place, after greasing the oil seal lip. That's not blood, just some stray grease.

If you have an old oil seal ring (a new one comes with the POC kit) also put this on the shaft and it will allow you to put the large sprocket nut on, giving you something to grab hold of when testing the gearbox on the bench, and will also stop the loose new ring from falling out. Alternatively loosely fit the chain sprocket.

Put the gearbox back onto the jig.

At this point it should be possible, by rotating the selector gear back and forth to easily find all 4 gears and neutral.

Neutral can be identified by rotating the clutch mainshaft, but seeing no rotation of the output shaft , and top gear by rotating the clutch mainshaft and seeing the output shaft turn at exactly the same speed. It will click firmly from gear to gear.

4.7 Once you are happy that you have achieved this remove the detent spring screw, apply Loctite to the casing and fully screw the plug in – its head sits around 3/8" below the casting face.

I decided to 'bed' my bearings in as initially it seemed a bit tight to turn in higher gears. I gave everything a good squirt of oil and put a ½" socket adaptor onto a drill, with a 9/16" Whitworth socket onto the mainshaft nut, and ran the gearbox for 5 minutes or so in each gear . The Oilites didn't get hot, and the mainshaft became easier to turn as a result when a gear was selected. No doubt 'running in' will loosen it up further.

4.8 Apply another good dose of oil to the exposed bushes & bearings and then fit the selector quadrant assembly.

You need to line up the 'O' marks that exist on the selector shaft gear and the gear quadrant. You may need to rotate the selector shaft position to do this, using Moles & leather – second gear (?).

(The positions of the marks will match those when you first dismantled the gearbox, so check any photos. If you fail to do this, or miss by a tooth, you'll end up with a 3 speed box, or one that jumps out of gear.)

Give the spring box and related parts a coating of grease, and fit the spring box and gear shift shaft, making sure that the 'claws' of the selector are fully in place.

4.9 Put the clutch pushrod 'clevis' in place into the end of the mainshaft with a blob of grease – remember this will also need a ¼" ball bearing or roller bearing between it and the clutch rod, and this can be fitted now, as long as there's a good dollop of grease to stop it falling though the mainshaft.

4.10 Coat the mid-casing with Hylomar, fit a new gasket, coat the outer case face.

Grease the gear shift shaft bush and lower the prepared outer casing into place, fiddling the clutch lever into the pushrod slot and making sure the pre-tensioned kickstart quadrant is sitting on its stop pin cushion. Place the nuts on the studs, remembering to replace the gear indicator pointer, and lightly nip them up.

Put the kick start lever on and try the spring pressure – the kickstart may appear to jam when tested like this as it doesn't tap the mainshaft round to allow the ratchet teeth tips to move over each other – your foot does a better job.

Rotate the clutch end of the mainshaft a little as you push down the lever by hand and it should now engage OK, and push down fully. (If the lever is floppy and slow to return under its weight you'll need to tension up the spring, and that means drawing the outer cover off (see dismantling)).

Fit the gear shift lever/Mole grips and now engage the gears in turn, rotating the mainshaft and checking the various rotation speeds of the output from first through to top gear. There may be some drag in neutral and this may also rotate the output shaft, but this can be held still by hand as the input is rotated.

Once you are happy that all gears select, there's a neutral where it should be and the shafts rotate smoothly, fully tighten the cover nuts.

Re-fit the clutch adjuster casting with 2 screws.

Re-fit the inspection cap with a label tied to it to remind you to add lubricant once the gearbox is back in place.

Once back in the frame you can re-fit the drive sprocket, along with lock washer and use the rear chain to hold the shaft still whilst the nut is tightened – you may have to resort to tapping it round in the absence of a large box spanner, and secure with the lock tabs.

Avoid using the inner main bearing nut (with outer cover off) as a brace to fit the drive sprocket nut as you will run the risk of stripping the smaller thread.

Lubricant is as recommended in the various 'manuals', and don't be tempted to overfill the gearbox as the excess lube will find its way out again. I use a 50/50 mix of gear oil and Spherol – a gloopy combination that seems to do the job, and a bonus is that much of it stays in the gearbox.

The gear lever on the Panther runs very close to the exhaust, and if the lever is set too low it can't travel its full distance and move the pawl assembly when changing up through the gears, which will either not select or drop out of gear. Make sure that the lever, when

depressed fully, is not likely to foul the exhaust. If you have a neutral pointer on the gearshaft make sure that it clears the matching point on the gearbox, or similar issues may arise.

Refitting the clutch assembly and cable set-up/adjustment are not covered here.

Recommended suppliers/Info :

First port of call, for Spares and Library, Panther Owner's Club.

Draganfly Motorcycles

Hayley Bearings

Bearing Boys

RDG Tools

Castrol Classic Oils – Spherol.

Oilite information https://www.oilite.com/PDFs/castBronze_designData.pdf

Final drive sprockets.