AF Rayspeed Clo5e Ratio Gearbox Instructions

What's in the Kit:
A Gear Cluster, Five Loose Gears and a 5 Speed Gear selector.

Quick Guide:
The Clo5e Ratio gearbox assembles in the same way as an original Lambretta gearbox, with three exceptions.

1. No shim should be fitted behind the gear cluster.
2. The main gear shim will be approx. 1mm thinner than the original, and must be between 1.4mm - 2.0mm for the height of the stack of 5 gears to correctly align with the cluster.
3. The gear stirrup may need to be filed (pictured further down) to clear the crankcase in 5th position.

The alignment of the gears can only be established when a rear hub is torqued down (to fully seat the layshaft), and a clutch spider is torqued down (to fully seat the cluster).

Parts that will need:
In a perfect engine the parts you will need once you have bought the Clo5e Ratio gearbox in order to fit it.

1. Selection of gear shims, (if you know what shim your previous correctly shimmed gear box used buy a shim 1mm smaller and a couple either side of that).
2. Clutch tab washer (unless your clutch does not use one), and chain tab washer (depending on type of chain guide fitted).
3. Crankcase gasket
4. St90 oil gearbox oil

Parts you are likely to need:
Most running working bikes that are well serviced should anticipate.

1. Gearbox bearings: rear hub bearing (double row type recommended), 6004 cluster bearing, layshaft needle roller bearing, cluster needle roller bearing.
2. Pair of gear Pawls and 5mm circlips.
3. Layshaft O Ring, and Selector Shaft O Ring.
4. Set of 6 M7 nuts and spring washers for the end plate.
5. Selector shaft with bush, and gear tie bar, with boot and 6mm circlip
6. Pair of gear cables and clutch cable.
7. Special shims for the rear hub bearing. To alter the height of the bearing.
8.

Less likely but critical parts:
Ensure your bike is well serviced, tyres, wheels, brakes, controls etc. are all in good condition. However as you are replacing the gearbox pay extra attention to the parts directly connected.

1. Layshaft bearing top hat, and cluster bush.
2. Layshaft (some early layshafts are too short (as pictured)).
3. Selector spring and balls.
4. Gear end plate, with oversized dowels.
5. Rear hub.

Golden Rule

Be fastidious. Check each component as you fit it, check the part, then check its operation, i.e. when you fit the selector, check that it can select all five gear positions and neutral, when you fit each gear, select it and see that it all lines up correctly and spins freely.

Gear Chart Guide

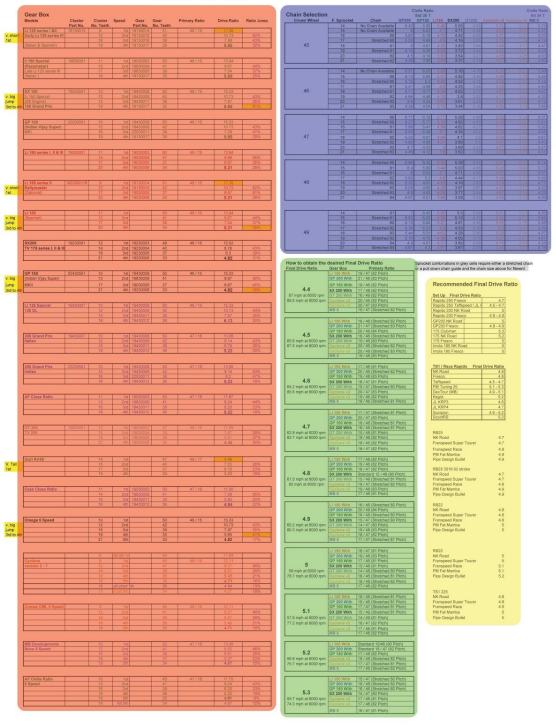
We supply a gear chart to aid in you selection of sprockets to obtain the correct final drive ratio for your engine. The correct final drive ratio makes all the difference in converting the power of the engine in to a user friendly speed range. I.e. If the gearing is set too tall, top gear will not be able to pull, and the rider will constantly be dropping back down the gearbox at the slightest head wind or hill. If set too short, top gear will be screaming at the top of the rev range at a low speed and the rider will be looking to select 'another' gear.

What is 'Final Drive Ratio'?

The Final Drive Ratio is a ratio of the number of revolutions of the crankshaft to one revolution of the rear wheel when the bike is in top gear.
I.e. A standard GP200 in fourth gear will rotate its crankshaft 5.22 revolutions for each single revolution of the rear wheel.
As such at 9000 rpm a GP200 gearbox with standard 18 - 47 sprockets fitted (5.22 Final Drive) will rotate the rear wheel 1724 times in a minute. If this final drive were set to 4.84 (GP200 box with 19 - 46 sprockets) the rear wheel would rotate 1860 times in a minute and will have travelled further in that minute. The lower number the final drive ratio, the taller the gearing of the bike, the faster the road speed at a given rpm.

The chart should be straightforward to use as a quick reference once you are familiar with the layout. The miniature chart pictured is only to highlight how to use the chart. The real chart will be supplied separately.

Gear Chart



Highlighted in red, all the most common gearboxes are listed and colour coded. If you are in doubt as to which gearbox is fitted in your bike you will have to count the number of teeth on the gear cluster to identify which one is yours from the list.

Highlighted in blue, the chain selection boxes allow you to identify which size of chain will fit with a chosen primary drive (F. sprocket and Crown Wheel). It also lists the final drive ratio with each given pair of sprockets and with each gearbox. Remember you will not be able to buy a stretched chain but you can now buy a pull down chain guide that will allow you to fit the next chain size up (i.e. a stretched 82 set up will now fit with an 83 chain).

Highlighted in green, quick reference for how to get a specific final drive and with reference to road speed at 6000 and 8000 rpm.

Highlighted in yellow, some recommended final drive ratios for specific kit and exhaust combinations. If you do not find your combination listed, speak with your local dealer or the dealer who supplied the parts on your bike and find out what they recommend.

Gearbox choice

Each gearbox has its own set of ratios (and jumps between gears). As a rule if your bike has an expansion system fitted you will not want the jump to fourth (or fifth) to be greater than 30%. The SX150 gearbox has a 41% jump to fourth gear. This is an 'overdrive' gear, once you are up to speed in third you click in to fourth to hold speed, this only works well with clubman style exhausts. Each gearbox has it's own foibles, the small yellow filled cells on the chart highlight some of these, if in doubt speak with your local dealer and take advice. These foibles are occasionally very useful i.e. a short 1st gear is great for a sidecar.

The AF Clo5e Ratio Gearbox ensures the jumps between gears are close and get smaller with each successive gear change. This makes it easier to stay in the 'powerband'. It is also kinder to the crankshaft when shifting back down the gearbox as the sudden increase in rpm of selecting a lower gear is not as abrupt as it would be with larger jumps. The jump between 4th and 5th (with either 5th fitted) is a smaller jump than any other production Lambretta gearbox has between two gears. This is very deliberate, and makes 4th a tall gear. The reason this is desirable is we expect 4th to be a gear that is comfortable to stay in for large amounts of your riding. Once the bike is up to speed the large overlap between 4th and 5th means it is easy to leave the bike in 4th when there is a head wind or hill and it shouldn't feel like it is 'screaming'. With 5th still there to carry the bike to an acceptable top speed without running out of rpm.

We offer two variants of 5th gear. A standard 35 tooth gear (9% jump), and the alternate 34 tooth gear (12% jump). There are two main considerations that should affect your choice. First is the type of riding you are doing, and the second is the cost benefit of having to buy another crownwheel to attain your desired final drive.

The Standard 35 T (9% jump) is best suited to when your riding speed is often dictated to you. By this I mean if you ride in a group or an area with many speed restrictions. This kind of riding is characterised by frequently dropping out of top gear because the rpm is too low and the bike is chugging, but often finding that 3rd gear is too high up the rev range, and not comfortable to sit in. This is very common, especially for riders of powerful bikes that comfortably cruise at 70mph, being forced to sit at 50mph. The tall 4th gear should now sit comfortably in that slightly lower speed range, making the bike nicer to use and more efficient.

The Alternate 34T (12% jump) is better suited to more aggressive riding, or riding where you are not being held back. This kind of riding tends to be solo riding where you are more likely trying to leave everyone else behind than pootle along with them. Reving out each gear making use of the whole powerband, not short shifting up the box. The larger jump then means that when 4th has hit its crescendo selecting 5th puts you back in to the center of the powerband rather than much of the way through it.

The secondary reason would be you have a high spec clutch with an expensive crownwheel, it seems a shame to spend another £80+ on another crownwheel. If you look through the gear chart, most popular sizes still allow you to get most desired final drives by choice of front sprocket and 5th alone. We'll use a 46 tooth crownwheel to demonstrate as they are very popular.

17-46 (81 Chain) std 35 5th FD = 4.98
17-46 (81 Chain) alt 34 5th FD = 4.84
18-46 (82 Chain with a pull down guide) std 35 5th FD = 4.71
18-46 (82 Chain with a pull down guide) alt 34 5th FD = 4.57

In most cases choosing the correct final drive for your Clo5e Ratio Gearbox will mean selecting the appropriate sprockets to get either the same final drive you previously ran, or placing your new 4th and 5th either side of your previous 4th. E.g. An RB20 running an NK Road would typically run a 5.0 final drive, with the AF Clo5e Ratio, you may choose to run a 4.8 final drive, placing 4th at 5.2 and 5th at 4.8.

Remember the 5th's are available separately, if you've made the wrong choice or your use of the bike changes. You only need to purchase the other 5th gear.

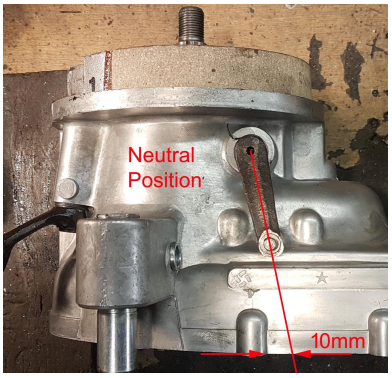
Detailed fitting instructions.

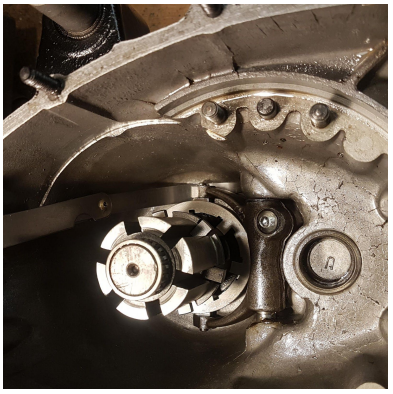
Preparing to build:
First strip down your engine to the point where you have access to both sides of your rear hub bearing. Clean the components and casing, taking care to look at the parts you are cleaning for damage.

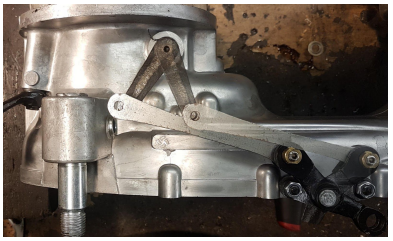
1. Asses the rear hub bearing, if it has excessive play, damage, corrosion or you are not completely confident in it, replace it. Then re-fit the bearing plate. We recommend our FAG double row rear hub bearing. It significantly reduces 'float' in the bearing.
2. Asses your gear selector arm, if it shows wear where it runs against the gear tie bar, or has excessive play, replace it. Check and replace the selector shaft o ring and bush as required.
3. Check the gear pawls are not worn, and that they are 'snug' in the gear stirrup. Replace as required.
4. Asses your layshaft. If it shows wear, has damage to its working surfaces or bearing surfaces replace it. Check and replace the layshaft o ring as required.
5. Check both the cluster bush fitted in the casing and the layshaft top hat fitted in to the endplate. Ensure they are not pitted, corroded, worn, or damaged. Replace as required.
6. Inspect your gear end plate for damage, and replace the 6004 cluster bearing if required.
7. Check all end plate studs nuts and washers are in good condition replace as required.
8. Measure the old gear shim and note the size.
9. It can be worth cutting some grip points in to your gear end plate (as pictured). You will be fitting and removing the gear end plate a number of times and this makes the job much easier. When you are instructed to tighten the gear end plate down this should be done in a cross pattern (like head nuts) and down in at least three stages, to ensure it is even.

10. Check the gear end plate for excessive wear and damage such as warping. A simple check is to put a straight edge across the back of the 6004 bearing. This should be parallel and at the same height as the back of the gear end plate where the gear shim runs. It the wear on this surface is even it will just mean you run a larger gear shim than expected. However it the two are not parallel it means the end plate should be replaced as it has undergone a significant event.

Selector assembly and checks.





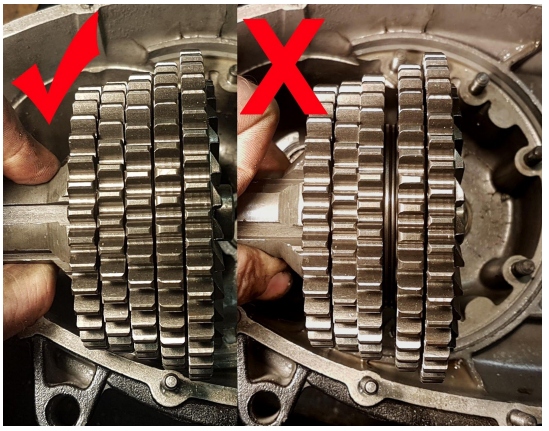


1. Fit the new 5 speed selector to the Layshaft and locate the neutral position.
2. Fit the Layshaft in to the rear hub bearing, taking care to locate the gear pawls in to the selector. Push the Layshaft all the way home (it may require a light tap). If more force is required the shaft should be pulled in.
3. When the selector dog is in neutral the selector arm should point about 10mm ahead of the crankcase stud position, one to the right of the rear shock stud (as pictured).
4. Check that the gear stirrup is not touching against the crankcase, if it is, it will prevent 5th from being fully selected. This can be corrected by filing the back of the gear stirrup. Or making two reliefs in the crankcase. A quick check is to pass a feeler gauge behind the stirrup to ensure it is not touching (as pictured).
5. Locate the front of the tie bar in you gear swivel with a trunnion. Select 5th. Check that the tie bar is capable of moving just beyond the position of the selector arm whilst it is in 5th. If not you must find what is stopping it and correct. Some swivels may now be pushing against their pivot and require relieving, until the tie bar is capable of selecting at least 2mm beyond 5th (as pictured. n.b. Do not fit the tie bar circlip and boot just yet.)
6. Once you have clearance, fit the rear hub and torque down to 120ftlb. This will ensure the Layshaft is fully seated in the rear hub bearing. Fit your engine jack to lift the rear wheel off the ground (if the engine is in the bike).
7. Now select 1st gear position. As before, check the tie bar is capable of selecting at least 2mm beyond the position of the selector shaft in 1st position. It is common for the tie bar to foul on the gear swivel, this may need relieving or replacing with a ‘bone’ shaped tie bar. The swivel may also touch against the pivot. Correct as required until you have your 2mm of travel beyond 1st.
8. If your engine is still mounted in the bike, now is the time to check your gear cables. Once the gear cables are attached, select 5th using the handle bar control. There should be a minimum amount of play in the controls, making selection feel very positive. The weight of the selector spring and any friction is easy to perceive now. Select each gear a few times and ensure the selection is ‘clean’ and positive. If it feels stiff, check and replace gear cables. If the selection is very heavy or very light you may wish to change the selector spring, or the length of the selector spring, until selection is positive and it is easy to select each gear deliberately.
9. Check that the tie bar can still travel 2mm beyond 5th and 1st positions. If not you may find the clutch cable is trapped as it passes through the headset bottom. In most bikes this can be corrected by adjusting the cables to line up the neutral position arrow, cast into the headset bottom, slightly closer to either 1st or 2nd position on the gear housing. Occasionally it may be necessary to cut the hole for the clutch cable in the headset bottom slightly longer to allow the gear housing to rotate further.

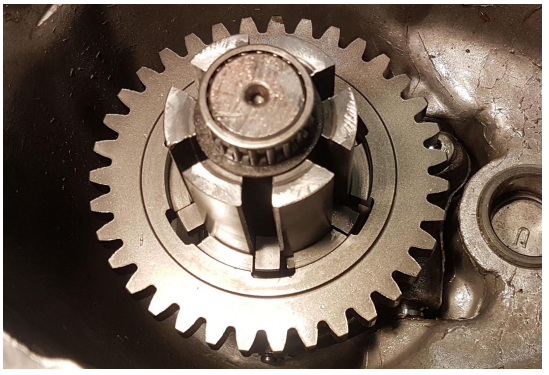
10. Now you should establish that with all cables attached, you can select all five gear positions and neutral, and that the 6mm hole in the tie bar can travel 2mm further than required in each direction. Then you can fit the tie bar circlip and boot.
11. Fit the layshaft shim and needle roller. Lubricate with a small amount of st90. Fit the gear end plate and tighten down. Select the neutral position. The rear wheel should still be off the ground on the engine jack. The rear wheel should now spin freely. If it does not, you need to establish why and correct.

Cluster fit and Loose gears

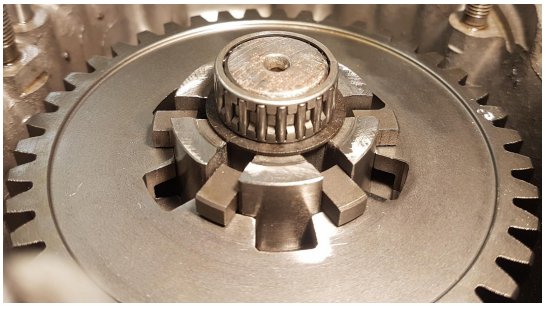
1. Do not fit a cluster shim behind the gear cluster. Lubricate the cluster needle roller with a little ST90 and fit it into the cluster bush mounted in the crankcase. Fit the cluster in to the bearing. It should spin freely. Do not fit the loose gears yet. Fit the gear end plate and tighten down. The cluster may need to be pulled through the 6004 cluster bearing in the end plate. This should be possible by hand, but you may find fitting the clutch shim and a clutch spider on to the end of the cluster and tightening down will help pull the cluster in to position. The cluster should now spin freely. If it does not you may need to check the gear cluster bush is correctly seated in the crankcase. It may be necessary to remove the cluster bush clean behind it and re-fit if it has been fitted badly.



2. Remove the gear end plate and pick up your stack of five loose gears. The smooth flat side of 5th will face your rear hub bearing, the toothed side of 1st will face the kick start. With 2nd, 3rd and 4th fitted the correct way around there will be an even 1mm gap between each gear. We put a small coloured mark on the kickstart side of each gear to help.
3. Once you are happy your stack is the correct way around, fit 5th gear on to your layshaft, spin the cluster to help align the teeth and push the gear all the way home on the layshaft. Select 5th gear. The height of the selector dog and the height of the 5th gear dog should be identical.



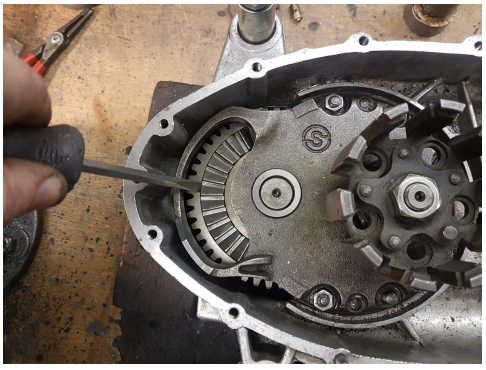
4. Move the selector in to 4th gear. Fit the loose 4th on to the layshaft, check the height of the selector dog and the 4th gear dog align perfectly.
5. Move the selector in to 3rd gear. Fit the loose 3rd gear on to the layshaft, check the height of the selector dog and the 3th gear dog align perfectly.
6. Move the selector in to 2nd gear. Fit the loose 3rd gear on to the layshaft, check the height of the selector dog and the 2nd gear dog align perfectly.



7. Move the selector in to the neutral position. Ensure the gears are all sat down by gently pushing 2nd in to the casing, rotate the 2nd gear and establish that the selector dog does not touch on 2nd gear.
8. Fit the Loose 1st gear on to the layshaft. Ensuring the gears are all sat down by gently pushing 1st in to the casing, rotate the 1st gear and establish that the selector dog does not touch on 1st gear.
9. Select 1st gear position. Check the height of the selector dog and the 2nd gear dog align perfectly.

Shimming

1. If you know the thickness of the gear shim you were previously running select a shim 1mm narrower as your starting point. If you have replaced your rear hub bearing, layshaft, or end plate. Or if you do not think your previous shim was correct start by fitting a 1.6mm gear shim.
2. A small blob of grease on the back of the gear shim can help to hold it against 1st gear.
3. Fit the gear end plate, pull the cluster towards you and tighten down the end plate. Continue to pull the cluster towards you and rotate as you tighten the end plate down. If you are not confident the cluster is pulled in to location, fit and tighten the clutch spider on to the cluster to force it to seat. Then remove the spider as you will have better 'feel' directly through the cluster than with the extra leverage the spider provides.
4. If the gearbox goes tight, the gear shim fitted is too large. In this case try fitting the next size down (1.4mm) and try again.
5. If the cluster spins freely without any notchiness (ensure the cluster is fully pulled in to the 6004 end plate bearing, using a clutch spider if required). You can check the clearance with a feeler gauge. Ideally this should be no greater than 5 thou (0.125mm).
6. The feeler gauge method is not always accurate as depending on the location measured small manufacturing variances (especially in the end plate) can give a false reading. An alternative is to find the shim 1 size too large, then fit the shim 1 size down from that. I.e. if the ideal shim is a 1.4mm shim, the gearbox would lock up when a 1.5mm shim is fitted, but spin freely when the 1.4mm shim is fitted.
7. Once you are confident you have the correct gear shim fitted. Re-Check the rear hub is torqued down. Replace the m7 end plate nuts and washers if they are looking a bit worse for the several fittings, and re-tighten the end plate down. Pull the cluster home with a clutch spider torqued down to 50 ftlb.
8. The gearbox should spin easily, smoothly and without notchiness by spinning the gear cluster. The rear hub should also spin around freely and easily. If this is not the case, there is a problem and you should jump back a step.
9. It is also good practice to check the stack has negligible float. This can be quickly established by using a flat blade screwdriver to lever 1st gear to lightly try to pull and push on it. If it lifts up and down by a couple of mm something is very wrong.



Cluster to gear stack alignment.

The gap between each of the loose gears is 1mm, the gap between the 4th and 5th of the cluster is 0.3mm. This means the 'float' between gear interference is 1.3mm. If you push the cluster in to the gearbox in most cases you will be able to get out of line by enough to feel this interference. It is important that the gears never become misaligned whilst the engine is running. Therefore it is vital the clutch nut does not come undone in the running engine. Ensure this by making sure your clutch nut is in good condition, that the nut is torqued to 50 ftlb, and use a small amount of loctite on the clutch nut threads when fitting (or a tab washer depending on clutch design).

The back of the 6004 cluster bearing when fitted in to the gear end plate should be at exactly the same height as the back of the gear end plate where the large gear shim runs. (pictured). When the cluster is pulled in to the 6004 bearing by tightening the clutch spider down on to it, its location is known compared to the surface the large gear shim runs against. Therefore once you know the correct thickness of the gear shim required to shim the gearbox, you can be confident (to within 5 thou) of the relative position of the stack of 5 loose gears compared to the Cluster. We've found the window of clearance between which the gearbox does not have interference is between 2.4mm and 1.0mm. As we do not wish to run the gearbox at either extreme, for safety sake only run a Clo5e Ratio gearbox when it is correctly shimmed between 1.4mm and 2.0mm.

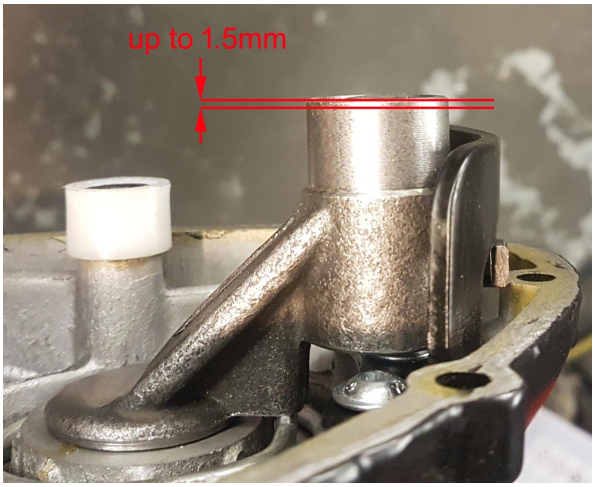
Layshaft height can be different in different engines based on the type of rear hub bearing and variation in the crankcases. As a result there will be some variation in gearbox shim size. If you find you are fitting a shim outside of 1.4 mm - 2.0mm we would recommend you first look for the problem. (This is significantly outside of normal tolerance you probably need to replace your rear hub bearing). Then consider fitting a special shim either behind the layshaft to lift it (thereby reducing the gear shim size) or a special shim between the crankcase and and rear hub bearing when fitting the bearing (to increase the gear shim size fitted).

Checking selection

1. Before fitting the chain it is convenient to check that the gear selection is still positive and clean.
2. The gearbox will not be able to select each gear without rotating it as the spaces between the gear dogs will never all align.
3. Spin the gearbox with the cluster and select each gear individually, to ensure there is no issue. If all the other tests have been done this should be a formality.
4. You can now fit the chain, clutch etc. but do not fit the crankcase cover until you've checked below.

Checking kickstart engagement.

1. Once you are ready to re-fit your crankcase cover. Check the kickstart lever is fully home in your crankcase cover. Most kickstart shafts will require more than one kickstart shim beneath the kickstart shaft circlip.
2. Check the condition of the kickstart piston teeth. Replace as required.
3. Fit a crankcase gasket and fit the crankcase cover in to place. Check that the cover sits down flat. If it does not check that the kickstart shaft in not touching on the kickstart teeth on first gear. The Clo5e ratio kickstart teeth are 1.5mm higher than indian GP200. On some engines this will be too close. If this is the case, you may need to remove a small amount from the end of the kickstart shaft (no more than 1.5mm). Then check again that the casing sits down without the shaft sitting against the Clo5e ratio first gear.



4. If you are having trouble confirming this placing some plasticine, or similar material on the end of the kickstart shaft and then fitting the cover so the plasticine is sandwiched between the shaft and first gear will quickly establish exactly how much clearance you have.
5. Remove the spark plug from the engine. Lift the rear wheel off the ground with an engine jack, and rotate the wheel so you can select 1st gear.
6. Rotate the rear wheel and listen. There will be resistance as even without the spark plug fitted you still have the primary compression to overcome. You're listening for any clicking or scraping noise from the

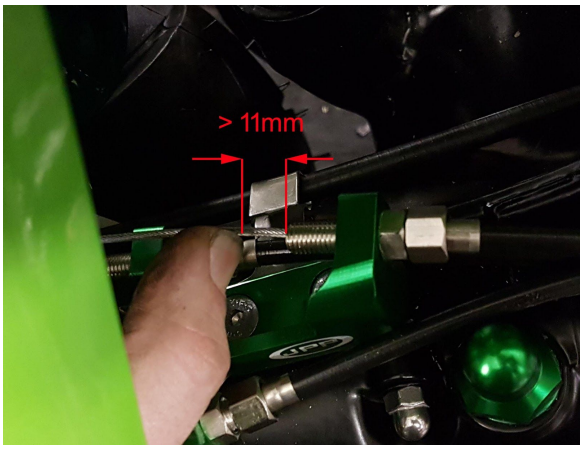
kickstart or clutch. If in doubt partially depress the kick lever until you hear it ratcheting on first gear. That sound should not be there when the kickstart is up. If it is ratcheting, you will have to adjust the kickstart position on it's spline, possibly cut the kick return buffer so the lever can return slightly higher (or adjust the LI kickstart ramp if fitted). If you can hear any scraping sound, it could be worth removing the cover and checking the top of the clutch is not touching on the back of the kickstart shaft. Relieve the kickstart shaft as required.

Cable adjustment for Clutch and gears.

Gear cable adjustment was covered earlier in the instructions. But your clutch will also have a large effect on how easy it is to select gear and especially how easy it is to get back to neutral.

How to adjust your clutch

A Lambretta with all new components and set up correctly will have a clutch inner cable travel under load of just below 15mm. This is measured by pulling the clutch lever all the way to the handle bar, then marking the clutch inner cable where it comes out of the clutch cable adjuster on top of the engine (or holding the clutch inner with your thumb nail against the adjuster). Once this is accomplished, the clutch lever should be released. The mark made on the inner cable will now have moved away from the cable adjuster by up to 15mm. If when this is done the mark has only moved 10 – 11mm you will have great difficulty setting up and getting a good lifespan from your clutch. So before attempting to adjust a clutch cable first check the cable inner travel. If it is insufficient address this issue first. This can only be measured when the cable is under the tension of operating the clutch, the measurement is pointless if the cable is not under load.



Typical causes are: a damaged / crushed cable outer allowing the cable to concertina under load. Cable outer pulled through its stop in the gear housing, play in the spline of the clutch arm, worn lever pivot, worn lever pivot hole in the lever or the gear housing, an aftermarket clutch lever with a smaller distance between the pivot and the cable. Thick handlebar grips can also reduce the distance you can pull the lever, and many 'dogleg' levers.

To overstate the point, before trying to adjust your clutch cable make sure you have sufficient cable travel or you are wasting your time. Between 12 to 15mm will usually work, some clutches like our 6 plate cassette designs will tolerate slightly less, others may require slightly more.

Clutch cable adjustment, if the clutch cable adjustment is too tight the engine will encounter clutch slip under load and the clutch plates will be damaged if the clutch slips under acceleration. If the clutch cable adjustment is too slack the clutch will drag, and the bike will be difficult to ride and it will be difficult to select gear (especially the return to neutral) In-between these two settings is 'the zone' of just right.

When the clutch cable is correctly adjusted the clutch lever will be applying no force on the clutch when it is fully released. This means that correctly set up the last 3mm (1/8 of an inch) of clutch lever travel should be loose, and when the clutch lever is pulled in to the handlebar the bike should select first gear easily and not creep forward.

For most clutches this zone is not large and as little as two turns on the clutch adjuster can be the difference

between slip and drag. Other designs can be more accurate and cable adjustment can control the position of their bite point within the lever travel.

Disclaimer: Rayspeed hope that you find this information useful and informative, but point out that this is intended as a guide only and not a replacement for the knowledge and experience of your scooter dealer. We do not accept responsibility for any costs and or damages you may incur as a result of incorrect assembly. If in doubt, please pay a professional to do the job.