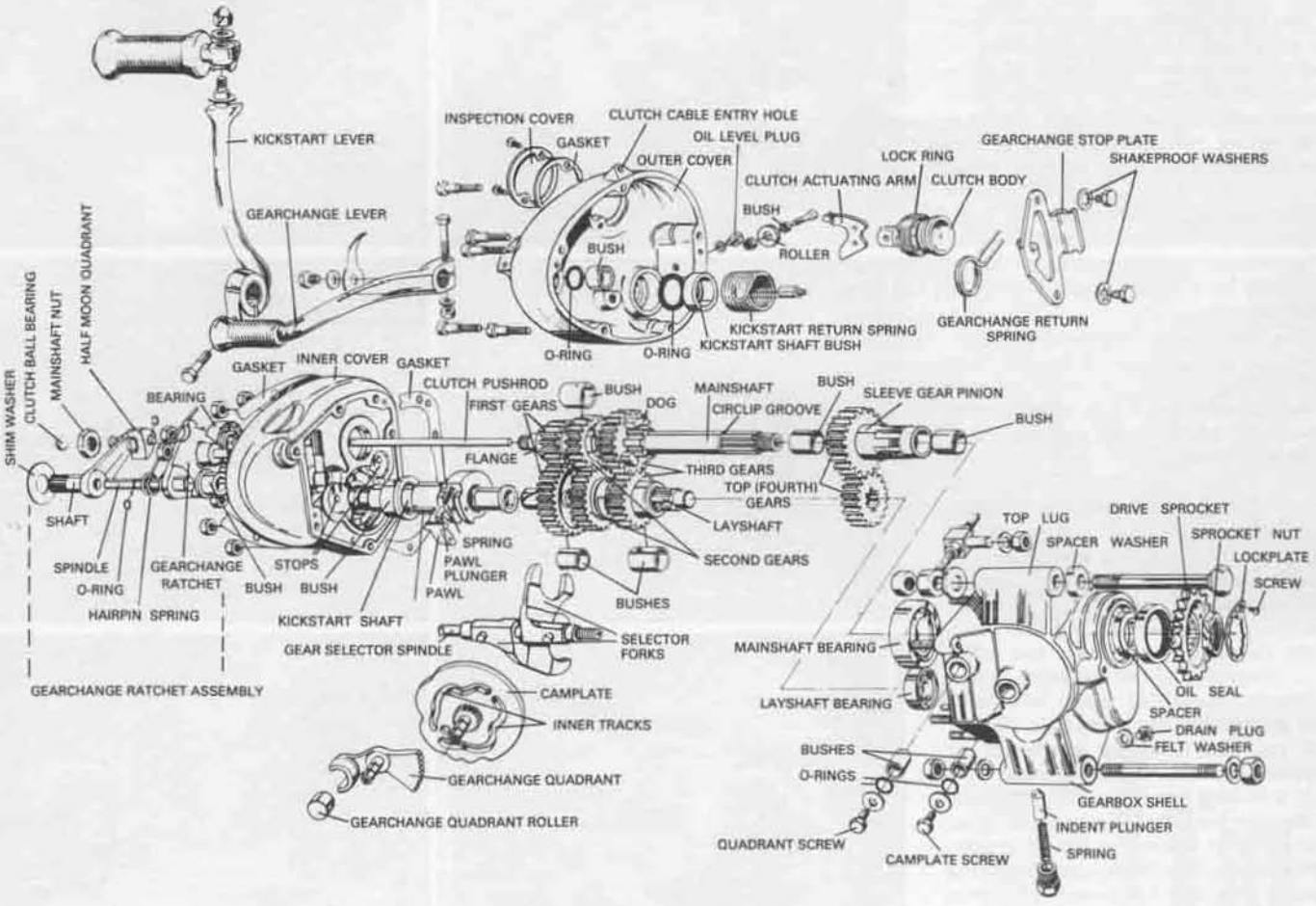
Norton gearbox

NORTON AMC gearbox overhaul with Norton specialist Mick Hemmings.

Words: Brian Crichton.

Pictures: Rod Sloane.



This stripdown and rebuild feature was done on a gearbox from a 1965 750cc Norton Atlas and can be used as a guide for four-speed Norton gearboxes from 1956 onwards. Relevant models include the 600cc Model 19S, 500cc ES2, and 350cc Model 50 which are all single cylinder models; the 850/750cc Commando, Atlas, Ranger, N15, G15 Matchless (which was Norton powered), the 650cc Mercury, Manxman, 650SS, the 600cc Model 77, Model 99, the 500cc Model 88 and Model 7, which are all twin cylinder models.

The gearbox used for this feature is stamped with the identification code: NA12622. The letters NA denote that the box is post 1962. The letter N alone is used for boxes made prior to that date. The code is stamped to the gearbox shell (see diagram).

On gearboxes used for the Norton Commando the number is stamped on the gearbox shell across the top lug (pic 1). This lug is of narrower width than earlier types. Thus, if, for example, you are the owner of a Norton 650SS and wish to fit a gearbox from a Commando you must fit the spacer washer to the left side of the lug. Width of the spacer is 0.129in. The narrower lug with washer change was introduced on the Commando to make it easier to 'wiggle' the gearbox out of its mounting plates.

STRIP-DOWN

● Having removed the gearbox from the frame drain the oil via the drain plug at the bottom of the gearbox shell (pic 2).

● Remove the kickstart lever. There is no need to remove the gear lever. It's useful to leave it on as an aid to pulling the outer cover off.

● Remove the outer cover screws. These are usually 'cheesehead' type. In this instance a previous owner had fitted Allen screws.

● Remove the outer cover. If it's stuck, as this one was thanks to liberal use of Red Hermetite, use a soft-faced hammer to tap it free.

● The outer cover comes away complete with ratchet assembly. At this point we advise the provision of three trays to separate components from 1: outer cover, 2: inner cover, 3: gearbox shell. Also, it is worth making your own notes and diagrams during stripdown in order to make re-assembly less of a mystery, especially if you find you cannot put the box back together the same day. This is likely to be the case anyway since you will not know which parts have to be renewed until the box has been taken apart.

● Take out the gearchange ratchet, (pic 3) then hairpin spring (pic 4), and then the gear change shaft (pic 5).

● Note that there is a large shim/washer for the gear change shaft (and quadrant) and outer cover (pic 6).

● Use a 3/16in Whitworth socket to remove the two bolts retaining the gearchange stop plate (pic 7). Remove the gearchange return spring and inspect it for wear as show in pic 8. This one was in good condition.

● Remove the small nut and bolt holding the clutch actuating arm and roller (pic 9). Inspect. If either are worn, ie flatted, renew. Note that there is a bush which goes within the roller (pic 10).

● If you are changing gearboxes or components note the following: the clutch actuating arm has a different angle than the arm for a diaphragm clutch. Thus if you wish to uprate by fitting a diaphragm clutch you will require the mating mainshaft (from the Commando) which is longer and has a circlip groove. You also need the clutch actuating arm from the Commando.

● To remove the clutch body lock ring you should strictly speaking use the special tool (available from Mick Hemmings) or you could make up an appropriate peg spanner, or simply use a punch. The lock ring pictured (pic 11) was burred causing the special tool to slip. So it had to be loosened by using a punch.

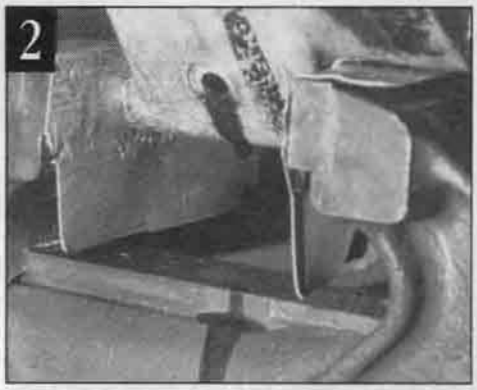
● The clutch body can now be removed. Inside is a ball bearing (pic 12) which bears against the clutch pushrod one side and the clutch actuating arm the other. The size of the bearing is important. It should be 0.5in diameter.

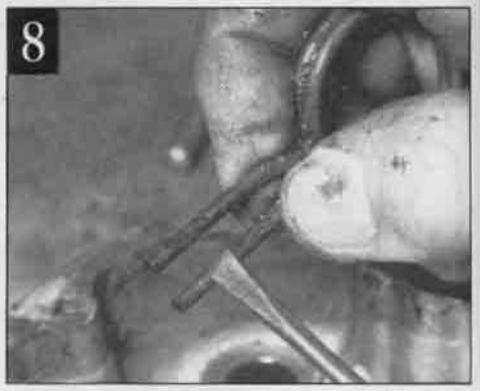
● Use a screwdriver to lever the kickstart return spring from its locating dowel (pic 13) and remove the spring. On the later 'NA' gearbox the spring is much stronger than on earlier 'N' gearboxes. You can use the later spring in conjunction with the NA kickstart shaft which is longer than earlier types. This uprate modification is recommended by MH, but it's expensive because you also need the later inner and outer covers.

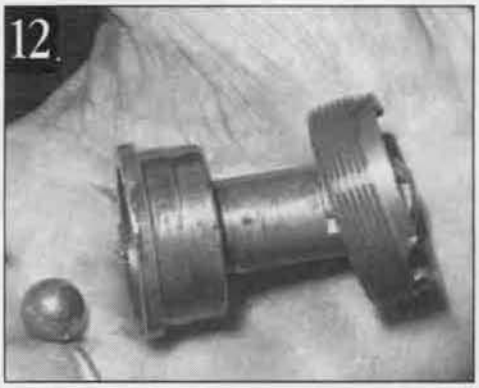
● To remove the gearbox mainshaft nut you need to devise a method to hold the shaft. MH uses an old clutch centre gripped in the vice to hold the shaft (pic 14).

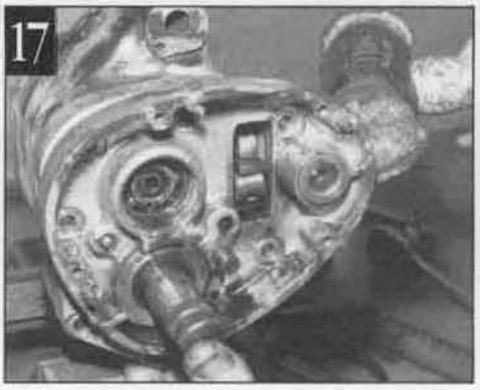
● An alternate method is to select gear with a screwdriver and then use an old chain round the drive sprocket, locked by the vice as in pic 15. You probably need someone to hold the box to steady it while you undo the shaft nut. Do not be tempted to grip the shaft in the jaws of a vice or you will damage the splines. You need a 1/2in BSF socket to loosen the mainshaft nut.

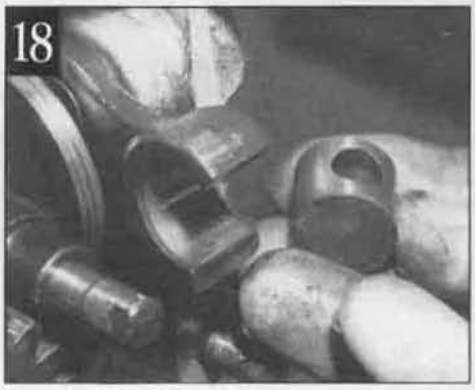
● Use the chain method (pic 15) to hold the drive sprocket in order to loosen the sprocket nut. Pre-Dominator models use 5/8 x 1/4in chain, models after have 5/8 x 3/8in chain. First undo the sprocket lockplate screw (pic 15). Now remove the large sprocket nut using a 7/8in Whitworth socket or Norton box spanner (old part no: NM12093, new part no: 067624). (This also fits the engine sump plug). Note that this is a left hand thread, ie you have to turn the nut clockwise to free it. This is the only left hand thread used in the AMC gearbox. On removing the sprocket note that there is a spacer within the oil seal in the gearbox shell.









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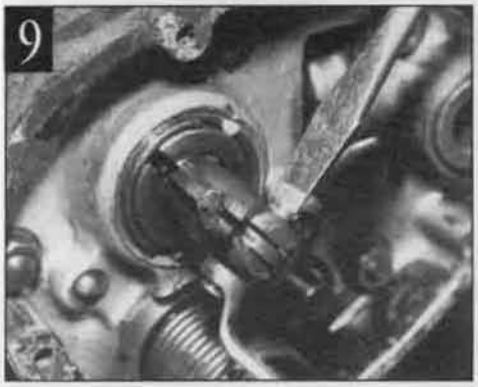
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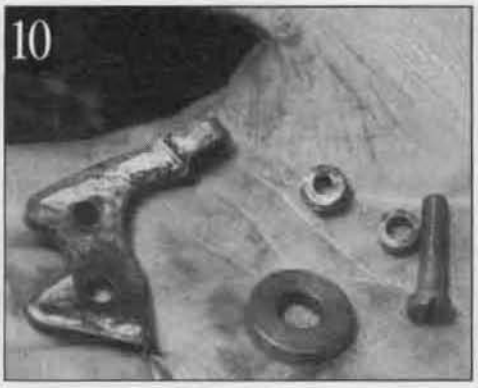
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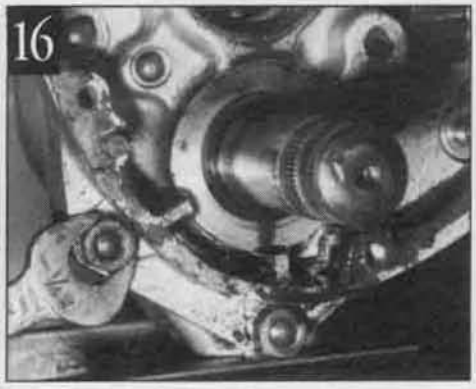
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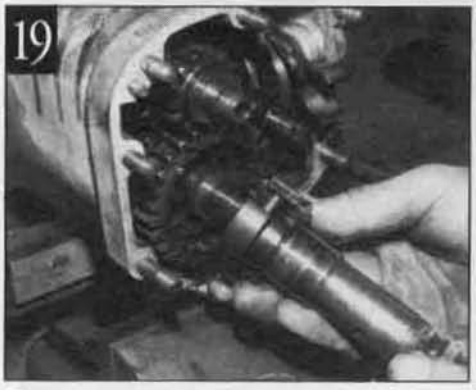
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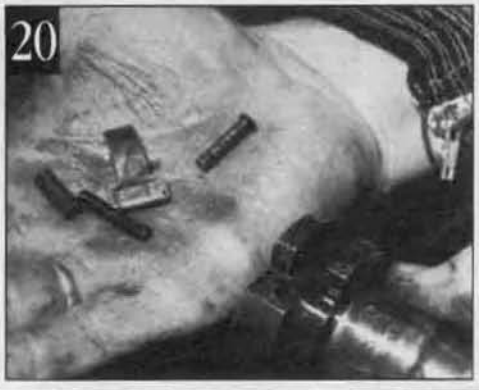
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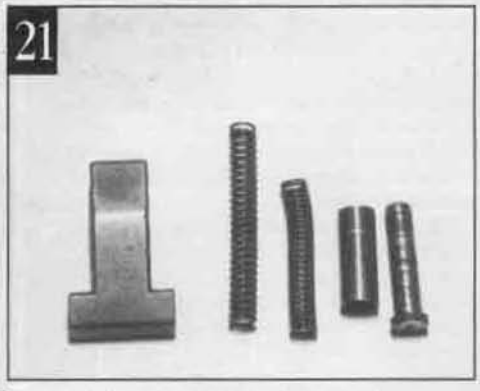
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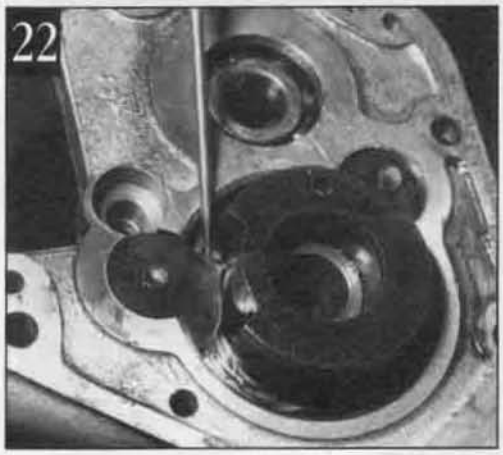
● Now remove the inner cover retained by a total of seven nuts, (five within the case and two outside). Use a ¼in Whitworth socket. For the outside bolts you will need a spanner (pic 16) because of lack of clearance for a socket.

● Support the kickstart shaft while tapping off the inner cover, if necessary, with a soft hammer (pic 17). While easing off the cover watch for the gearchange quadrant roller (pic 18) which may fall out. Remove the roller and place it in your inner cover components tray.

● Ease off the kickstart shaft while supporting the spring loaded pawl (pic 19). Take out the components (pic 20) being careful not to lose any of them and inspect the pawl for wear. In this case the pawl was still serviceable but the spring had become shortened. Pic 21 shows it against a new one which was fitted during rebuild. Free length of a new spring is 1.3-1.4 inch. At the same time it was decided to fit a new pawl pin.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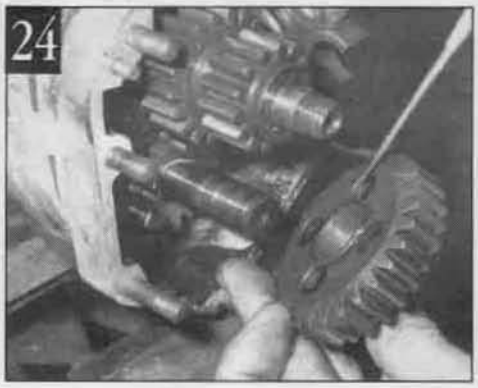
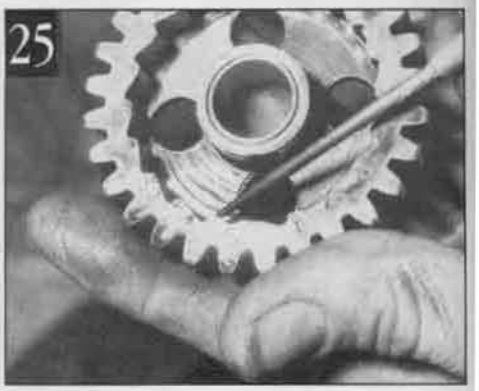
● Check the two kickstart shaft stops (pic 22). These may have been damaged as the shaft bangs against them when at the top and bottom of kickstart lever travel. Check both for burring at contact areas and for loose rivets. Those pictured were still in good condition, thankfully, because the stops cannot be purchased separately. You have to buy a complete inner cover!





● Check the kickstart shaft for cracks as shown in pic 23. A crack such as this means a new shaft is necessary. Here the shaft is relatively weak because of lack of metal.

● Measure the diameter of the kickstart shaft boss. It revolves against a bush and this one had felt rather loose indicating wear of the boss and bush. A new shaft was measured and found to be 1.123in in diameter. The shaft removed was only one thou less (ie 1.122in) and so it was decided to fit a new bush only.

● A note of caution. Mick Hemmings recommends using only genuine Norton replacement parts. There are many pattern copies on the market which Mick has found to be of inferior quality. In his words: "They are absolute rubbish and should not be used from a safety point of view." Anyone who has ever suffered a gearbox lock-up knows exactly what he means!

CLUSTER

● Now we can move on to the removal of the gear cluster and other components within the gearbox shell.

● Remove the bottom gear layshaft (pic 24) and inspect the teeth for wear, the engagement holes (being pointed to in the pic), and the ratchet teeth on the inner circumference which engage with the kickstart mechanism (pic 25).

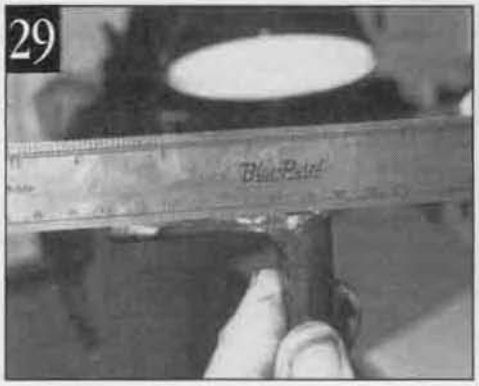
● All gears should be closely inspected for cracking and pitting and wear on the protruding 'dogs' and the slots in gears with which they mate. All gears in the box pictured were found to be in good order. If you are in doubt about wear consult your dealer. Where a gear's meshing teeth are worn its mating gear should also be replaced even though it may show no sign of wear.

● When removing gears note which way round they fit for future reference. With this gearbox it is easy to replace some of the gears the wrong way round and then find the gearchange will not work.

● With respect to the above paragraph, remove first gear mainshaft noting that the longer flange is outboard (pic 26).

● Remove the gear selector spindle using an 8mm spanner. "Millimetres?" we hear you ask. Yes that's right. Even though MH believes only in 'Christian' measurements he has found that an 8mm open-ender fits best (pic 27).

● Check that the spindle is not warped by holding it against a straight edge such as a steel rule, or by rolling on a sheet of glass.



● Remove the gears and selector forks. Pic 28 shows one of the two forks resting in its relevant gear groove. Remove remaining gears and shafts.

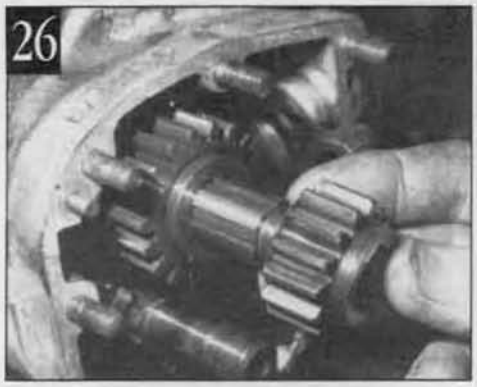
● The two selector forks are the same, and thus interchangeable. It is desirable that they should be replaced, if still serviceable, in their original places rather than be swapped over. So note which one came out first. Check that the forks are straight (pic 29) and that the tips of the forks are not worn and show signs of excessive overheating which can be caused by lack of oil.

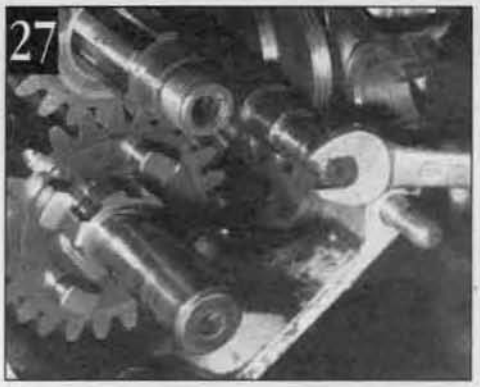
● Remove gears remaining on shafts (pic 30), noting that free spinning gears rotate on bronze bushes (pic 31). These gears should be a sliding fit over the bushes and be able to spin with no resistance. The bushes should be replaced as a matter of course.

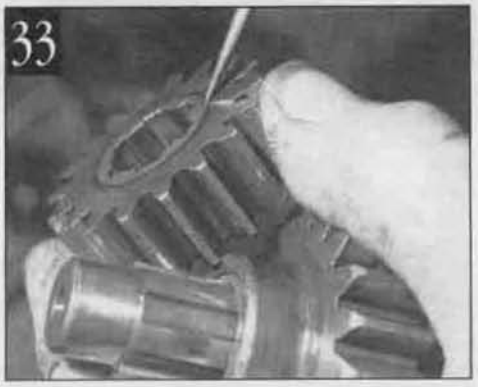
● If layshaft fourth gear is a little tight on the shaft it may be necessary to free it by tapping the shaft with a soft face hammer (pic 32). Note that there is a small flange on layshaft fourth (pic 33). This faces the layshaft bearing in the gearbox shell.

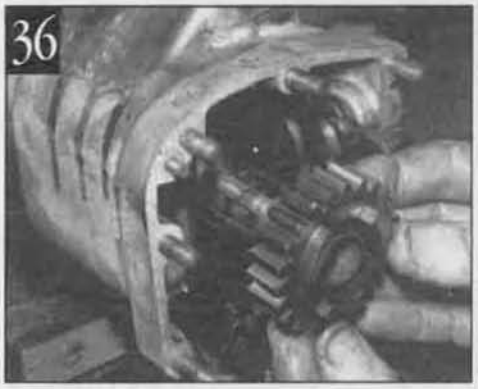
● Now remove the mainshaft praying that it is in good condition, since MH informs us they are very difficult to obtain (pic 34).

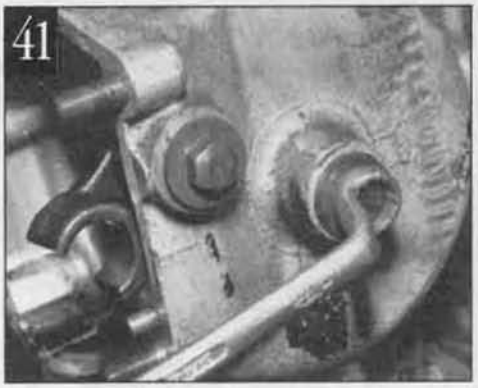
● Use a soft hammer to dislodge the







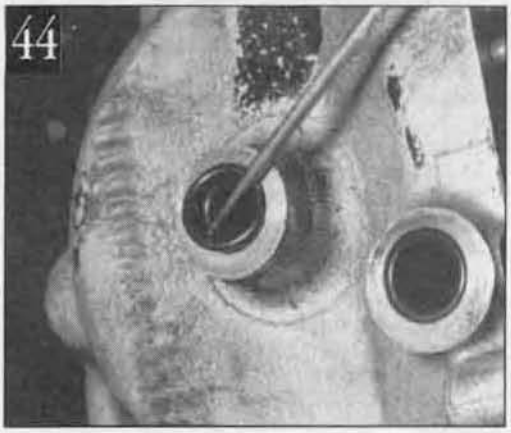




sleeve gear pinion which is also mainshaft fourth (pic 35) and remove the pinion (pic 36). If the mainshaft bearing is loose in its housing it will fall out when the sleeve pinion is removed. This indicates wear in the housing.

● Remove the spacer from the centre of the mainshaft oil seal (pic 37). This spacer, mentioned earlier, is very important because it bears against the sprocket. Lever out the mainshaft oil seal and discard.

● Check the gearbox shell for signs of cracking as pointed to in pic 38. This one was fine. But it's not uncommon to find cracking caused by the layshaft bearing exerting pressure on the shell. If this is the case the shell should be replaced.



● Remove camplate indent plunger (pic 39). Note that this should never be removed unless doing a complete gearbox strip. Check the spring and tip of plunger for wear (pic 40). These rarely give trouble.

● Remove the camplate using 5/16in socket or ring spanner (pic 41), and check the camplate circumference and inner tracks for wear (pic 42).

● Remove gearchange quadrant (pic 43) and note that both camplate and quadrant have rubber O-rings housed in the shell which should be replaced (pic 44).

CLEANING

● The stripdown is complete apart from the removal of bearings. At this stage all components should be cleaned in readiness for re-assembly. Strictly speaking you should use high-flashpoint solvent. Mick prefers petrol for cleaning and is very careful to thoroughly dry components afterwards. The gearbox being stripped had a fair amount of sludge in it, indicating that the oil had not been regularly changed. Mick changes the gearbox oil in his privately owned Nortons every 1,000 miles and would recommend not allowing the change period to go beyond 2000 miles. He recommends ignoring the filler level plug, and filling from dry with exactly one pint of EP90 oil. His preference is for Shell Spirax 90.

The marks you can see on the gearbox shell in pic 44 were made by the mainstand spring on a Featherbed frame. This doesn't happen on non-Featherbed models.

The previous owner had allowed paint to spill on the gearbox shell. This was cleaned up by wire brushing and Mick recommends cleaning with thinners to draw grease out of the castings. He also makes a practice of putting away tools and cleaning down his workbench in readiness for bearing renewal and re-assembly of the box.

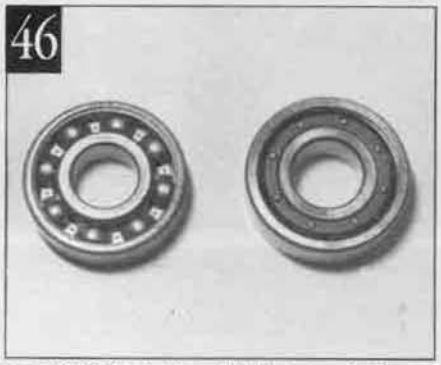
BEARING REMOVAL

● The home DIY mechanic can either put the shell in the oven for an hour or so to heat it, or use a blow torch (pic 45) to

warm the cases so that the main and layshaft bearings can be knocked out. Mick always replaces bearings as a matter of course. After heating, the bearings usually fall out. If not then a light tap using an appropriately sized socket, for example, as a drift should free them. Or simply whack the casing against a block of wood to shock the bearings free. If heating with a blow torch play the flame over the whole of the casing to uniformly heat it. Concentrating the flame around the bearing only may result in distortion of the shell. A simple way to tell when the shell is hot enough to free the bearings is to spit on it. Ungentlemanly? In that case sprinkle some water on it. If it evaporates instantly then the shell is warm enough.

● On the subject of replacement bearings Mick says there are three options: standard ball race roller, and high quality ball race. He recommends the latter option, arguing that the roller conversion holds the shafts too rigidly and can result in shaft breakage.

The layshaft bearing is known to be a weak point in the AMC gearbox, and so a high quality Tufnol bearing (shown on the right in pic 46) was selected, even though

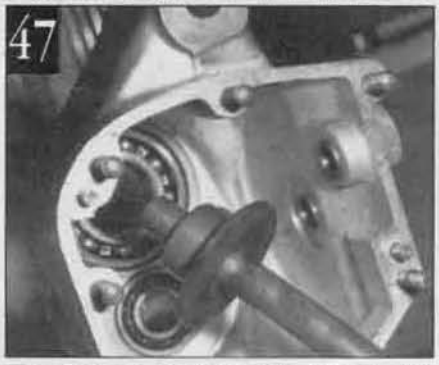


at £18.50 including VAT it is much dearer than the £2.92 standard type, or £12 roller bearing.

The Tufnol bearing features a flexible rather than steel cage. This allows flexing of the layshaft with much reduced possibility of the cage breaking up, the main cause of layshaft bearing failure.

Though not covered type similar to the original, the replacement mainshaft bearing is high quality type costing £18.48.

The new bearings should be ready for insertion while the shell is still warm. Mick has made up his own tool for pressing the bearings home squarely (pic 47).



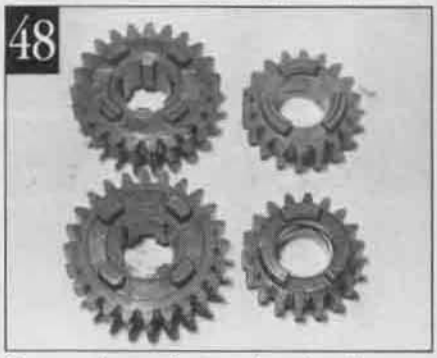
The DIY mechanic could follow this example or use a socket with care. Use the back face, so to speak, of the socket to press against the bearing, and never try to press a bearing home by putting pressure on its inner race only. Press against the bearing as a whole or against the outer race.

You may have to reheat the shell somewhat to get the new bearings to fit. Another useful tip is to wrap the new bearings in plastic bags and put them in your freezer to shrink them.

Once fitted, double check that they are squarely home. This is important, since, if they are slightly askew shafts and bearings will be under stress causing premature wear of the bearings and possible shaft breakage, plus absorption of engine power to overcome the additional resistance.

● If the old bearings were loose in their housings then the use of Loctite Bearing Fit is advisable to hold the outer race. If the wear in the housing is quite pronounced then use Loctite Quick Metal. The bearing outer races should not be allowed to rotate within their housings. If this happens they can move from side to side, overheat, and cause cracking of the shell, mentioned earlier. Also the drive chain can be caused to rub on the gearbox shell because of the excess play. It's worth noting here that a wider drive chain than standard should not be fitted because this too can rub against the gearbox shell.

● Further uprating on pre-Commando gearboxes can be carried out by fitting later Commando second gears. These must be fitted as a pair. Later (Mk 3) Commando gears are identified by the grooves in their dogs (top pair in pic 48).



They are better for tuned engines because the teeth mesh over a wider area to spread the load. The Commando gears are bigger in overall diameter, hence the need to change them in pairs. They mesh more deeply with each other, thus there is no problem with shaft-to-shaft dimensions.

REBUILD

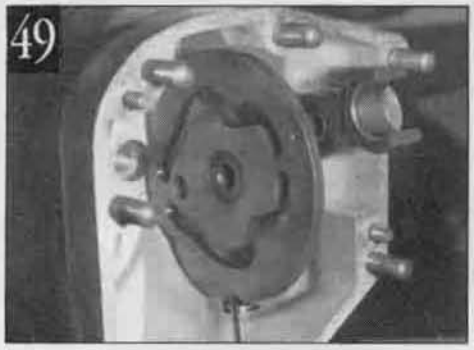
● Essentially the reverse of the stripdown, the rebuild will take longer than the stripdown. If replaced parts do not appear to fit together do not force them. Look for the reason why. Some of the rebuild work is 'fiddly' but no undue force is necessary. The following rebuild points are either important or useful tips.

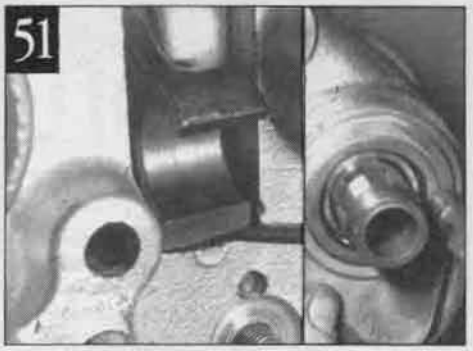
● First fit the quadrant with new O-ring in gearbox shell.

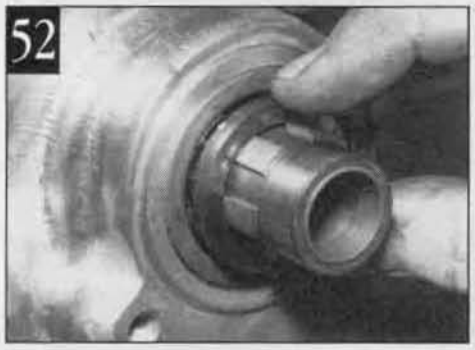
● Refit the camplate with new O-ring in the shell, but do not yet fit retaining bolt. Fit indent plunger finger tight. The camplate can now be "timed" as in pic 49 with the plunger pressing against fourth (top) gear indent on the camplate and the top of the quadrant arm level with the shell stud as shown in pic 50 illustrates how the camplate and quadrant mesh together. We used a spare quadrant to show this in case you're wondering if there should be two quadrants.

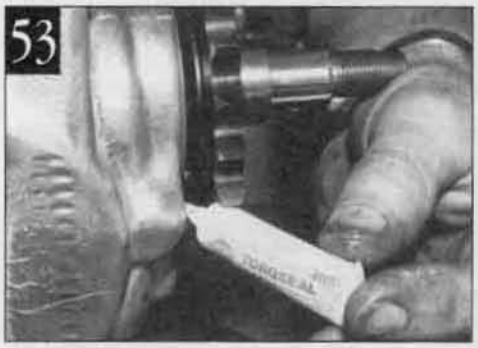
● Now fit the inner cover to the shell. You will need to move the quadrant down in order to fit the inner cover over it. There's no need to do the inner cover up. The idea is to check that at the top and bottom of its travel the quadrant does hit the inner cover. Use a screwdriver to move the quadrant up and down. At the bottom of its travel (pic 51) first gear is selected. Then count the clicks for neutral, second, third and fourth (top) gears as you lever the quadrant upwards. Once you have established the correct timing (gearing) of camplate to quadrant, tighten quadrant, camplate and plunger bolts. Keep the inner cover on while you do this to limit quadrant travel and thus prevent the camplate from being turned while you tighten the bolts.

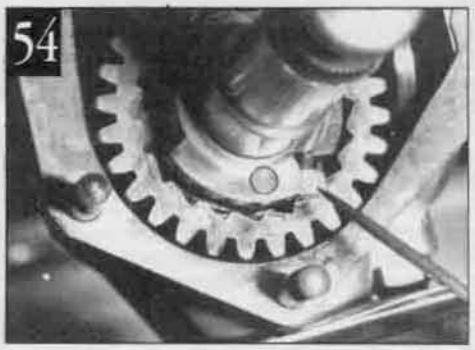
● If you intend to fit rearsets and wish to retain the one-down three-up pattern at the gear lever, MH can supply a reversed

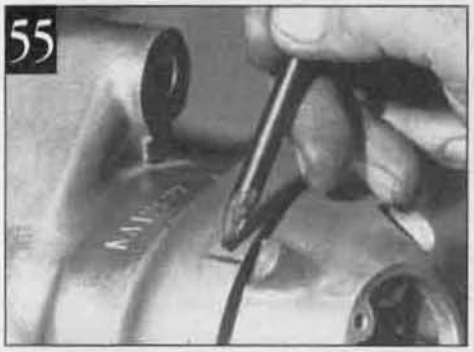


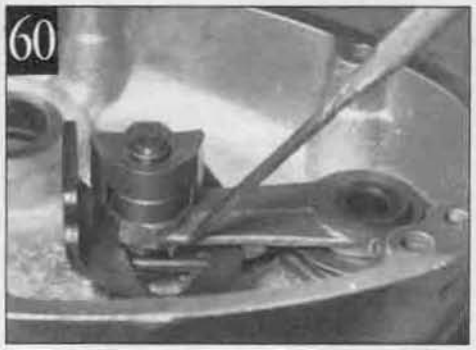






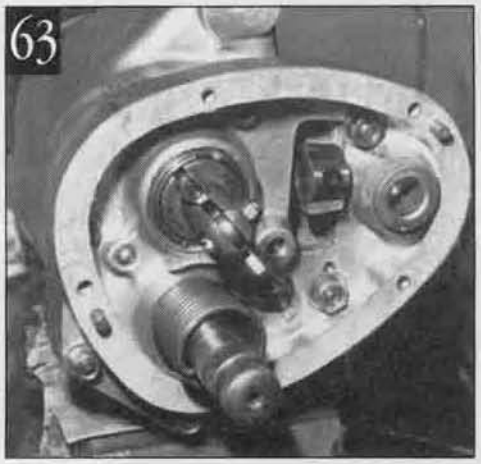


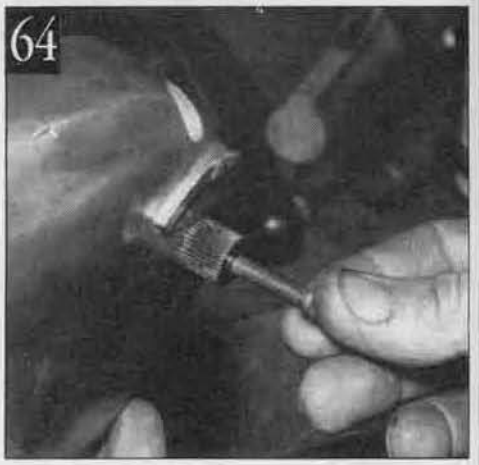


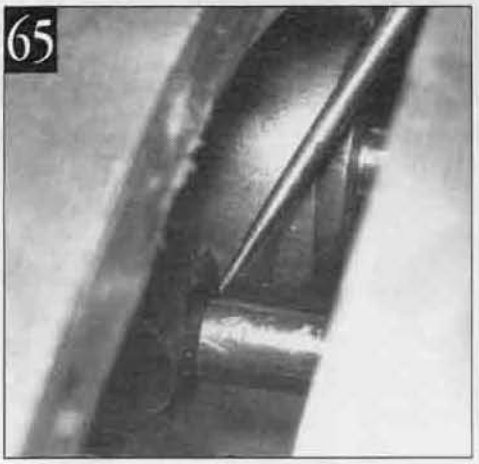


camplate to facilitate this.

- Remove inner cover and fit sleeve gear pinion. You will most likely need to gently tap it home with careful use of the mainshaft. With that done prime main and layshaft bearings with oil.
- Fit oil seal over shaft of sleeve gear (pic 51). The new seal being fitted here has a metal outer cage instead of the more common all rubber type. Now fit the essential spacer (pic 52).
- The sprocket, left hand thread retaining nut and locktab can be fitted. The opportunity was taken to replace the worn 19-tooth sprocket with a 21-tooth sprocket for more relaxed cruising at lower revs. Sprockets from 16-24 teeth are available for this gearbox.
- If the sprocket nut has a chamfered edge this should mate against the dish of the sprocket. The nut needs to be tightened so that locktab aligns with one of the two holes in the sprocket. You will probably need an extension to get enough leverage to tighten the nut. Use Loctite on the locktab screw.
- Fit drain plug with fibre washer and Loctite as a precaution.
- Turn camplate to neutral position, ie shallowest groove. This is most important and surprisingly ignored in some manuals.
- Now refit the gear cluster using new bronze bushes and making sure gears are the right way round as mentioned in the stripdown process. Lubricate all parts liberally with gearbox oil during assembly.
- It is also advisable to Loctite the selector spindle. Do this by applying Loctite to the threads in the shell (pic 53). If you apply Loctite to the threads on the spindle it can get wiped along the spindle and so bind the selector forks.
- Before the inner cover can be fitted the mainshaft bearing it contains should be replaced plus the kickstart bush if necessary. Use the same heating method explained earlier to carry this. You can use the clutch body retaining ring to hold the new bearing in the heated cover while you tackle the new kickstart bush, if necessary.
- Assemble kickstart ratchet assembly with new spring and pawl pin. These components must be in good condition or the pawl and gear can be damaged, and the pawl alone costs £4.
- Fit shaft assembly into layshaft first gear and rotate until the pawl is at six o'clock (pic 54) so that it clears the stops when the inner cover is fitted.
- Fit the gearchange quadrant roller. This must be done before the inner cover is fitted.
- Fit inner cover using a new gasket. Coat both sides of the gasket with grease. This helps the gasket to seal, and also avoids sticking and possible tearing of the gasket should you need to remove the case.







● When refitting the nuts which secure the inner cover Mick adds washer and replaces the two exterior nuts with stainless steel types of smaller diameter. These look better than original and allow the use of a 5/16in socket rather than open-ended spanner. Torque setting of 10-15ft-lb.

● If the inner cover is reluctant to fit snugly, lightly tap with soft face hammer. If this doesn't do the trick remove the cover and check that main and layshafts are properly home.

● The mainshaft nut should be torqued to 70ft-lb. It's advisable to use Loctite on the threads.

● When refitting the clutch mechanism, it is important to get correct alignment with the clutch cable for smooth clutch action.

● To do this fit the outer cover and mark the inner cover with a felt pen to show the entry angle of the clutch cable (pic 55). Now remove the outer cover and fit the clutch body and ball bearing so that the slot for the actuating arm is in line with the mark on the inner cover (pic 56).

● Tighten the clutch body with the special tool. You may find that you need to use a punch for final tightening. use one only if really necessary.

● To check alignment replace outer cover and pass a scribe or similar through the clutch cable entry in the outer cover (pic 57).

● You may need several attempts to get this alignment spot on, but it will be worth the trouble to avoid stiff clutch action.

● To refit kickstart spring turn the kickstart shaft so that the spring locating hole is at 12 o'clock. Insert the spring tang into this hole, then turn the shaft clockwise until it is against its stop. Grip the U-section part of the spring with long nose pliers and pull the spring round full circle and locate it against its dowel.

● Components housed with the outer cover can now be assembled. Insert gearchange spring and top plate. Use a 3/16" Whitworth socket to tighten the two bolts securely, not forgetting the shakeproof washers.

● Fit new O-rings to the kickstart housing (pic 58) and to gearchange ratchet shaft (pic 59). Instead of O-rings MH offers a conversion to oil seals. This requires machining of the outer cover.

● Fit gearchange shaft assembly to outer cover not forgetting large diameter shim washer. Using a screwdriver ensure the peg on the assembly locates between the two ears of the main gearchange spring (pic 60).

● Fit gearchange hairpin spring with straight leg uppermost (pic 61). If you fit this the wrong way round you won't be able to select gears. Insert gearchange ratchet after oiling shaft making sure half moon quadrant is pointing towards the teeth (pic 62).

● Before the outer cover can be fitted lever the quadrant to select second gear and make sure the hole in the quadrant roller points outwards (pic 63). Fit new gasket greased both sides. Insert a suitable screw to the centre of the gearchange spindle (pic 64). This allows you to move the gearchange mechanism housed within the outer cover.

● Now you can attempt to fit the outer cover. The art is to locate the pin on the ratchet assembly into the quadrant roller (pic 65). This looks straightforward in the picture, but it can be a real fiddle. It is also important to make sure the clutch actuating lever doesn't get in the way. To prevent this use the clutch pushrod to push back the clutch mechanism so that the actuating lever is lifted. You may also find it necessary to slip the gear lever on to make it easier to wriggle the outer cover home.

● Once the outer cover has been fitted double check that the gear selection works.

● Now fit the inspection cover and gasket. This cover gives access to fit the clutch cable. Note that it has a tiny breather hole. Make sure this is clear. Covers with the Norton legend in relief are available from MH.

● To improve gearbox breathing on pre-Mk3 Commando gearboxes MH recommends drilling the inner cover to accept a main jet or the Mk 3 breather (pic 66). Obviously this should be done during the stripdown stage if desired.

● **Now you can put the kettle on. If you are stuck for parts then get in touch with Norton specialist Mick Hemmings Motorcycles at 36-42 Wellington Street, Northampton NN1 3AS. Tel 0604-38505.**