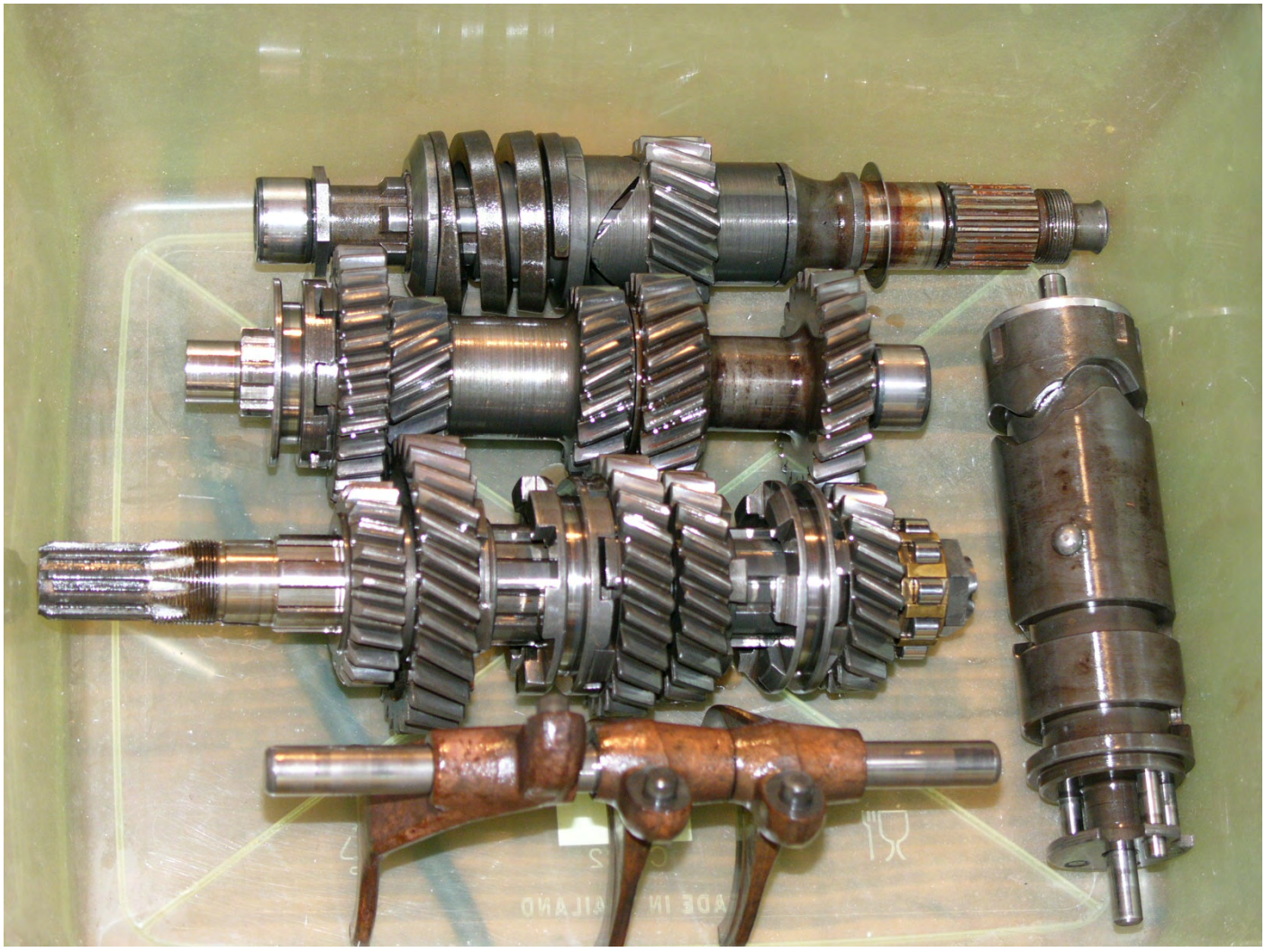
Inside the Lemon box

Strip and re-build of Guzzi's, 5 speed Helical box

john.noble100@ntlworld.com



Introduction

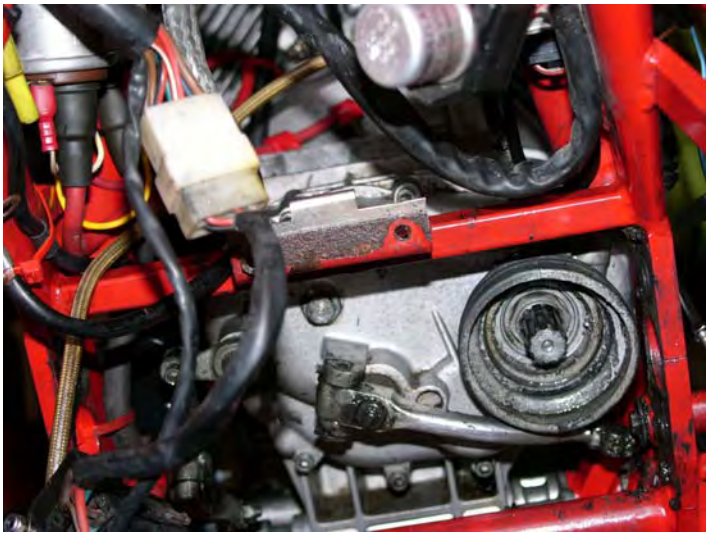
This article was written while stripping down a Guzzi LM 1000 (aka LM V) bog standard 5 speed helical gear, gearbox. In one form or another this box has been around for a very long time so it covers a wide range of models, however there have been changes over the years so this article may not be totally identical to yours, if in doubt check out the parts book for your bike. It is limited to splitting the drivetrain, which has already been removed from the bike, opening the box, removing the components and reassembling. It does not cover crabbing the frame or shimming the box, Pete Roper's article covers shimming admirably, nor does it cover the stripping of the gears and bearings on the shafts.

It was written for anybody who, like me, had never been into the box, had no real idea how it worked and is a bit apprehensive about venturing into it. Only average mechanical skills and an average tool kit are required with no access to fancy equipment (although there are some non standard tools you will probably need), you don't need to be an engineer or mechanic. The box is straightforward, but it needs to be done in an orderly fashion (don't ask me how I know). I would recommend having the parts, maintenance manuals & a camera available. There are a lot of washers, shims, O rings etc: tag, bag & label as you go, there are also parts which have an un-nerving ability to leap off the shafts so be careful and do it slowly.

There is no black magic or special powers you need (although X-Ray vision would have been useful). David MacMillan my local expert, suggested I do this, helped me strip it, and answered mails on stupid queries. The Wild Goose forum were invaluable and pitched in with patience and good grace to my inane and obvious questions, especially Pete Roper and Dave who both seemed to have a masochistic tendency to come back time and time again with suggestions and solutions.

A point on the references, I eventually chose to use page numbers where I refer to a component assembly etc: that's shown elesewhere, the page number is linked by clicking on it you will jump to that page, to return use Alt left arrow.

Finally like all amateur articles it's written in good faith for no financial gain. Feel free to distribute it or use it, for whatever purpose providing it's not for commercial purposes or financial gain. I take no responsibility for the accuracy of it or for any injury that results by following these instructions, although I do hope it's of some help.



What prompted the strip

EXTERNAL PREPARATION

Back of the gearbox with most of the components in place. This is a Magni so some of the components may be a little different from a standard Le Mans.

Open the oil fill plug then drain the gearbox of oil, using the plug on the bottom of the box, it's the only one on the bottom. The reason for opening the fill plug is it allows the box to drain faster. When you've finished they can be bagged.

Match mark the gearchange linkage and spline as it will save some grief when re-assembling.

Match mark the pawl adjuster bolt and casing, this may not be strictly necessary depending on what you're doing, but it's good practice anyway to allow the bolt to be reinstated to its original position if it's moved.

Remove the gear change linkage except the end piece that's attached to the splines this helps later in the dis-assembly.

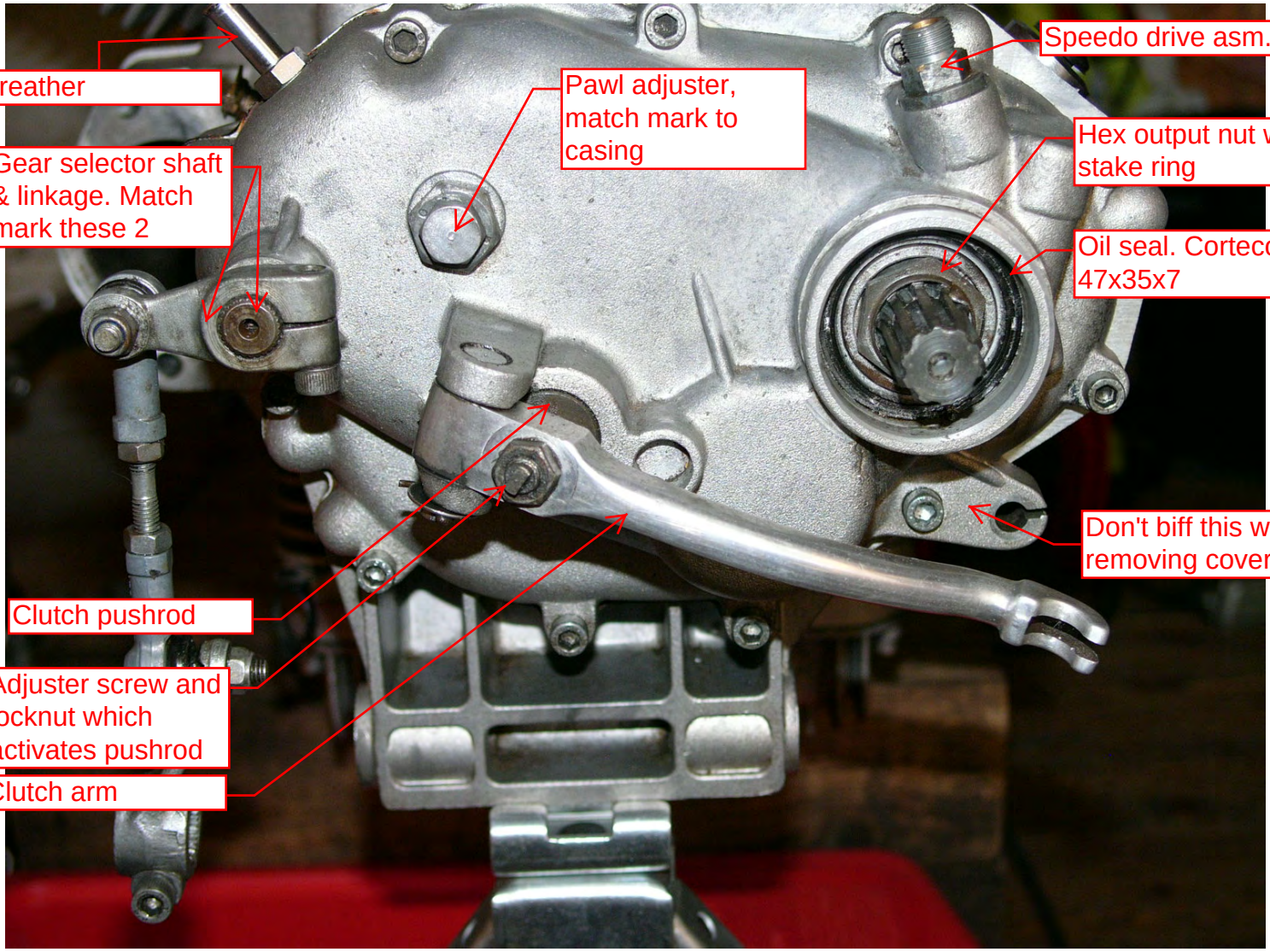
Unscrew and remove the breather pipe, not strictly necessary but it could get damaged or broken so I took it off.

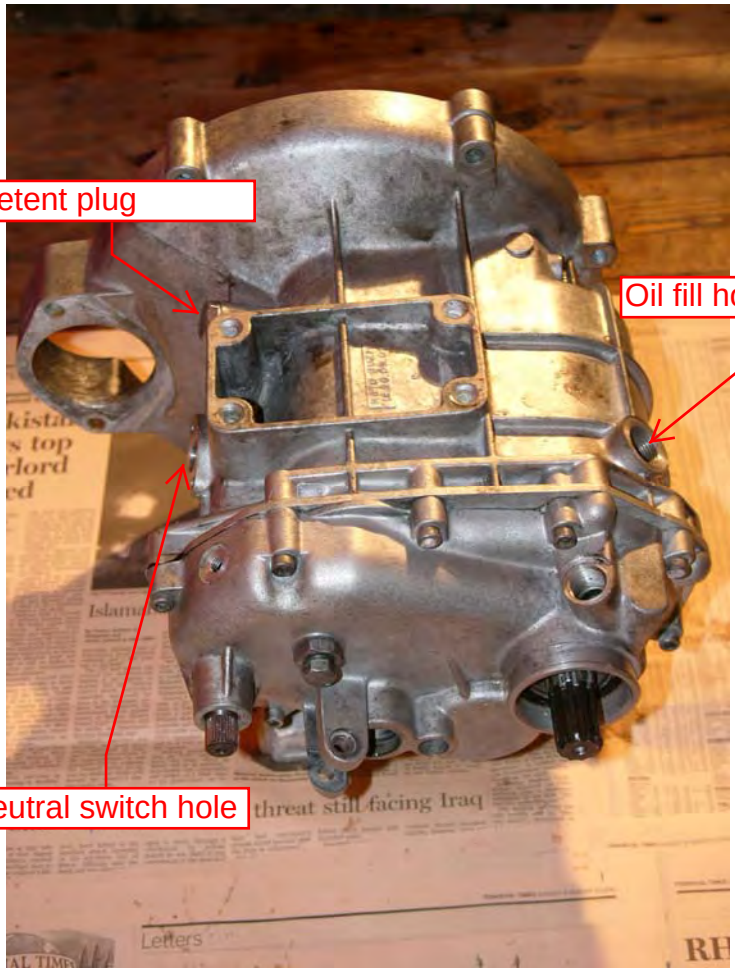
Unscrew and remove the speedo drive, it should pull straight out but may require a little wiggling, and the hardened washer that lies beneath it. Most recommend a magnetic pickup tool or a small magnet on a stick, don't jostle the box too much until this is out as it can drop down into the bowels of the box. Not a problem if you're fully stripping as you can always retrieve it later. The washers are specials and cannot be purchased separately so tag and bag. (Not a problem for me as a previous owner had thoughtfully removed them and not bothered to replace).

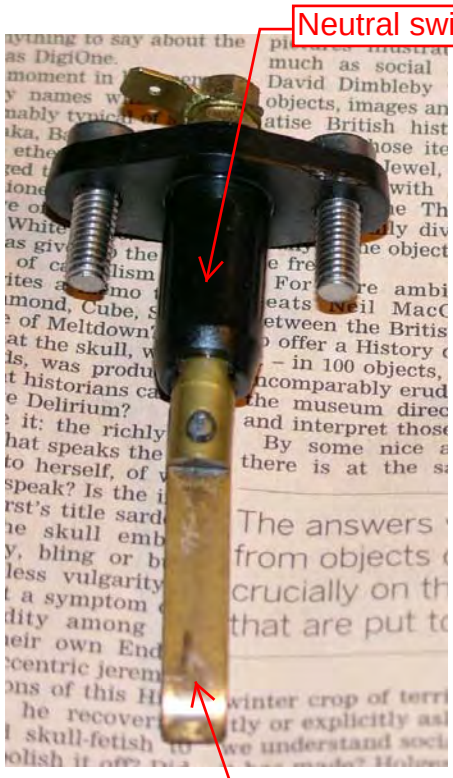
Remove the split pin and washer on the clutch arm and tap the pin up to remove. Then pull off the clutch arm. This then gives you access to the clutch pushrod plunger assembly. With a pair of grips pull it backwards, it has on O ring on it so it may feel a little reluctant. Once that's out the rest of the pushrod assembly can be extracted. Place you hand under the hole after the plunger is out, there is a thrust (or throwout) bearing and it's 2 runners, the bearing rollers can sometimes come out of the cage, mine came out in one piece without any grief. After that extract the second plunger, the 2 oil seals and the pushrod.

I also removed the neutral indicator switch (it's really just a grounding strap) but if you do not plan on doing anything to it or don't need to remove it for any reason it can be left in place. It has a paper gasket behind it, so if you don't remove it you don't need to replace the gasket. Mine was reluctant to come out, it pulls straight out, and I had to wiggle it a little. It may also help to remove it in 4th or 5th gear (as it sits against a dimple on the selector drum when in neutral, moving to a high gear will move the dimple well clear of the switch). If you turn it too much when removing you stand a chance of breaking the plastic housing.

Do not touch the pawl adjuster and leave the detent plunger assembly in for now.


Breather
Pawl adjuster, match mark to casing
Speedo drive asm.
Gear selector shaft & linkage. Match mark these 2
Hex output nut with stake ring
Oil seal. Corteco 47x35x7
Don't biff this when removing cover
Clutch pushrod
Adjuster screw and locknut which activates pushrod
Clutch arm

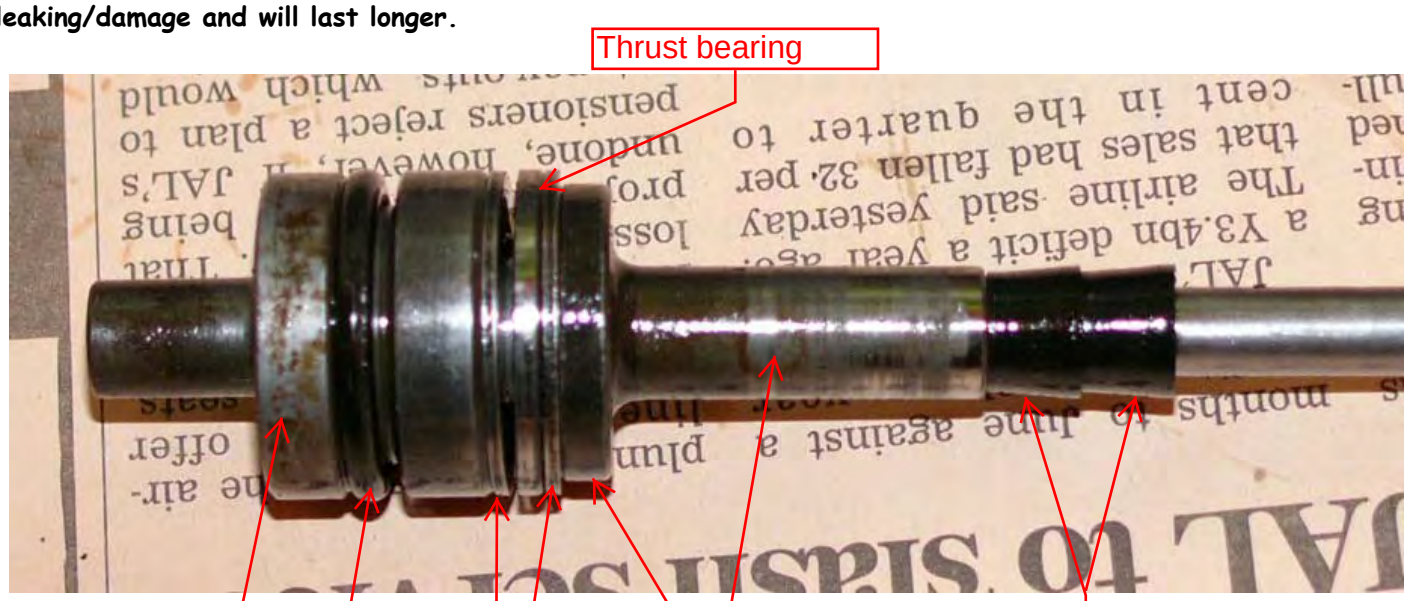

Detent plug
Oil fill hole
Neutral switch hole

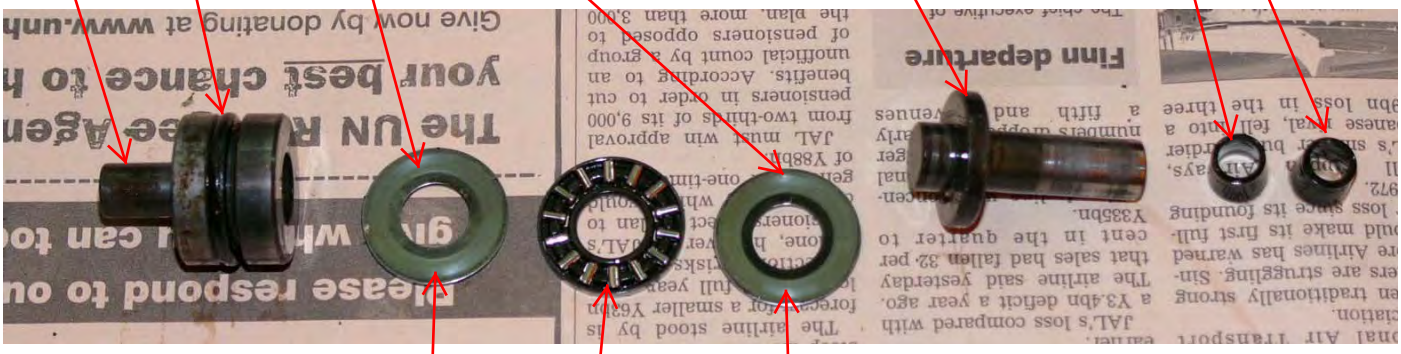

Neutral switch
Installs into box with end facing downwards

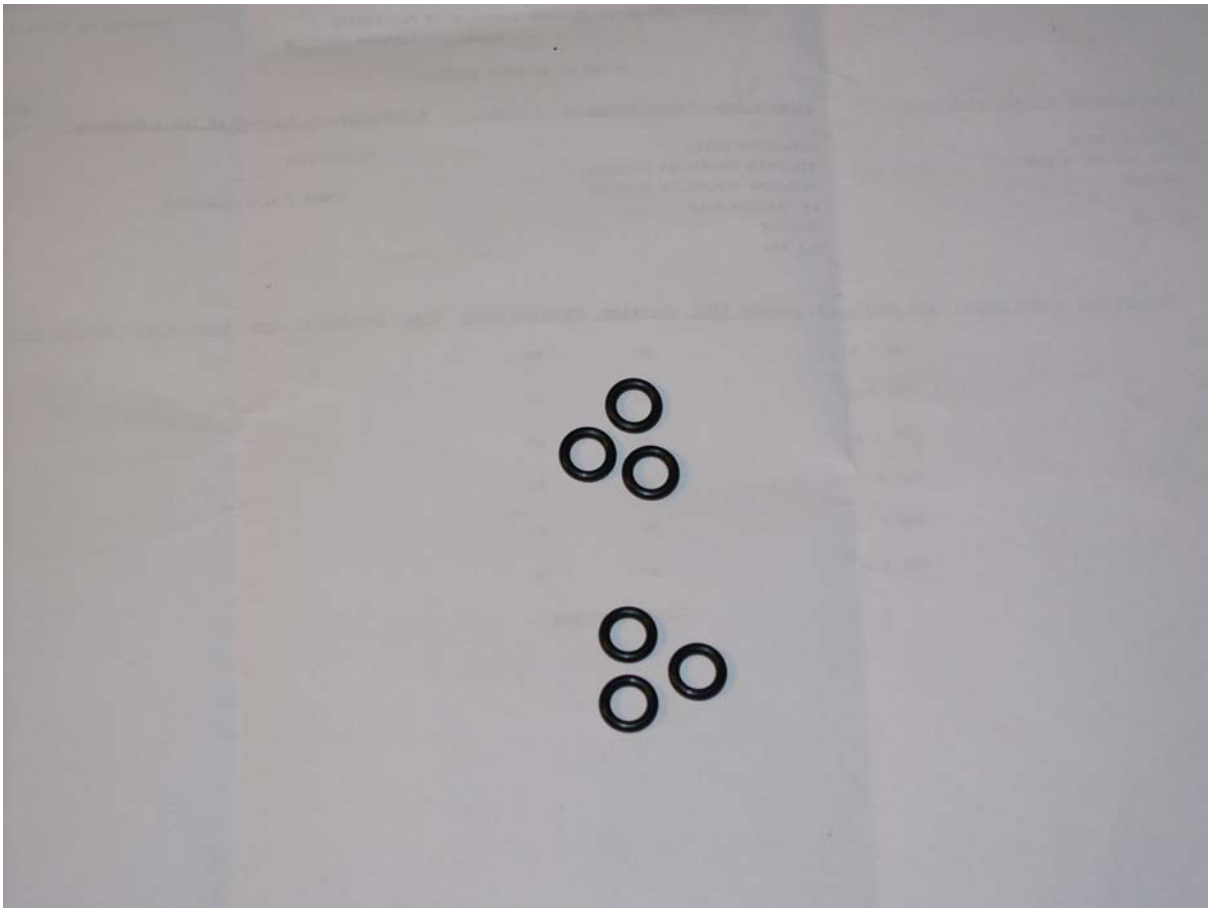
The speedo drive assembled & dis-assembled. I had to get the special washers made up, the lower one, the one at the end of the drive is the washer that can get left behind in the hole when the speedo drive is removed. The drive is just lifted straight out from its hole after being unscrewed from the endcase, although it may require a little wiggling.

Although not a problem for most, I subsequently found the washers I had made were a bit too thick at 1.5mm and fitting both caused the drive and layshaft to lock, they should have been 1mm. Apparently running the drive without washers is not a huge deal but not ideal. I overcame the problem by getting a 1mm spacer made to install under the top stationary collar which lifted the housing out of the endcase and accounted for the extra thickness of the washers. This allowed me to run a top and bottom washer. The washers spread the axial load of the spinning helical drive.

Shots of the clutch pushrod components after they have been pulled through. This was included to show the thrust bearing and the conical oil seals. The seals fit with the narrow diameter towards the plunger on the pushrod. They fit together and butt against the part shown immediately to their left. They stop oil creeping up the pushrod and getting into the clutch, not a good thing with a dry clutch.
Apparently O ring seals are now available as an alternative to the Guzzi conical oil seals, which are fragile and prone to leaking. It's reported that the O ring seals provide better sealing, are less prone to leaking/damage and will last longer.







A photograph of the clutch pushrod O rings that I mentioned on the previous page. These can be used in place of the conical seals Guzzi supply and all the reports I have heard are favourable. The O Rings are usually fitted in sets of 3 in place of 1 conical seal. Therefore most put on 6 or sometimes 5 in place of the 2 original seals. These were kindly given to me by "Amboman" on the Wild Goose forum.

The measurements I took from the seals (O rings are rather tricky to measure) were 9.5mm OD, 6.0 mm ID making them 1.75 mm thick. These O rings can be sourced from Mercedes parts dealers, Pt No 017 997 73 48 and are used in automatic transmissions.

Before we go any further it will be necessary to change gear in the box and find neutral at various points throughout the disassembly and build with the box on the bench.

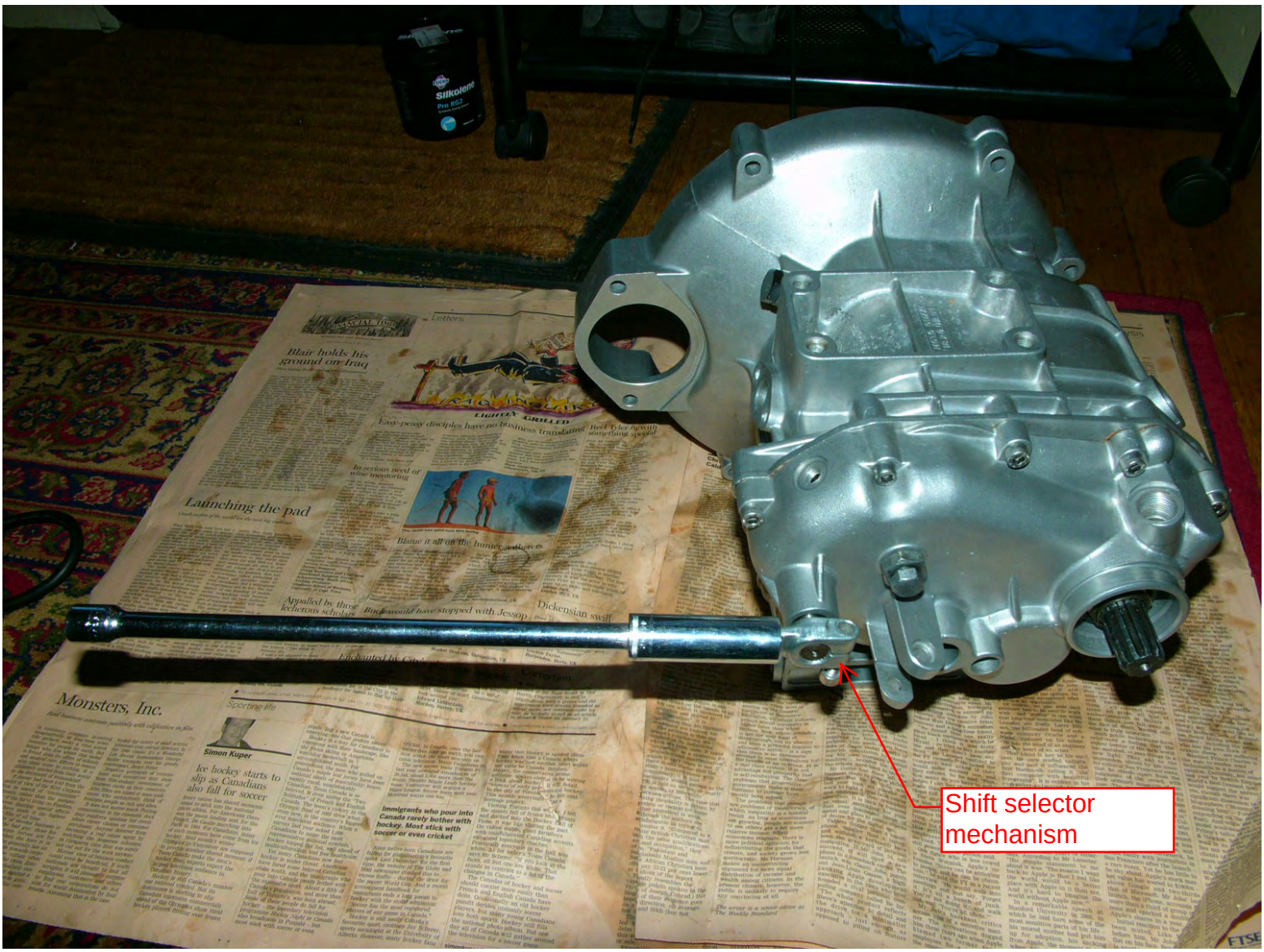
Another thing, although I didn't do it, in hindsight it would have been nice to know how well the box operated pre-strip. Selecting all the gears up and down the box a few times using the same method you will use after the build to check it, will help you gauge your work later.

To turn the selector shaft requires a fair amount of effort, the common approach is to use a pipe or hose pliers with some protection over the splines. When I used grips I found that it was difficult to turn the selector to select gears and also any slippage of the grips was damaging the splines.

Using the first piece of the shift lever selector mechanism that fits onto the gearbox selector splines and a deep 15mm socket with extension bar. I found that I could slip the socket over the shift lever and operate the mechanism reliably without damage to the components, although it did mark the shift lever a little, maybe some foam rubber and bigger deep socket would be even better.

The selector shaft turns anti-clockwise to select 1st gear, when viewed from looking onto the endcase. If using the extension bar push it downwards to select 1st gear.

In order to get the box to change it may be necessary to turn the input (clutch) shaft and place some drag on the output (lay) shaft, to eliminate bearing drag (why this is so will be more obvious after you understand how the gears select later).



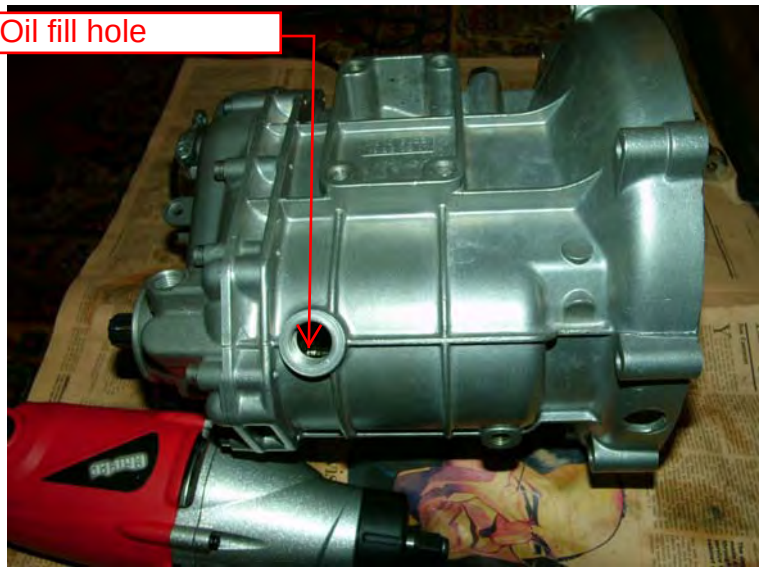
It's also pretty easy to get confused when checking out the gears to know which gear you're in. By shining a light down the oil fill hole you can see the dog which selects first and second gears. It's a little difficult to see in the photos, but if you do not know what gear the box is in, look down the hole and see where that dog is (it looks like a slotted disc with square lugs on both edges, sliding on splines).

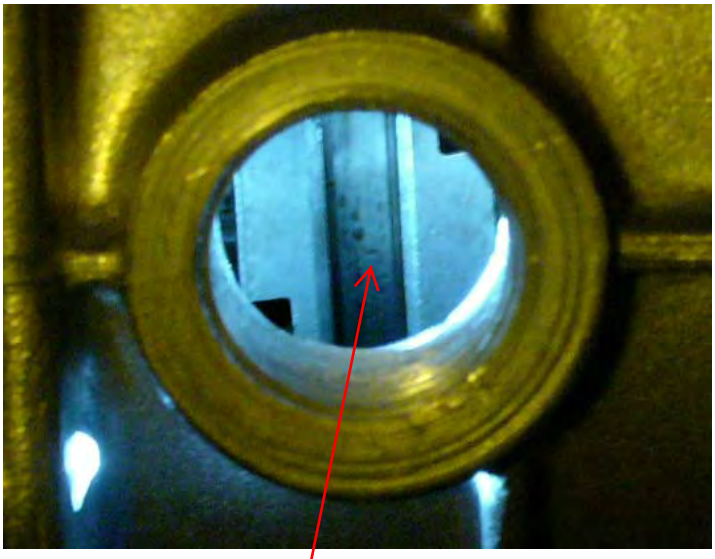
If it's towards the rear of the box (nearer the endcase) engaging the rear gear it's in 1st. If it's towards the front of the box engaging the front gear it's in 2nd. If it's in the centre position, in line with the hole, it could be in any gear other than 1st or 2nd. Remember that if the input and output shafts rotate independently it may not necessarily be in 'true' neutral, it could be a false neutral.

If the dog is centred and the input and output shafts can rotate independently move the selector down to see if the dog moves rearward, if does it was in 'true' neutral, so move the lever back up to centre the dog again. If not, or if the gears are engaged, keep moving the selector down until you see the dog moving forward. One more downward movement of the selector should see the dog moving to the centre position and you know it's in 'true' neutral. Another method of checking for 'true' neutral is to look down the neutral switch hole, if you see the dimple on the selector drum in the position in the photo the box is in 'true' neutral. Finding 'true' neutral is important when stripping the box, more of which later.

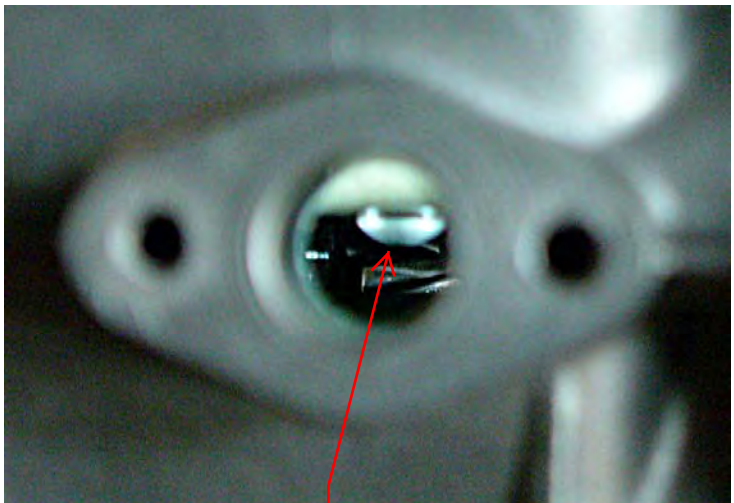
Neutral switch hole

Oil fill hole





1st & 2nd gear dog, viewed thru oil fill hole in neutral



Dimple on selector drum viewed thru neutral switch hole, when in neutral

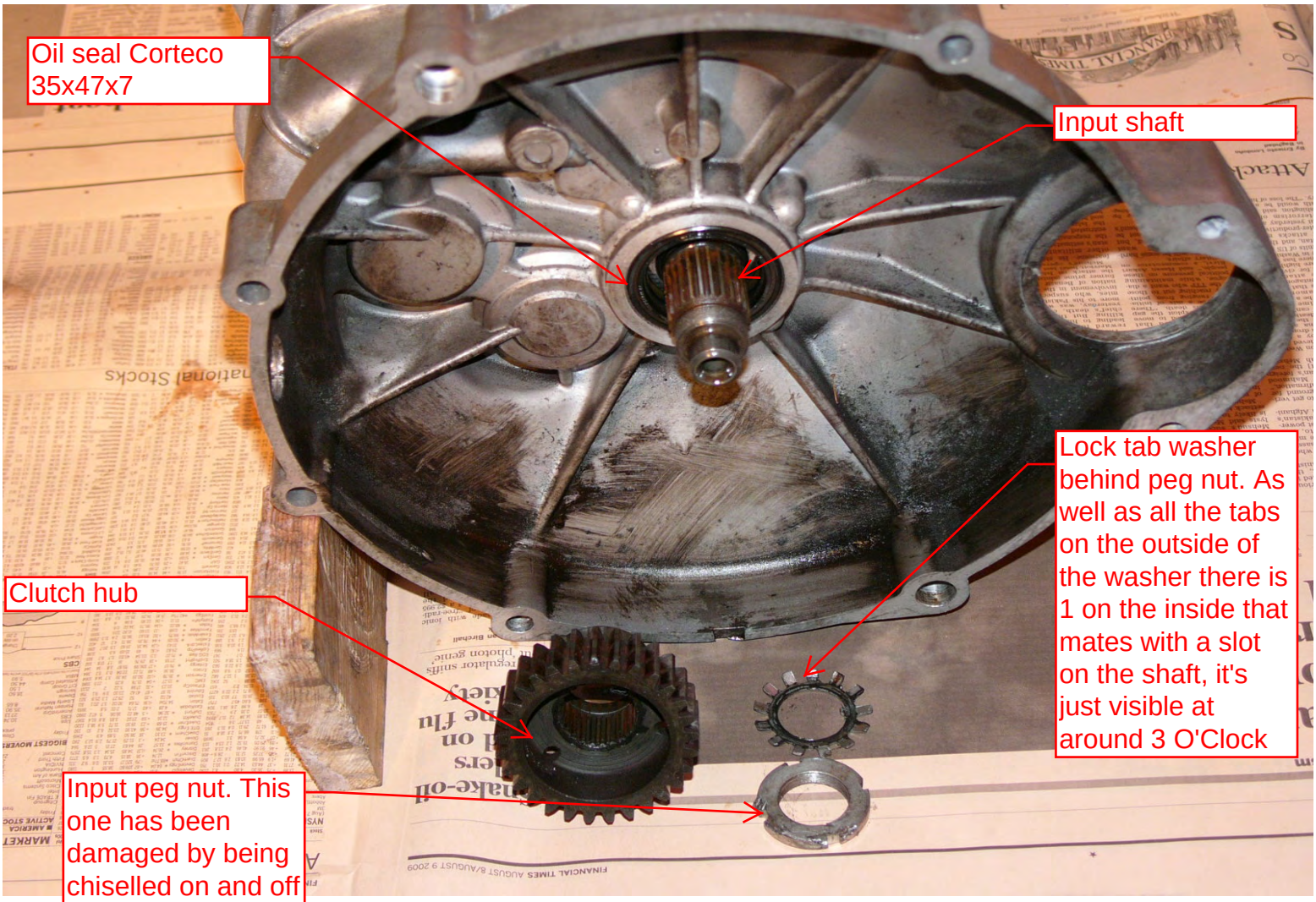
Front of the gearbox/clutch housing. The housing simply unbolts from the engine side using the 6xM8 nuts and 2 bolts that retain the starter. This is where the clutch lives and does not contain any oil, or it shouldn't. There is a small gap on the bottom of where the casings join to act as a drain and "tell tale" to let you know if oil is getting in there. Still have something underneath just in case, papers, tray etc: and some rags at hand.

I removed the starter & retaining bolts then blocked under the engine using 2 pieces of wood. If the engine is off the floor or bench ensure the front and rear of the sump are supported. The rear of the gearbox was on a scissors jack under the gearbox frame support. After removing all the nuts grab the gearbox and pull it back. It is not overly heavy.

Once split the next job is to undo the peg nut on the input shaft, retaining the clutch hub. To remove this, the lock tab on the washer behind the nut has to be bashed up clear of the slot in the peg nut, very similar to the crank nut in the timing chest. I used an old jeweller's screwdriver which fitted between the splines & levered then gently tapped it up, not a difficult job. The next job is however if you do not have the proper tools.

The peg nut is torqued extremely tight and it's recessed in the hub and difficult to access. The standard bodge is to attack it with a chisel to get it on & off. If you are lucky a previous owner has not torqued it too tightly as he couldn't get the access to do it properly. I don't recommend the chisel approach but if you go down that road make sure you have a replacement on order. Also if you destroy it & don't get it off you are in trouble as it will not be easy to cut it off due to the recess, I reckon you'd need to get it to an engineering shop, it wouldn't be impossible but bloody difficult.

I bought the special socket from Rolf Halverson, not cheap but well worth the money for the grief potential it removes. To lock the shaft in place a special tool can be made from an old UJ to lock the output shaft. Refer to the special tools article on Guzzitech DK for this. Obviously the box needs to be in gear. The other method to stop the hub spinning is to wrap it in rags or better still foam rubber and use a pipe wrench to hold it. If you have the special socket remove the nut with an impact gun, if you don't have one, buy one, hire one, borrow one or take the box to your local garage with the peg nut tool, it just whizzed the nut off, even though it had been hacked to bits by a previous owner. There is also the added benefit that it doesn't put a huge load on the shaft which increases the chances of damaging the clutch hub or turning over the gearbox and having it bang into something and take a lump out the casing, or anything fragile in the garage.

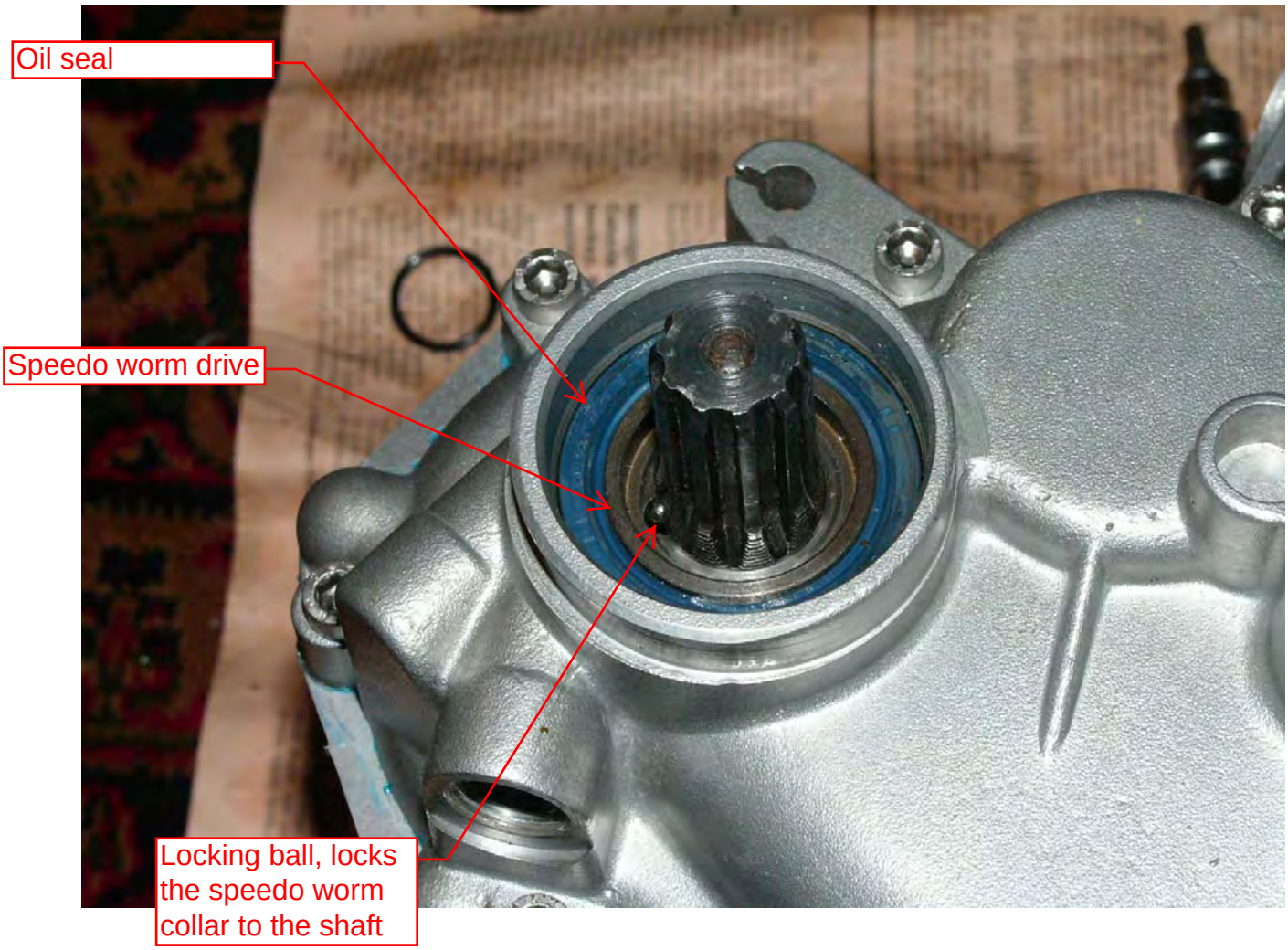

Oil seal Corteco 35x47x7
Input shaft
Lock tab washer behind peg nut. As well as all the tabs on the outside of the washer there is 1 on the inside that mates with a slot on the shaft, it's just visible at around 3 O'Clock
Clutch hub
Input peg nut. This one has been damaged by being chiselled on and off and had to be replaced.

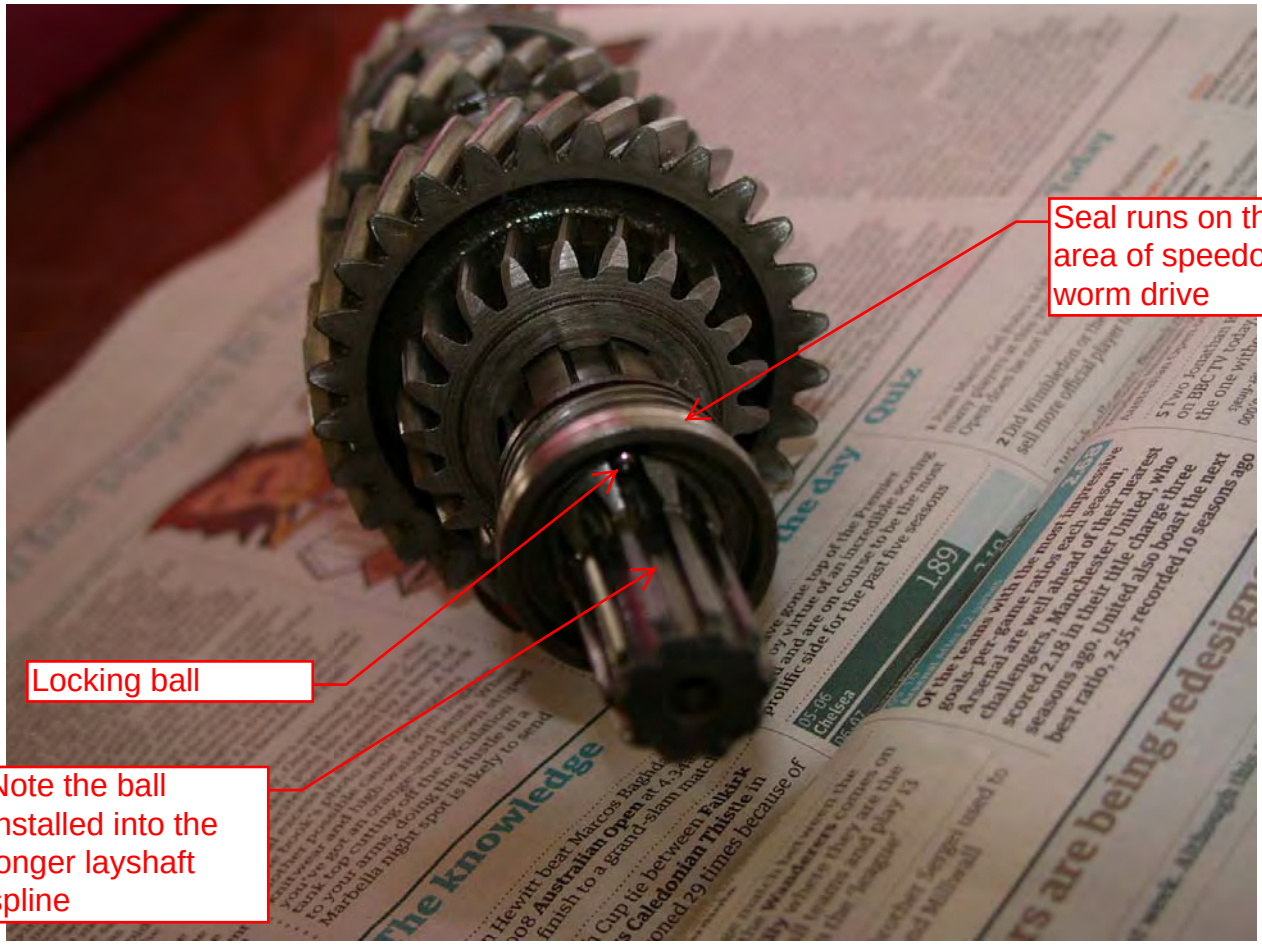

New peg nut, the shouldered side shown is the side that installs onto the hub. The taper allows the lock washer tabs to be bent over
Peg nut socket, note the 4 rectangular tabs that install into the peg washer
Oxfam

Turn the box around and undo the nut on the output shaft, it can be seen on page 4. This nut has a ring around its inside diameter, which is tapped (not bashed as it cracks the stake & then it's useless) into the recess in the splines. That jeweller's screwdriver did the trick again and easily broke the stake. The bad news is this guy is similarly tightened to a zillion torques. An M27 deep socket is needed to get at it. Rolf also can supply this, his is chamfered to ensure it seats on this quite shallow nut. Go on buy it you can also use it to undo the cam nut on the timing chain. I also found a Britool hex impact would also do the job, probably a bunch of others. I'd recommend the impact as they grab on the flats of the nut as opposed to the corners so a lot less chance of mayhem & destruction to said nut. Guzzi gearbox designer had a wicked side as this is also recessed, make sure whatever you use seats well on the nut.

To lock the box a special tool could be made using an old clutch plate or better still clutch hub with a handle welded to it to lock the input and stop the whole lot spinning or the pipe wrench on the clutch hub trick - not ideal, but you work with what you got. While you have the impact whizz that off as well, I cannot stress how much easier this is using an impact on both input and output nuts, there is no real need to restrain the shafts when getting these nuts off, there are other ways but the impact removes a whole world of grief.

The speedo worm drive and steel ball, are shown installed on the layshaft spline. These photographs were taken during assembly and after the layshaft had been removed but clearly show the pieces and how they fit together. The ball is taken out after the output nut has been removed and the worm drive just pulls straight off the layshaft. The worm is quite soft on its outside edges and should be removed using an external circlip pliers to grab the inside recess. Any clumsy attempts to remove it with long nose pliers may damage the outside surface that the seal runs on. If the ball and/or worm refuse to move don't worry, it can be taken off when removing the endcase by tapping down on the end of the layshaft until it's clear of the endcase. The ball and worm drive will stay on the outside of the endcase and can then be picked off. The only problem with this method is there is a good chance the ball will roll out either into the box or onto the floor so keep your eye out for it if you need to do this.




Seal runs on this area of speedo worm drive
Locking ball
Note the ball installed into the longer layshaft spline


Narrow washer
Speedo worm drive
O ring
Locking ball
Support washer


O ring
Narrow washer
Support washer
Speedo worm drive
Seal runs on this flat
Bearing in end case runs on this area

Select neutral and remove the detent plunger. The detent plunger pushes into holes on the selector drum to ensure positive changes and prevents the drum turning which would result in false neutrals or jumping into another gear. The box needs to be in neutral to allow the selector pawls to slip out of the selector drum, if the box is in gear the pawls will foul the drum and prevent the endcase from lifting off.

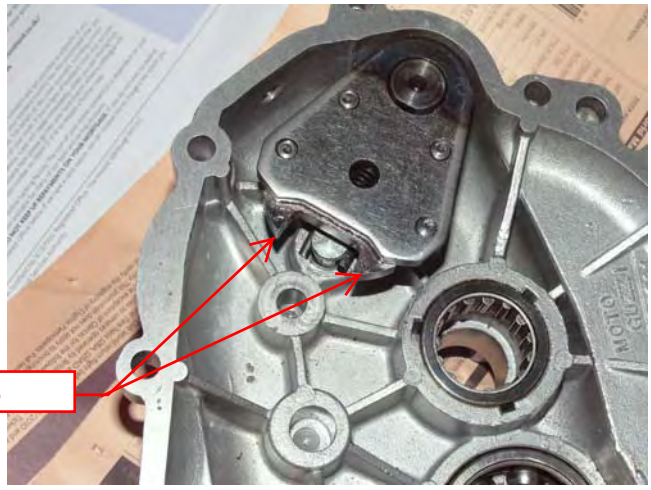
Be careful here, its spring loaded so has potential to biff you one. It's not a very strong spring but just be aware in case it flies out either into your eye or down the drain. The plunger is behind the spring and the assembly is shown below with the original plunger and a replacement I purchased.

I hoped the replacement would improve the gearchange action. It didn't and I used the original component. If the radius on yours is radically different to the items shown it may be worthwhile getting the later part as many report a marked improvement to the quality of gearchange with the later plunger.

REMOVING THE ENDCASE

Turn the box on its end bell housing down. Put a small tray under the input shaft to catch any residual oil.

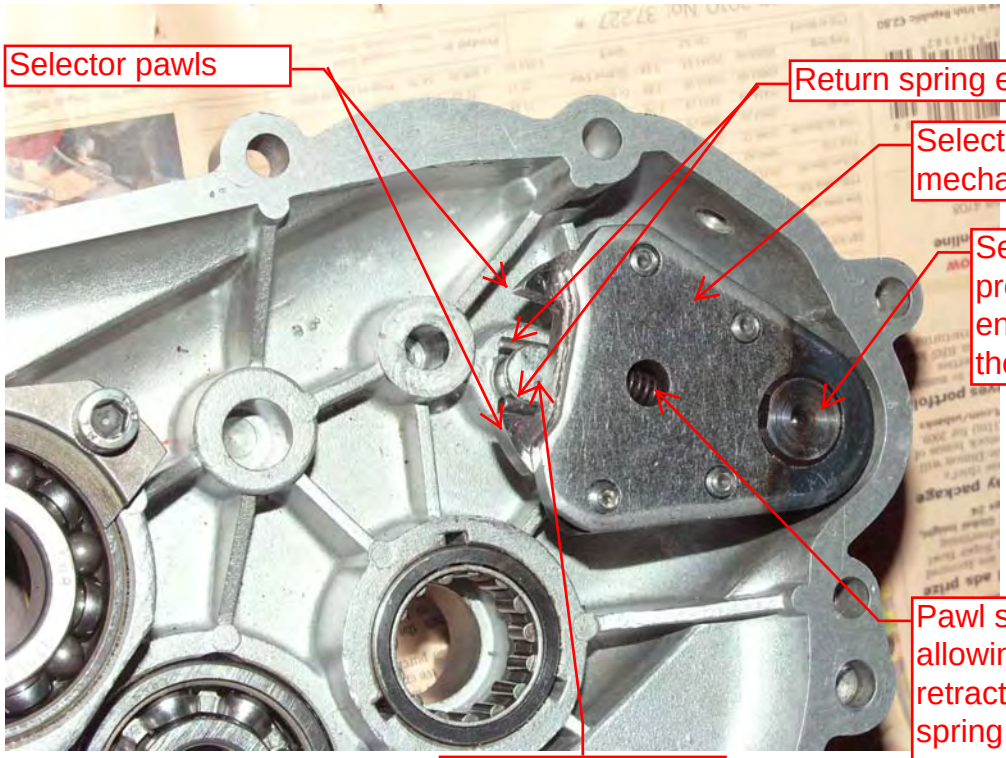
Remove the screws from the rear case and lift off. The rear case is on pretty damned tight and needs to be tapped liberally with a soft mallet or dead blow plastic hammer. As the casing starts to lift tapping down on the layshaft helps as it is tight on the bearing in the endcase. The other thing that needs attention is the pawl selector mechanism. The idea is that the cutouts in the drum selector allow it to be lifted through them IF the box is in neutral.



The return spring ends are held in place by the pawl adjuster.

As the pawl adjuster is screwed in or out, the cam action turns the mechanism side to side as well as pushing the pawls deeper or shallower onto the selector drum pins, allowing adjustment of the mechanism.

From this it should be clearer about getting the pawls free from the drums. The pawls operate on the pins at the top of the selector drums. When lifting off the endcase the pawls either have to pass through the cut-outs on the top of the selector drum when the box is in neutral, alternatively the return spring has to be levered free of the pawl adjuster which holds the mechanism onto the endcase. I'd recommend trying to get the pawls through the cut-outs on the drum as levering off the return spring is harder and has the added hazard of breaking the return spring in the process.



The casing may also have to be biffed liberally and levered with wooden wedges to gradually lift on both sides. Try to lift the casing evenly.

Another warning is do not biff the arm that holds the clutch cable as it allegedly breaks off if you happen to stare at it long enough. It's under the output shaft & can be seen on page 4.

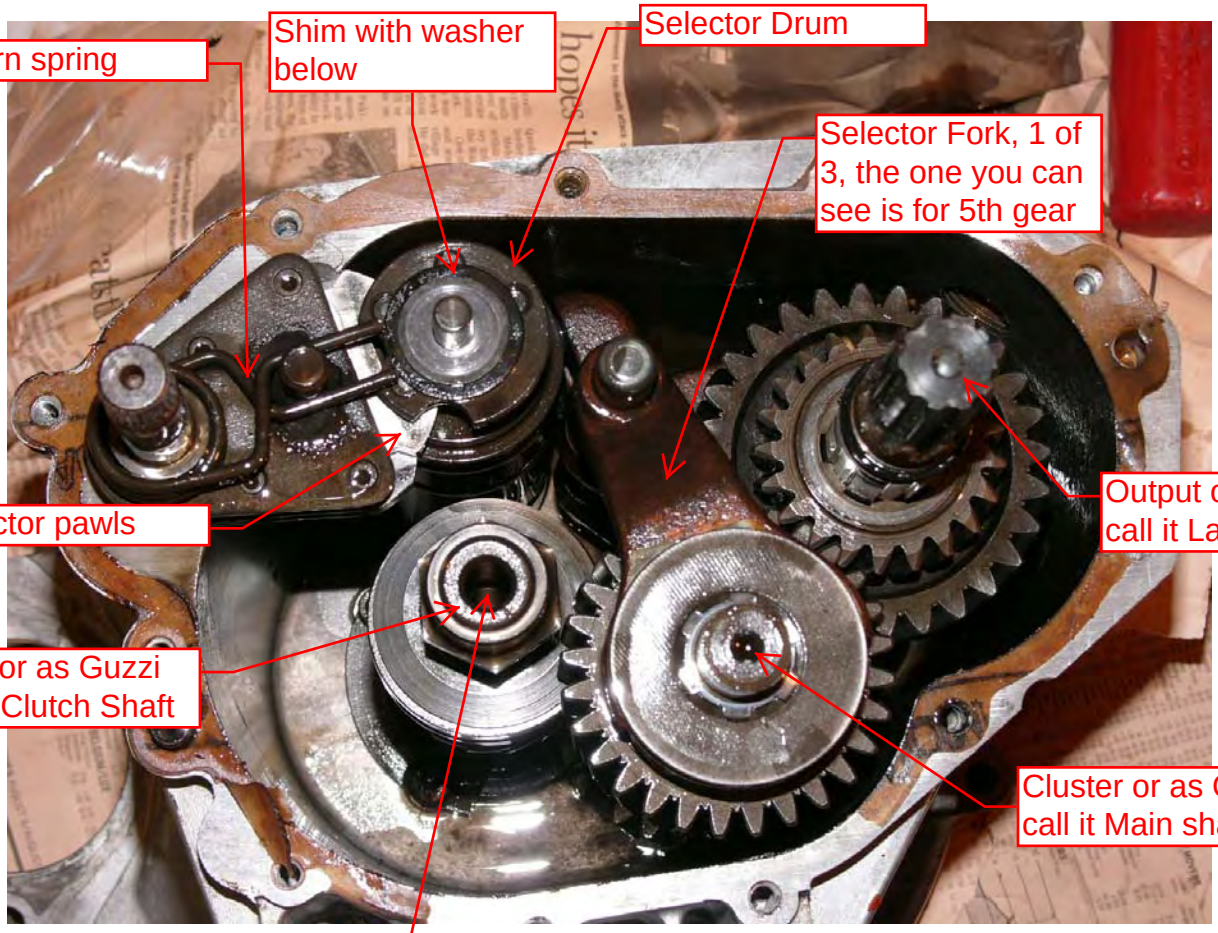
INSIDE THE BOX

The bit you've been waiting for the magic shit inside.

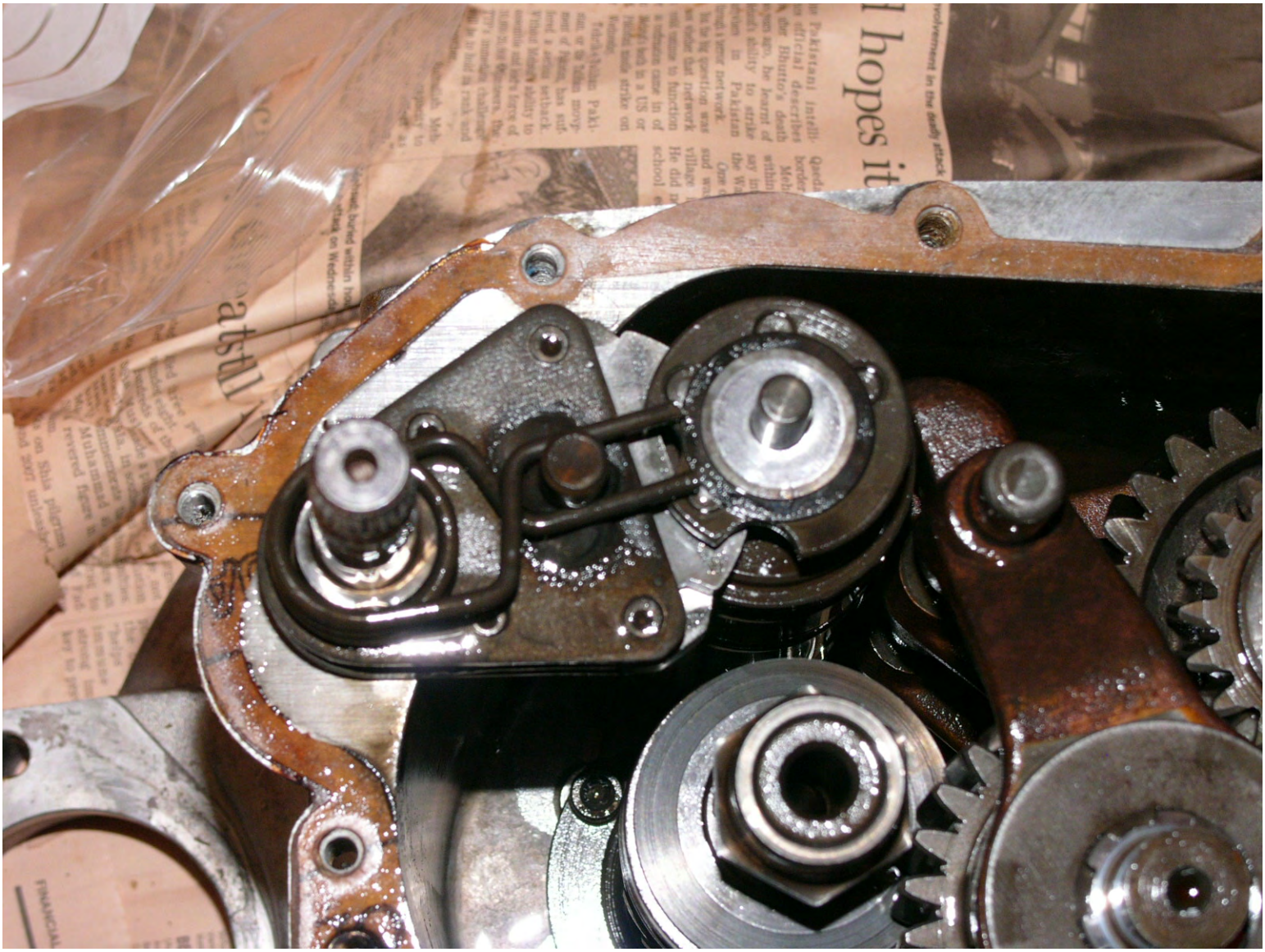
The box consists of 3 shafts the input, cluster & output or as Guzzi call them the clutch, main and layshaft. Also in there is the gearchange selector which operates pawls (if you slid the selector out of the drum they will have stayed with the endcase) and turns the selector drum a given number of degrees every time it moves. The selector drum has a series of shaped slots into which the selector forks slot into, as it turns the slots force the forks up or down (or back and forth when the box is in its correct orientation).

The forks force the dogs on the cluster and layshaft to move and engage/dis-engage the relevant gears refer to page 25 for an explanation of the dogs' function and the shafts.

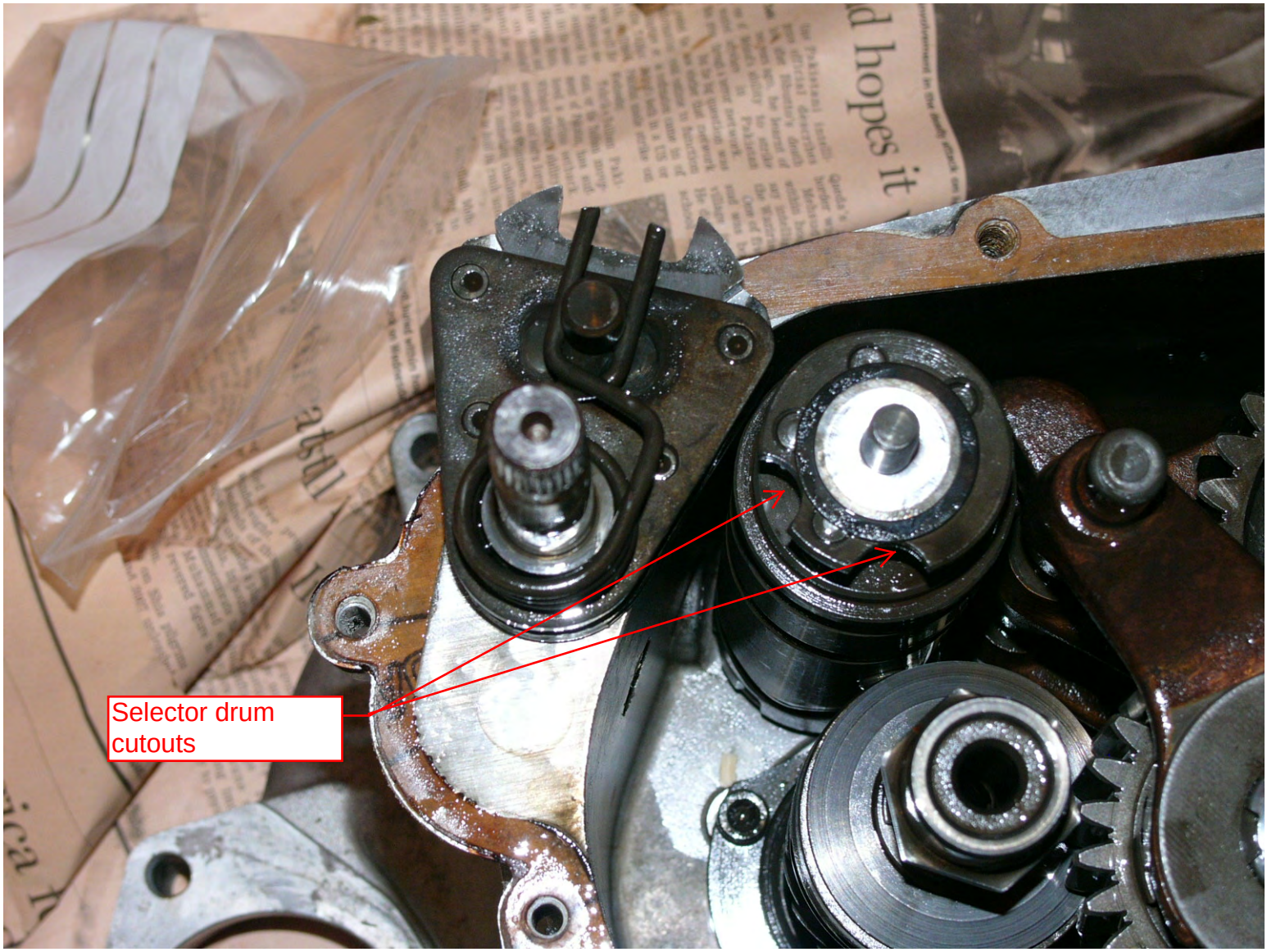
Each of the components come out in one piece, but be careful as well as the main elements there are also shims, washers, seals and O rings in there and they shouldn't be mixed up.



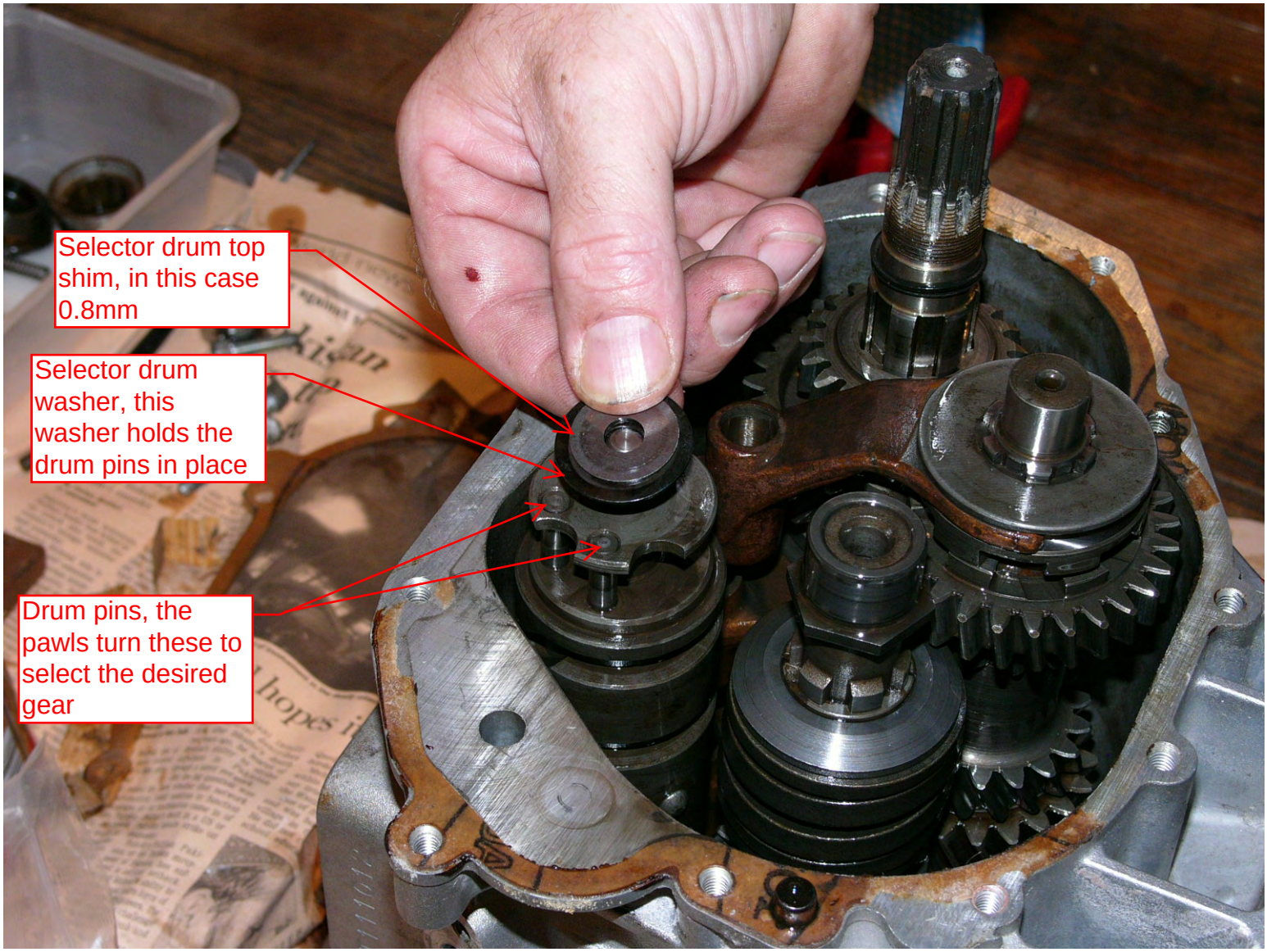
You can see in this picture that my box was not in neutral as the selector pawls don't line up with the cutouts, locking the selector onto the drum. A lot of forums suggest that anytime the gearbox is opened the return spring is replaced as it is a weak item and prone to failing. Don't remove the existing one until you have a replacement as they are allegedly prone to breaking when removing, that said I had mine on and off a few times with no problems.



The selector mechanism can be lifted off. The 2 cut-outs on the selector drum, which allow the pawls on the selector mechanism to be lifted out, can also be clearly seen in this figure.

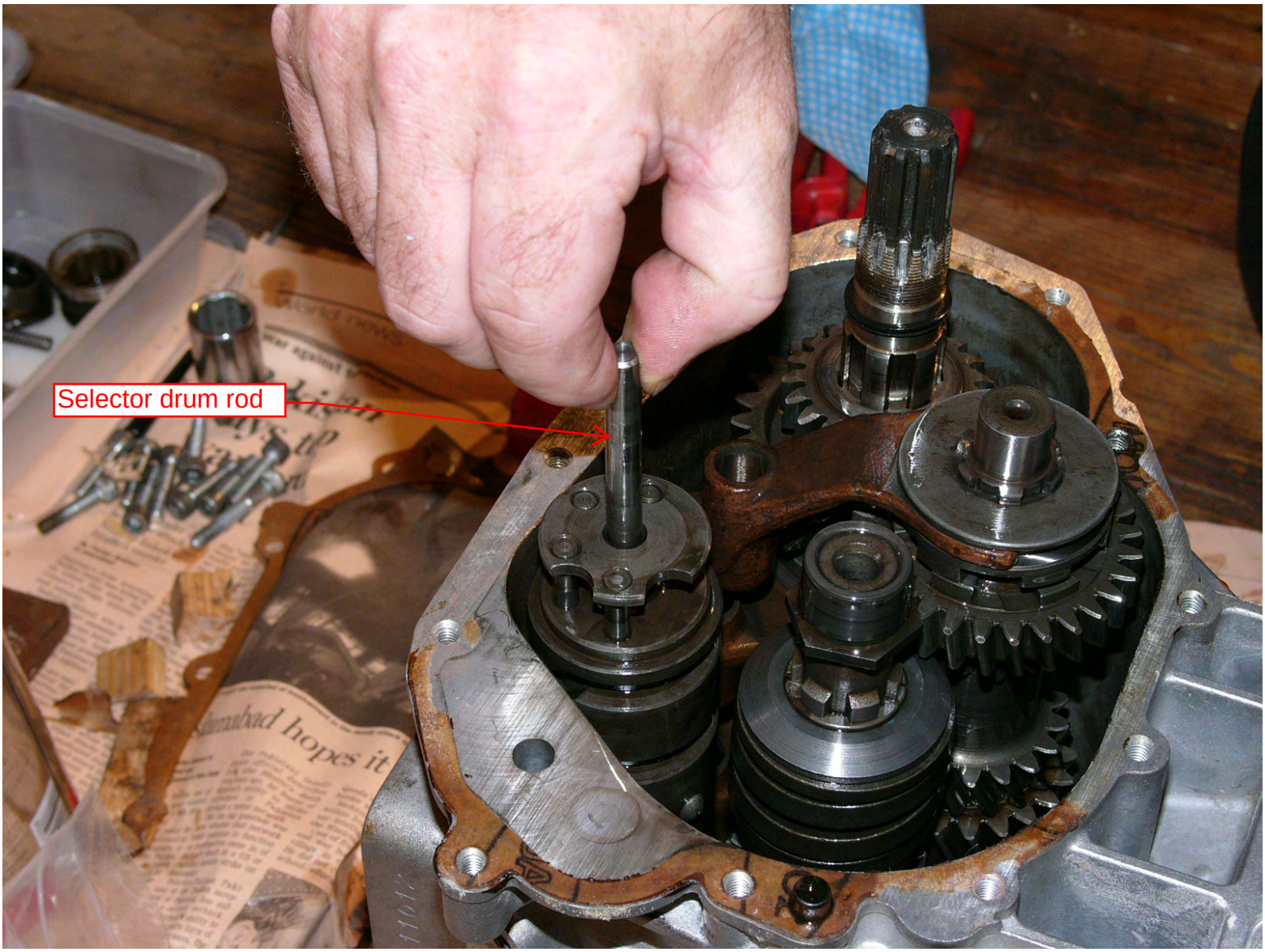


Pay attention here. This is the top selector drum shim (on the top) and washer (below it) which hold the selector pins in place. Tag it & bag it. As I previously mentioned don't get these mixed up or your in a world of pain. The hands here are not mine but David McMillan Guzzi Gnu, he showed me how to take the box apart. I hope he's around when I'm assembling.



Remove the selector fork rod.

Remove the selector drum rod, the selector drum can then be wiggled free of the selector forks which are located in the drum with short pins and the drum lifted out. There is a possibility of the selector pins on the top of the drum to drop out if the drum is turned upside down when removing, although they will normally stay put.

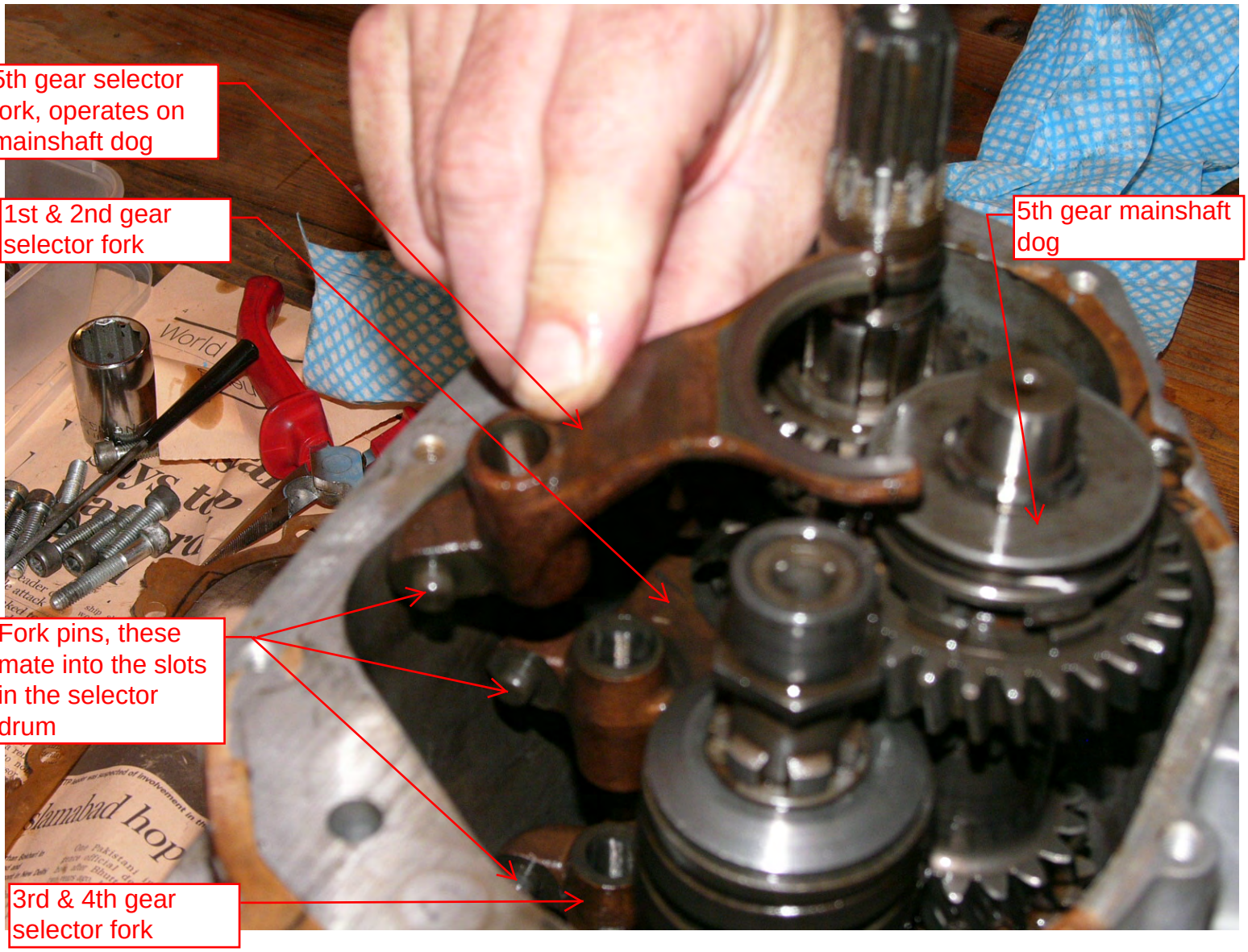


Remember the shim on the bottom of the selector drum. Tag & bag.

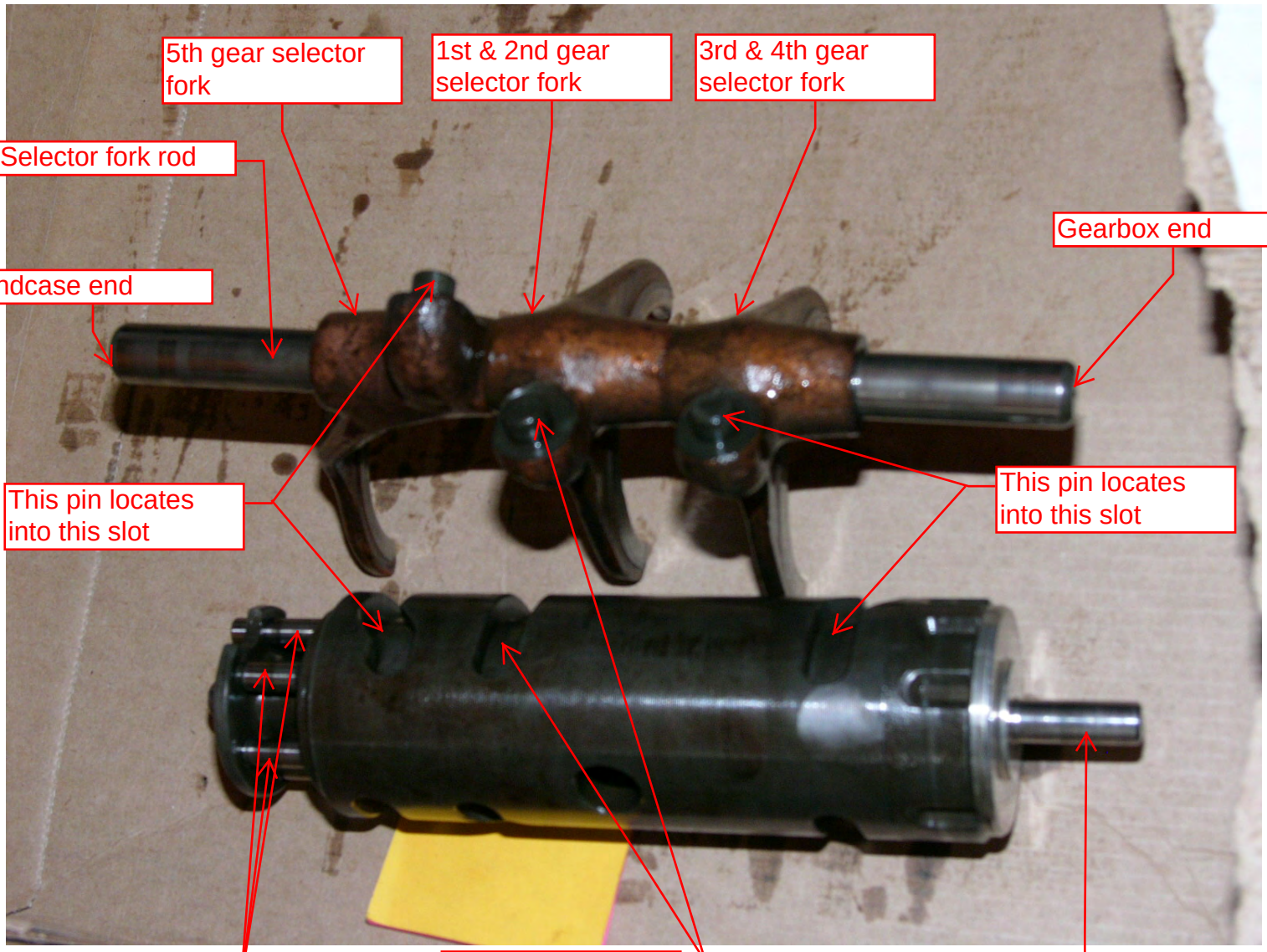
Note my pickle jar full off gearbox oil, ready to go back into the box for when it's been stored assembled or for pouring over the gears if they are going to be out of the box for a while.

The slots which the selector forks slide in and the depressions that the detent pin/plunger locates into for each gear can be seen well in this shot. The dimple or rivet at the edge is the grounding contact for the neutral switch.

Start taking out the selector forks, top first obviously, which is 5th gear and on the mainshaft, the other 2 are on the layshaft. You can see all 3 in this picture. The pins that sit in the selector drum can also be clearly seen.



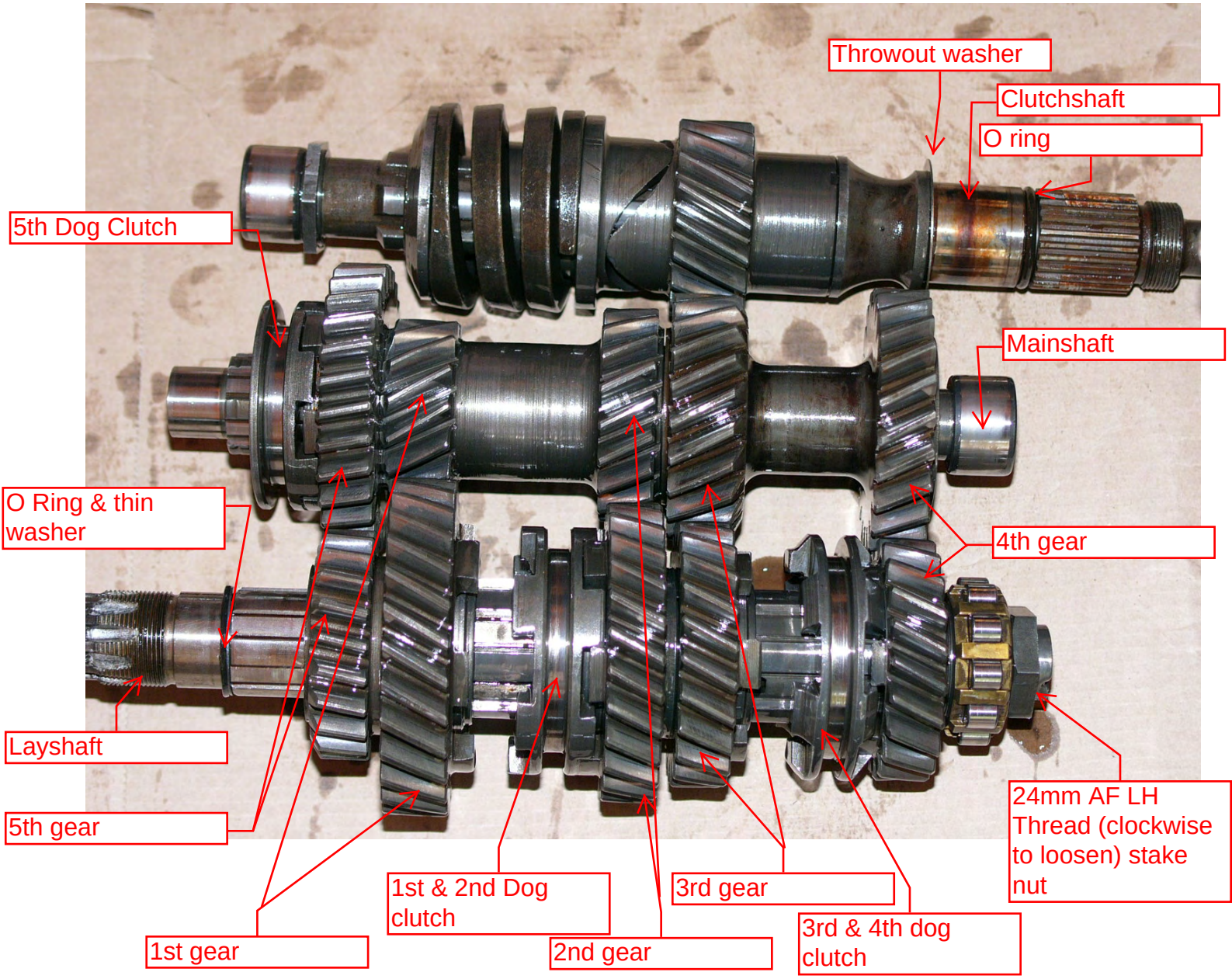
All the selector forks and selector drum out with their respective pins and rods. The bottom 2 for the layshaft are interchangeable the top one on the mainshaft is not. That said it is better if you know which fork is which as examining the wear on the fork faces can help establish where the selector drum shims need to be placed if you are going to reshim the selector drum.



The 3 shafts lifted out of the box. The shafts just pull out start with the layshaft, the mainshaft will lift out with it and can be wiggled free of the clutchshaft, alternatively all 3 shafts can be pulled out together.

Do it slowly, keep your eyes open for falling shims or washers. The layshaft O ring, washer, 5th and 1st gear and the bearing inside can easily slide off. If they do 5th gear has the thinner of its 2 shoulders and the angled edge of the gears to the output side (towards the splines).
Likewise the mainshaft's thrust bearing, runners and washer can also slide off or be left inside the box, see page 26.

From the notes below you can get an understanding of how the gears are selected. The input drives onto the main shaft's 3rd gear and is permanently engaged with the mainshaft. All the gears are meshed at all times, the trick is the gears to the mainshaft and layshaft are <u>not</u> all engaged to their respective shafts. 1st, 2nd, 3rd & 4th gears are free to spin on the layshaft and 5th gear free to spin on the mainshaft, if in neutral (no dogs engaging any gear). The selected gear is held in position by the use of the 3 dog clutches. Obviously only one is locked onto any gear at any one time, so 1st and 2nd uses a dog that can move onto either gear and lock that gear onto the layshaft, the same for 3rd & 4th, while 5th has its own dog clutch on the mainshaft, all the other un-engaged gears stay meshed but just spin together, it's the dog clutches that lock the gear onto the shaft and provide the required drive ratio. The action of the dog clutches are controlled by the selector forks, which are in turn controlled by the slots in the selector drum. In the photo 5th gear is engaged on the mainshaft, 2nd and 4th on the layshaft, something you would not want to happen when the box is assembled (the box would lock up or explode or both).

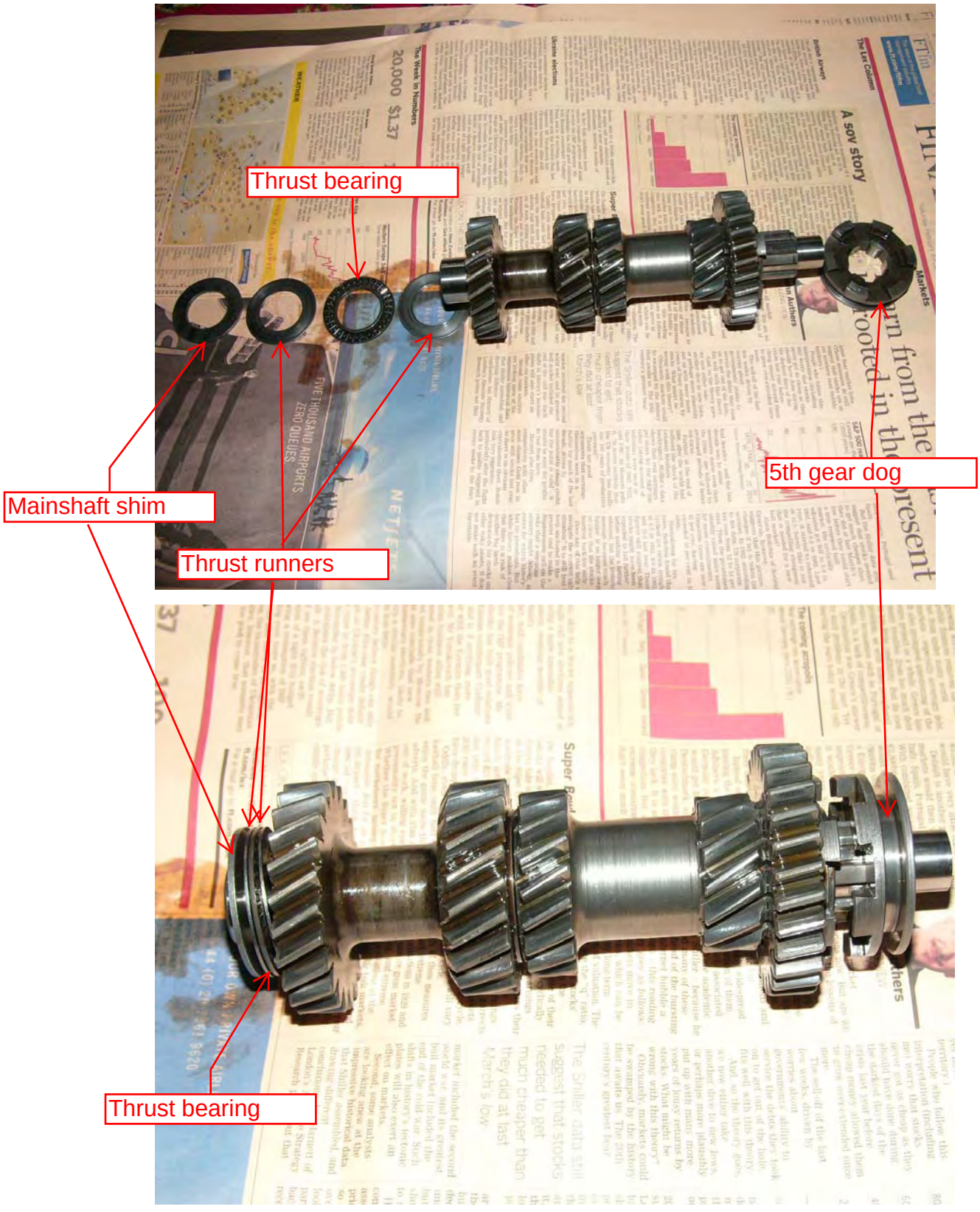


Mainshaft and the components that come off at the drop of a hat.

On the gearboxcase end the thrust bearing that sits on the shaft against 4th gear and the shaft shim. Looks like 2 thin washers a thick washer and a bearing. The thick washer is the shim, so to put the pieces on the shaft, it's bearing race (thin washer), bearing, bearing race (the thin washers are interchangeable) and finally on the end the shim (thick washer). The thrust washer takes the axial load of the floating mainshaft when the box is being driven.

On the endcase end is the dog for 5th gear, it goes on with the dogs towards the gear (the castellated side to the inside, smooth to the outside).

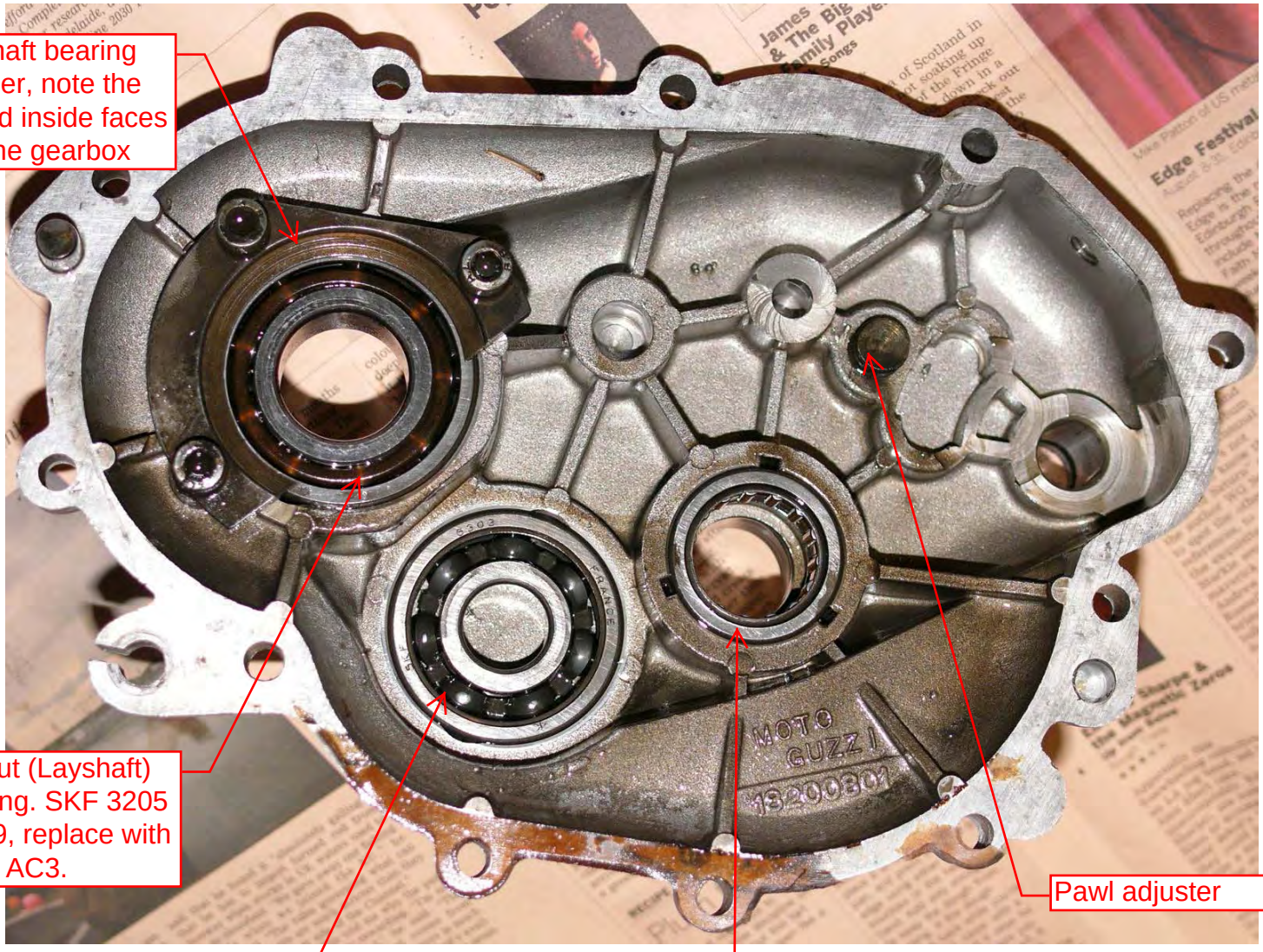
Just in case!!



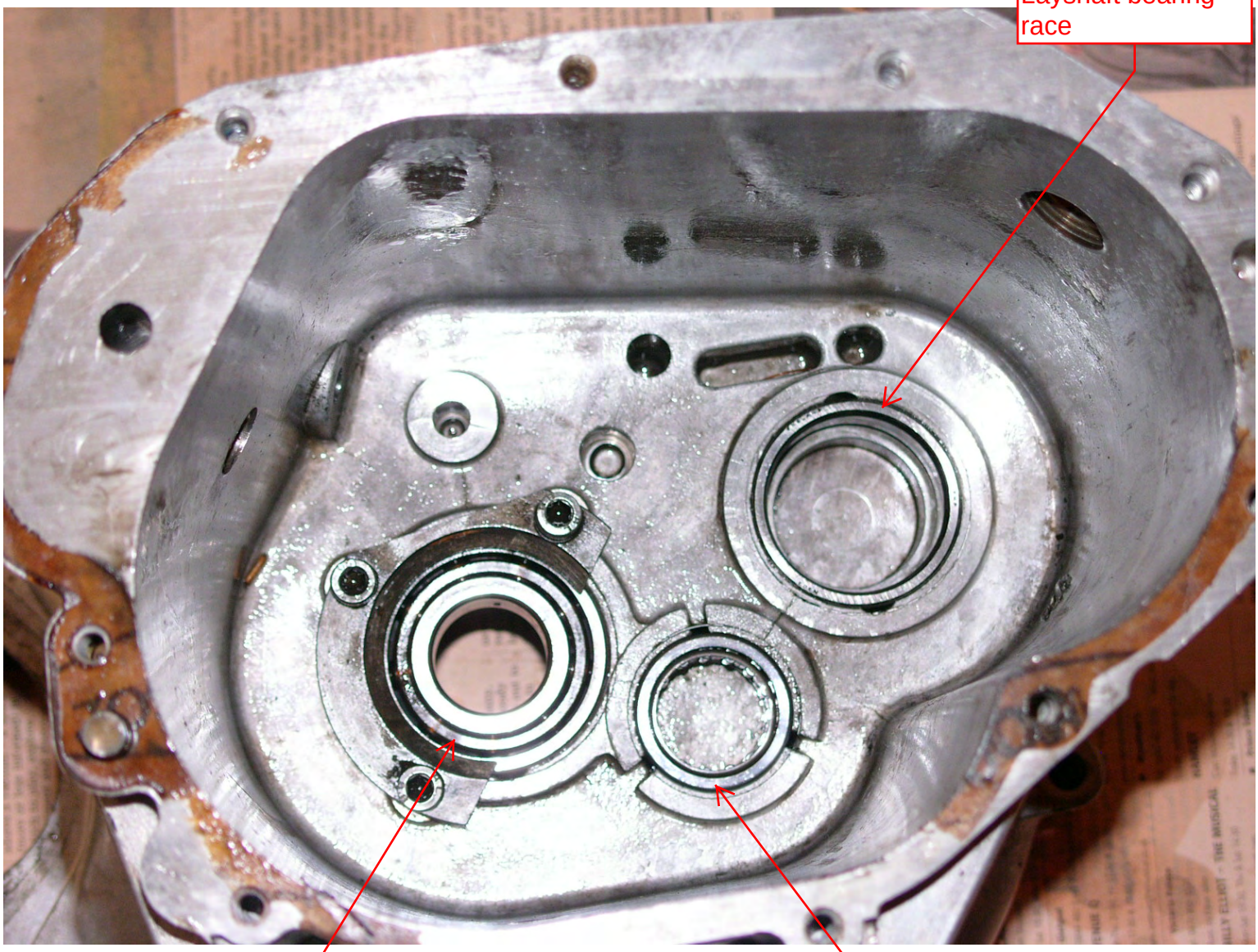
View on the back of the rear casing showing the bearings.

The retaining plate on the output & input is apparently made of nylon on some bikes and a lot of the experienced Guzzitista recommend that it should be replaced with a steel item, mine were steel. The output and input bearings are nylon caged on later bikes as seen here. Rolf Halvorsen, Pete Roper & others recommend these be replaced with INA 3205 / SKF 3205 AC3 /NTN 3205 AC3 / NSK 3205 JC3 which have more balls, 14 as opposed to 9 and metal cages, Rolf or Pete can supply or a local bearing supplier.

The pawl adjuster can be seen here as well. If removal is necessary, for casing cleaning for example, then the bolt and casing should be matchmarked and the number of turns for removal noted. This way the adjuster should be able to be re-instated to the same depth in the end case, a photograph may also be good idea.



View of the inside of the gearbox, showing the 3 bearings left behind when the shafts are removed

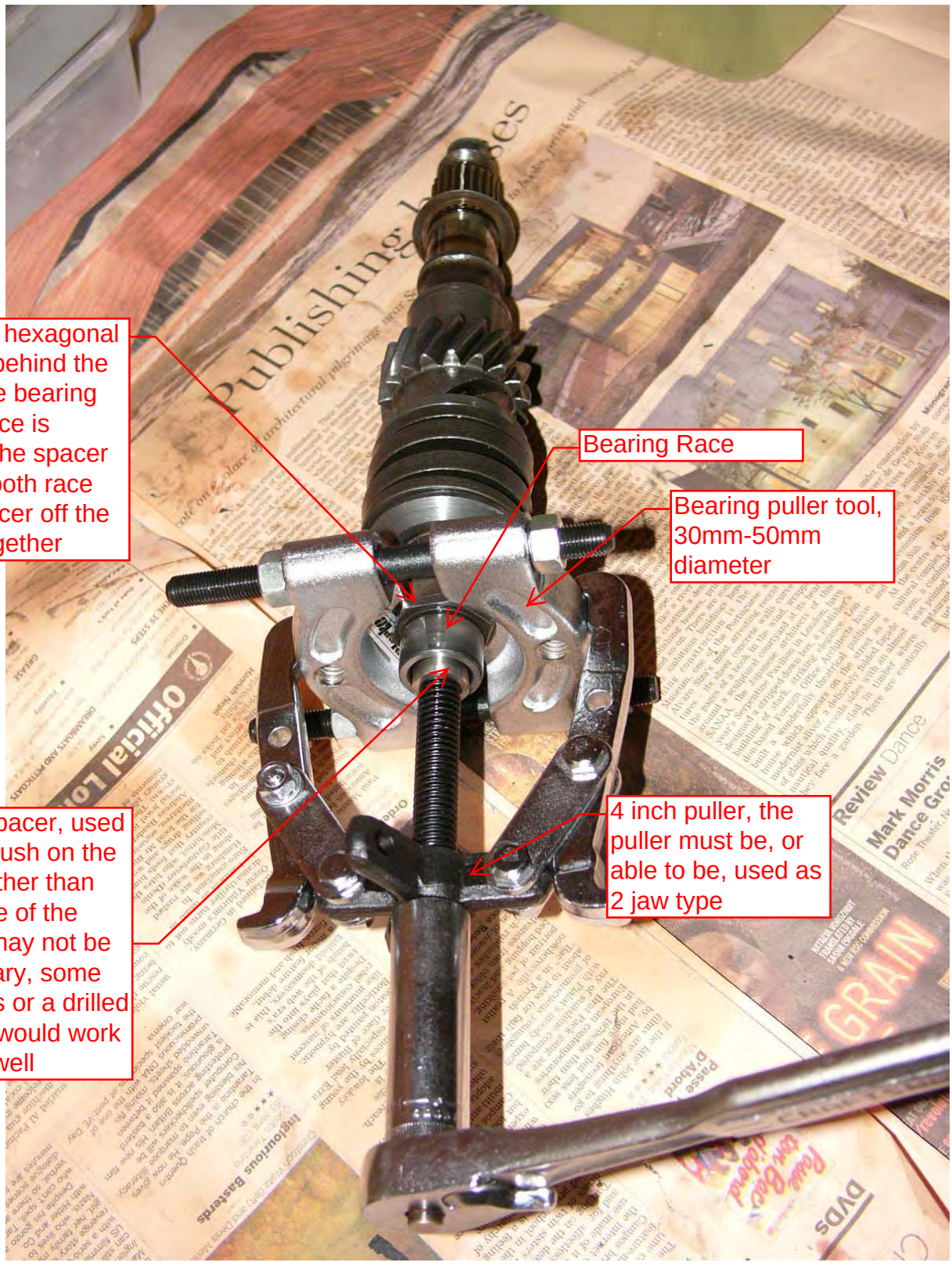


The bearings in the blind holes on the end case and the gearcase apparently drop out of the casing by application of a little heat (150-160°C) on the casing around the bearing area, Guzzi recommend an oven. Mine did not come out so easily and I had to take them to an engineering shop to remove them. Later for another job I purchased a blind bearing puller kit, this consists of mandrils of varying sizes and a slide hammer. The mandril is inserted into the back of the bearing or on the edge of the needles (if the bearing is hard against a step, like the mainshaft needle roller). The bolt on the mandril is screwed in spreading the jaws causing the edges of the mandril to grip the bearing. The slide hammer is screwed onto the mandril and by whacking the weight upwards the centre section of the slide hammer is forced up. This then pulls the mandril and attached bearing, upwards and out of the blind hole. I am certain if I had applied heat then used this tool the bearings would have come out easily.

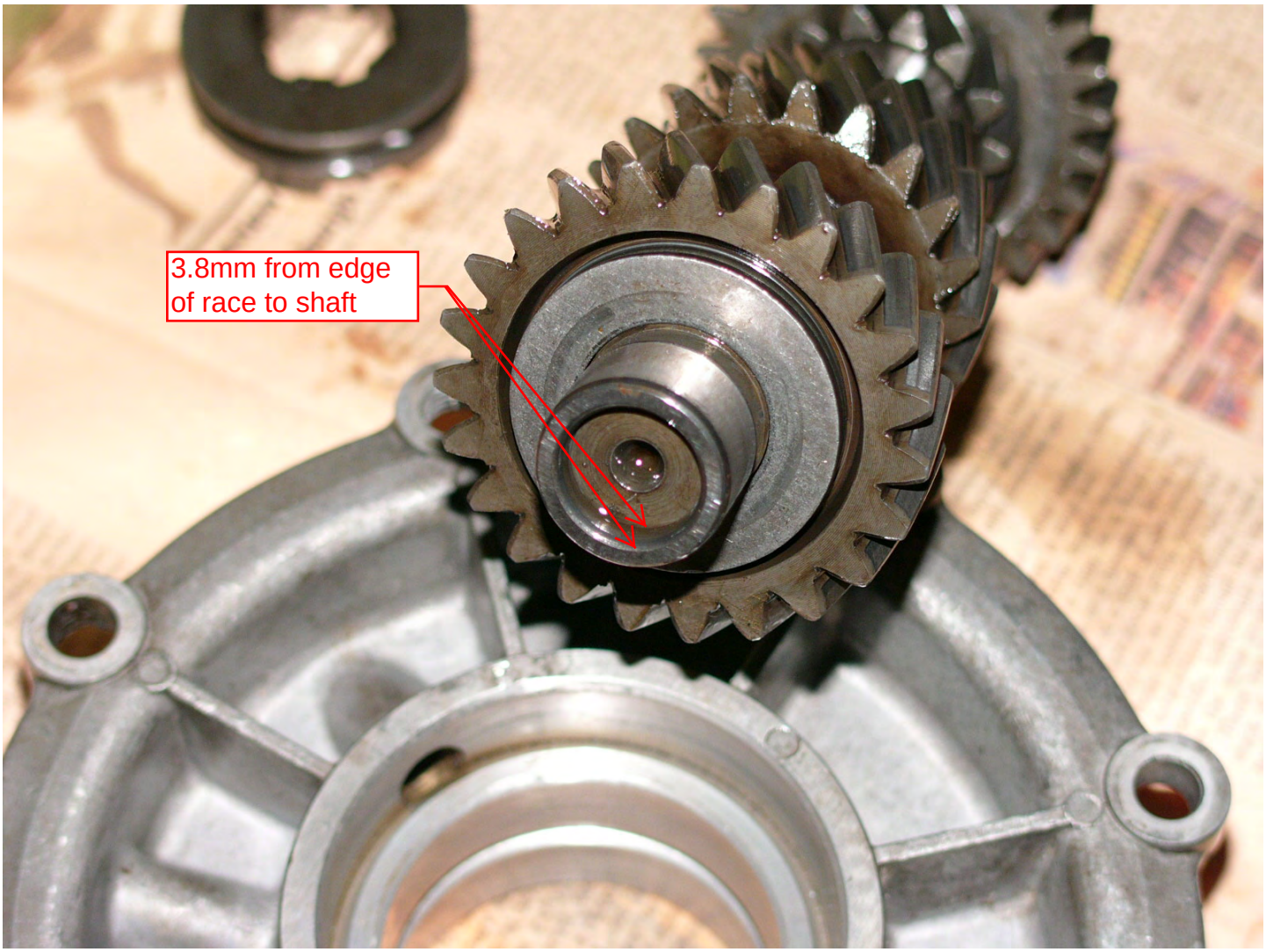
Pulling the bearing race off the clutchshaft.

I purchased a bearing puller tool suitable for 30mm to 50mm shafts and a 4 inch puller, from a local tool supplier. Worked a treat for the 2 races one on the clutchshaft the other on the mainshaft. I also used this to remove the inboard bearing on the layshaft, after removing the 24mm AF left hand thread stake nut on the shaft first. Nothing special broke the stake and then took it off with an impact (remember its clockwise to loosen).

It may be better to see if you can remove the nut with a breaker bar as I noticed some slight thread damage to the shaft threads, unsure if this was as a result of using the gun or had been there all along. It states in the Guzzi manual that this bearing has Loctite 601 applied (high strength). Mine came off very easily using the puller, a lot easier than the races.



Just a shot of the race on the mainshaft before I pulled it off. This is not normal but not uncommon apparently. The factory were a bit lax when it came to using Loctite on the races. The race was proud of the shaft by 3.8mm. There is no step on the shaft, the race just looks as is if it has either walked or was never installed fully onto the shaft in the first place, probably the former.



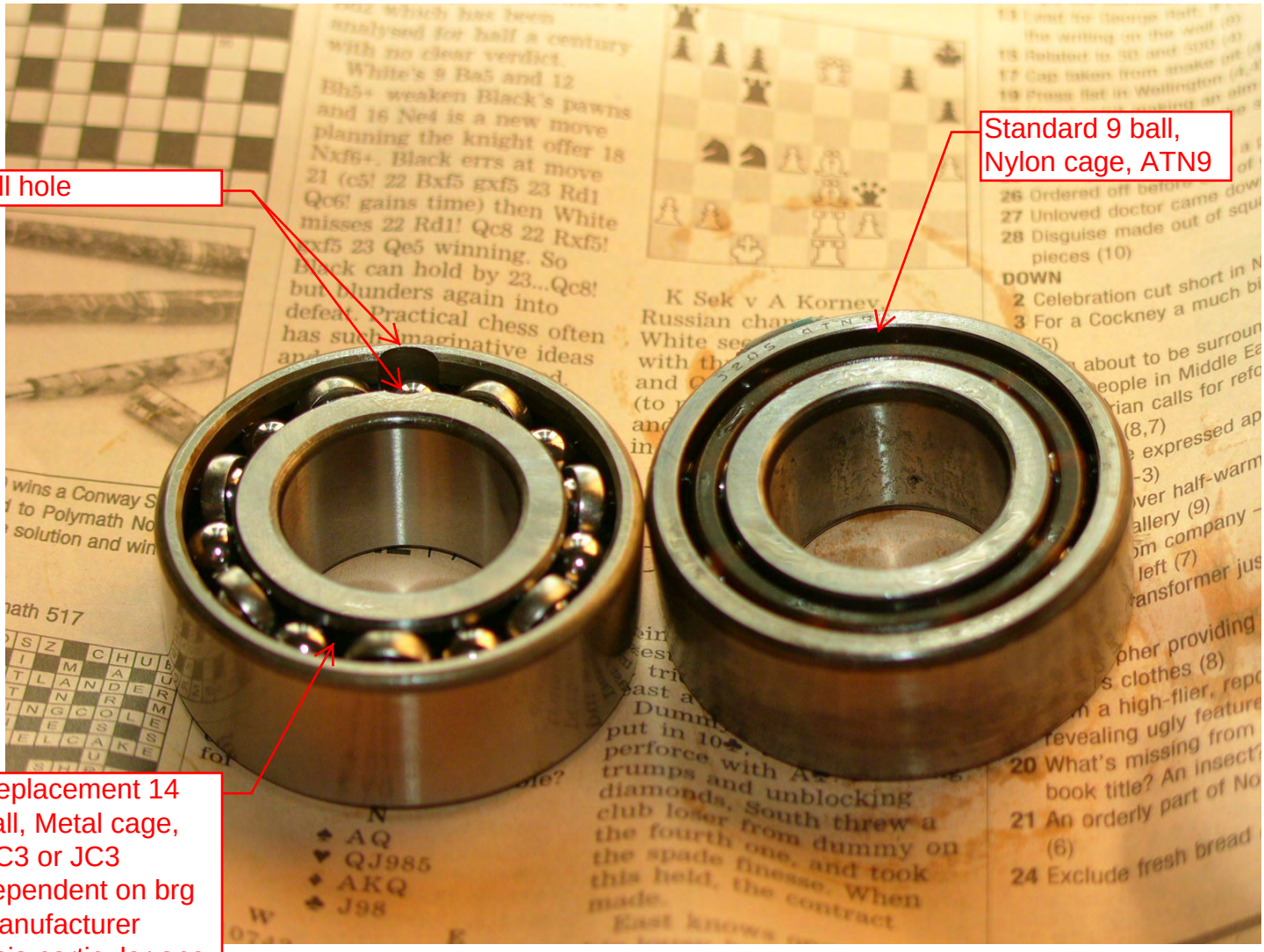
The old & new input & output bearing (the input & output use the same bearing types).

On the right the old double row nylon caged 9 ball standard bearing ATN9, on the left the replacement 14 ball AC3 (or JC3) all metal replacement.

The standard recommendation is the AC3 only needs to be used on the output shaft (the one in the endcase).

There was also debate regarding synthetic oils attacking the nylon cages, however the consensus is that the box does not run hot enough for this to be an issue.

I replaced both of mine as both had some roughness. Note the thinner wall on the AC3 & the fill hole on the bearing at 12 O'clock. The fill hole is used to insert the balls into the bearing during its assembly, due to the increased number of balls. It is preferable that this hole is installed on the side of the bearing that will "see" less thrust. This means that the fill holes should be installed facing into the casings. The input should have the fill hole facing towards the clutch and the output fill hole facing towards the rear wheel.

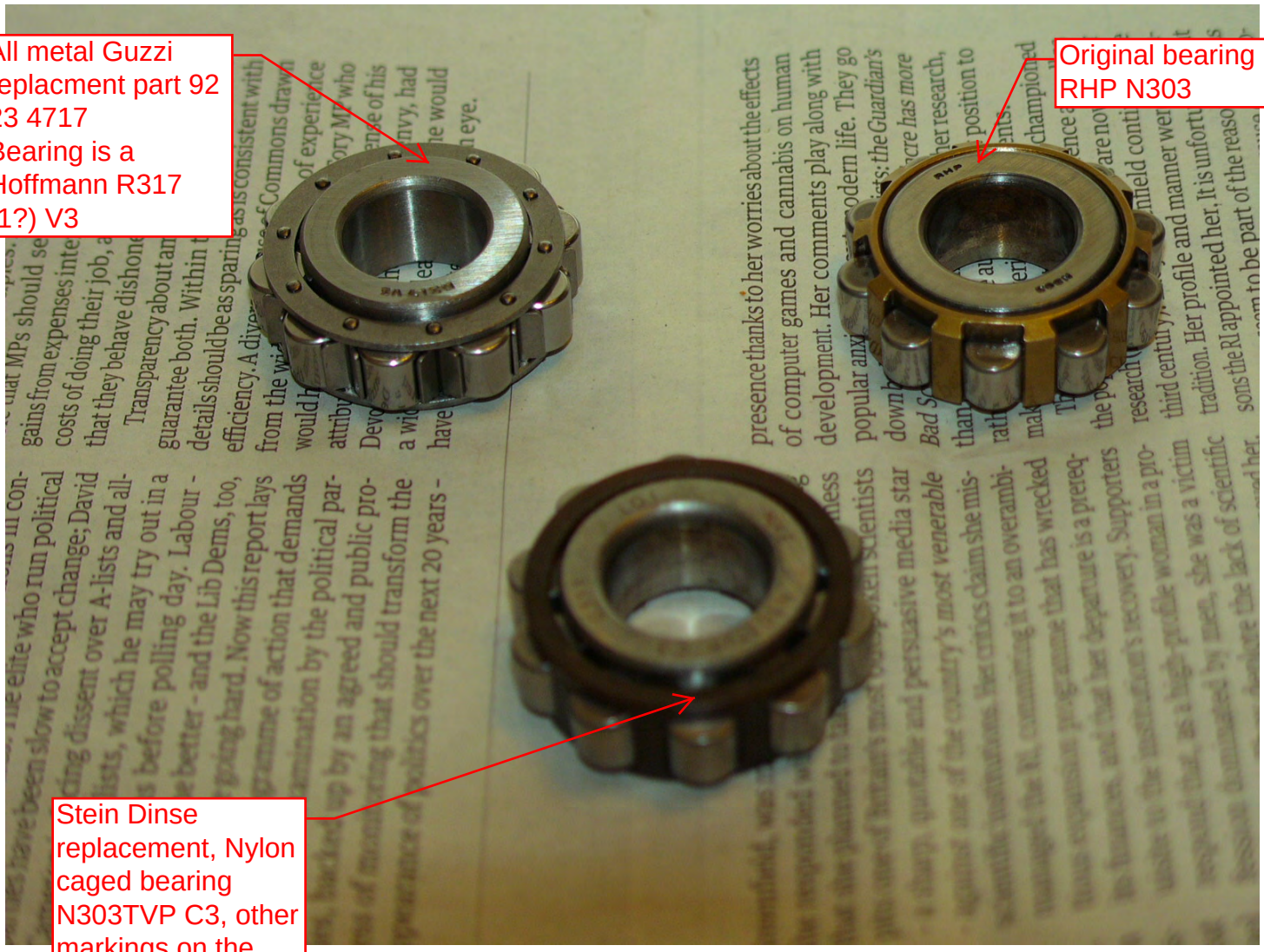


A tale of 3 bearings, the layshaft gearbox case end (inboard) support bearing. The picture shows the 3 I ended up with.

The original bearing, top right, has what looks like a bronze cage. This bearing is all metal but of a smaller diameter than either of the available replacements, being approximately 39mm diameter excluding the race.

The new bearings are 40mm diameter and the rollers are looser in their cages, the Stein Dinse noticeably so. I had ordered the SD item as a replacement but did not realise it was nylon caged. After going to all the trouble of eliminating the Nylon input and output bearings I bought the third original Guzzi item which is all metal & a lot more expensive than the SD item. All bearings had 10 rollers, the new ones with a 3 designation.

Although not certain I think these are equivalents of the AC3 designations on the SKF bearings. This designation denotes increased clearances within the bearing and is used where the bearings are expected to get hot and rotate continuously at high speed. As an aside bearing manufacturers recommend you do not use AC3 bearings unless required.



PUTTING IT BACK TOGETHER

I'm not sure if this is the normal method or Guzzi method either. I had the box in bits a few times and found this the easiest way to put it together, it's not the only way for sure.

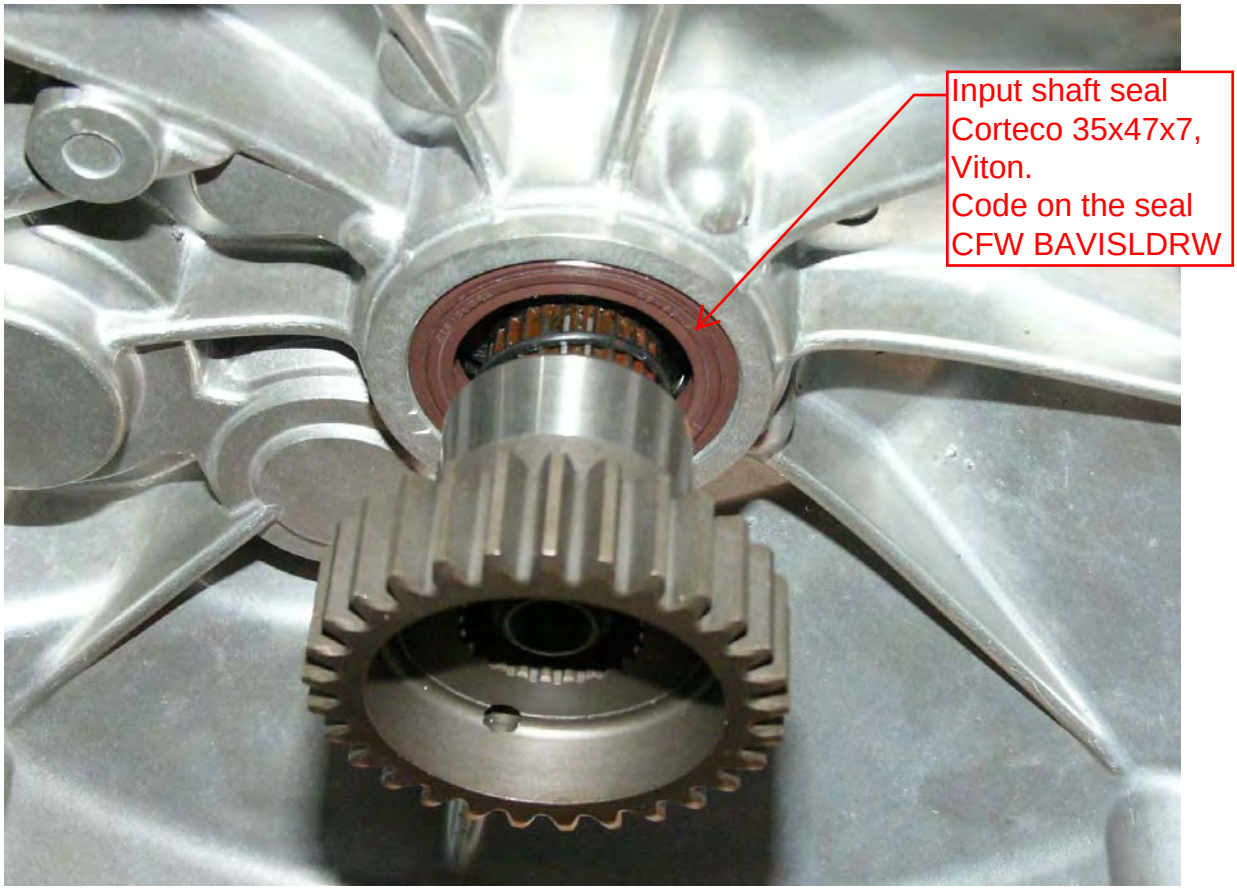
After having done whatever you needed to do inside the box, in my case, replace the endcase and gearcase bearings, replace seals and O rings and shimming to eliminate selector drum float.

A short note here on my experiences when shimming. How to shim the selector drum is covered in Pete Roper's excellent article and I recommend you get a copy and read it as well, it's on the Guzzitech DK site. It also covers how the box operates, disassembly and reassembly. It's best the shimming is done without the oil seals if you're replacing with new. New seals place drag on the shafts making them harder to turn and might give you a false impression on how the box is operating, it also reduces the chance of damaging the seals. Also when checking the box ensure the components are lubricated, obvious I know, but stiction from lack of lube can make the change feel bad or even jam. Gearbox oil is ideal but I just used WD 40 and lithium grease as the gearbox oil would have been too messy.

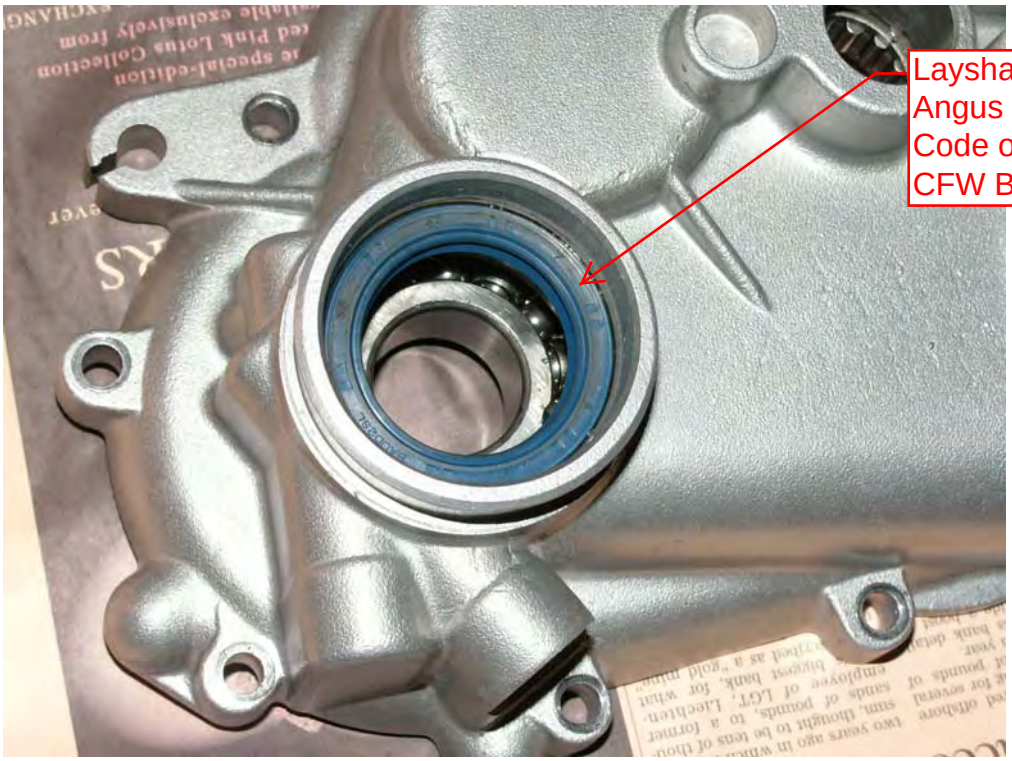
One stupid thing I did was get the shims mixed up. Not enough to stop the selector drum turning but enough to put just a bit of drag on the drum, this stopped the box selecting properly. So when shimming the drum up ensure it turns completely freely with no drag or stiffness. In the end on mine there was still a little free play without the gasket, approximately 2 thou, but I felt that was preferable to having the drum drag in the casings.

Ok assembly, starting with oil seals, there is 1 for the input and 1 for the output shaft. The new input seal is a Viton type, brown in colour. Viton seals can withstand higher temperatures, I assume this is because of radiant heat from the engine passing into the clutch chest and also passing along the shafts. To install seals use a seal installation tool if you have one. I didn't and used a socket that fitted as neatly into the hole as possible and as close to the edge of the seal as possible. I used the end of the socket that fits onto the drive towards the seal and with a piece of wood across the open end tapped that with a mallet checking the seal went in straight. I used Loctite 641 as the seals fitted easily and I wanted to eliminate the possibility of creep.

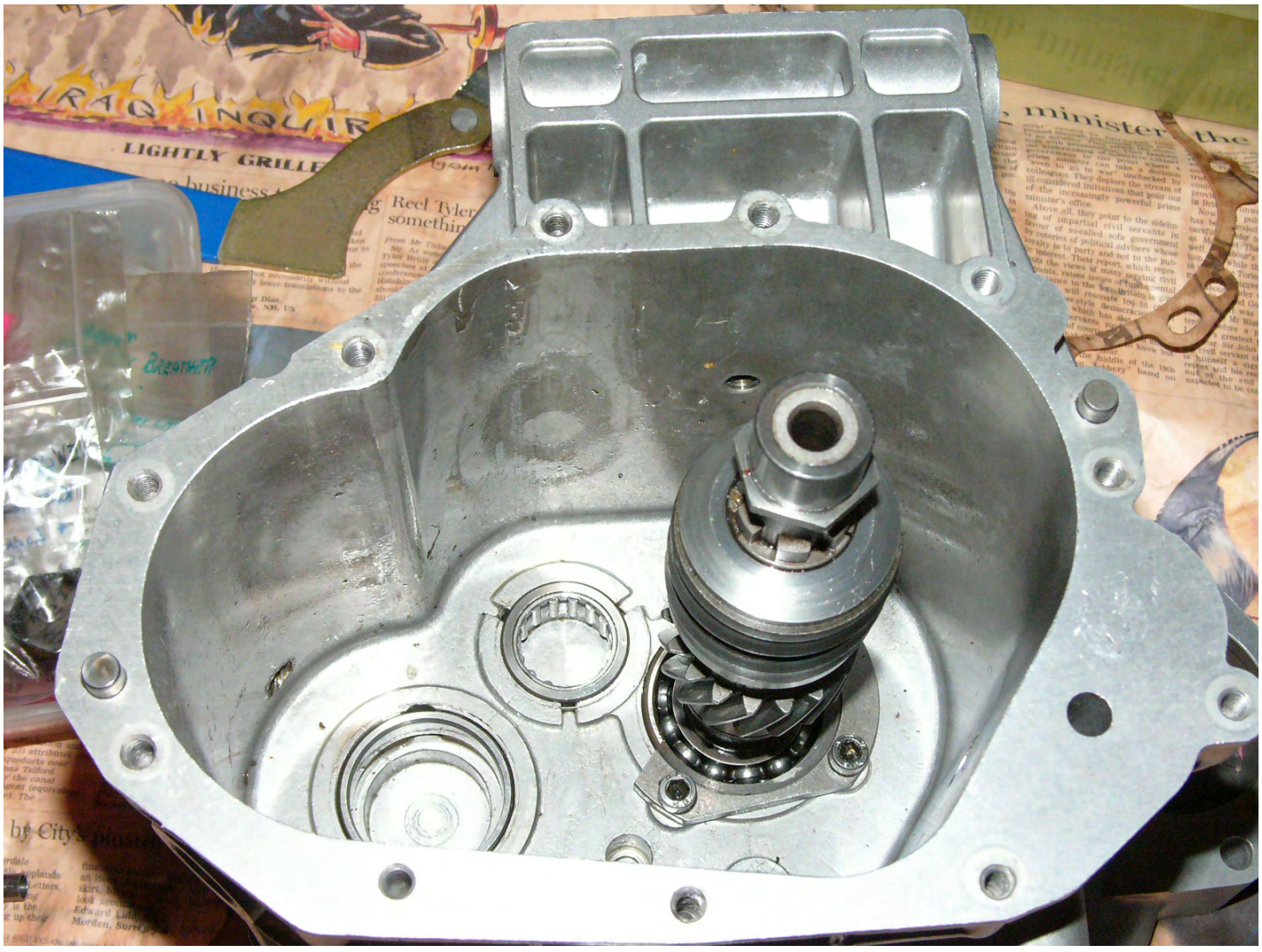
The seal on the input is tapped down till it's clear of the tapered section, not all the way down.



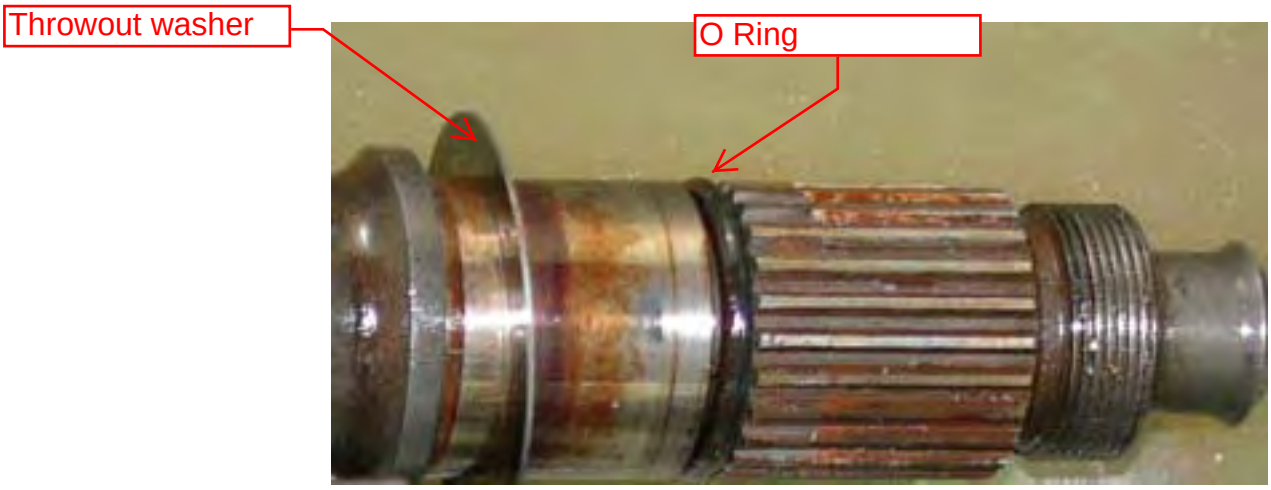
The output has to tapped all the way down until it seats against the stepped recess inside the endcase.



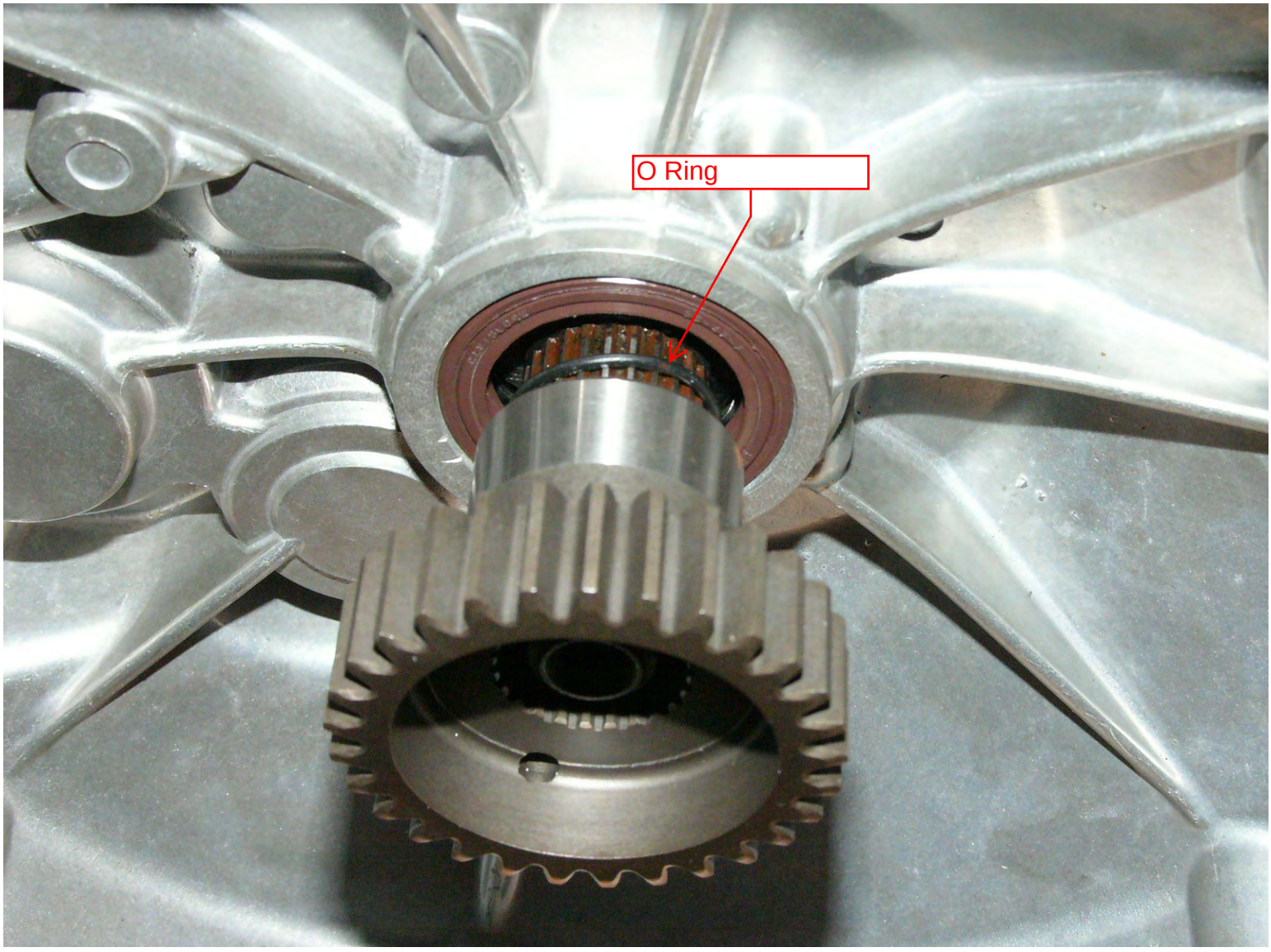
Now for assembly first with the gearcase bell housing down, insert the clutch (input) shaft.



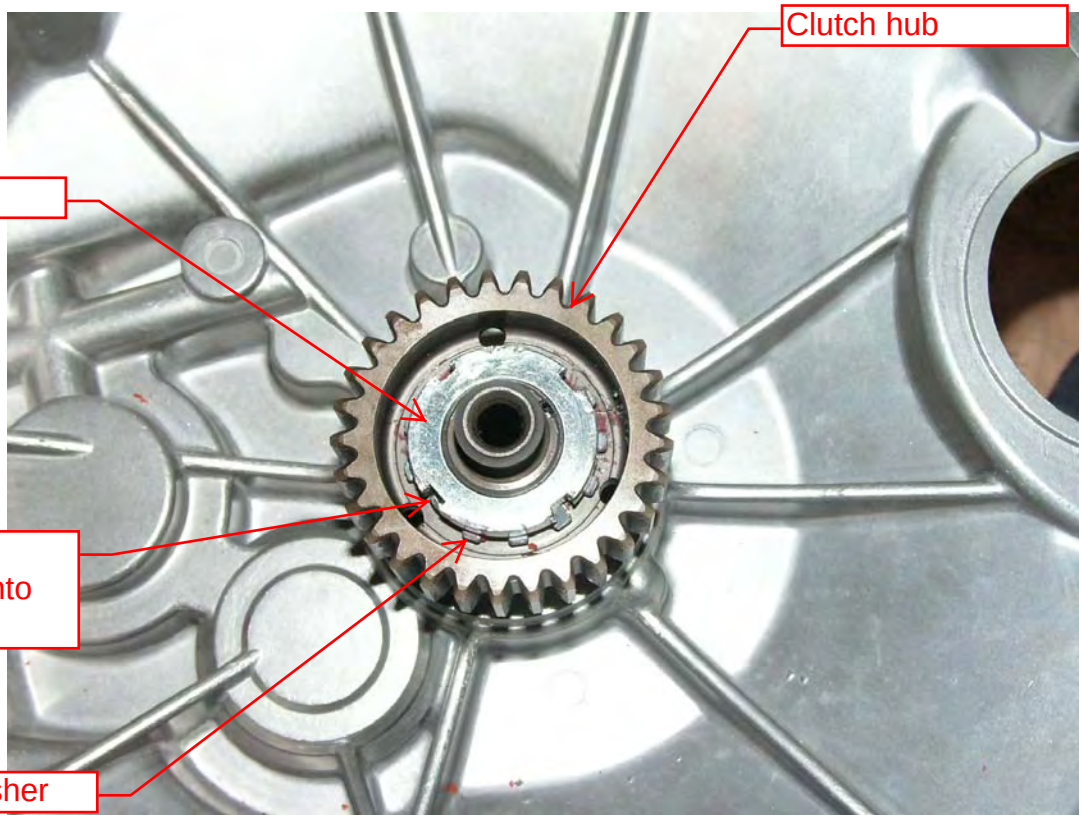
There are 2 O rings first the one on the shaft & remember the throwout washer for the bearing which sits against the shank on the shaft inside the gearcase.



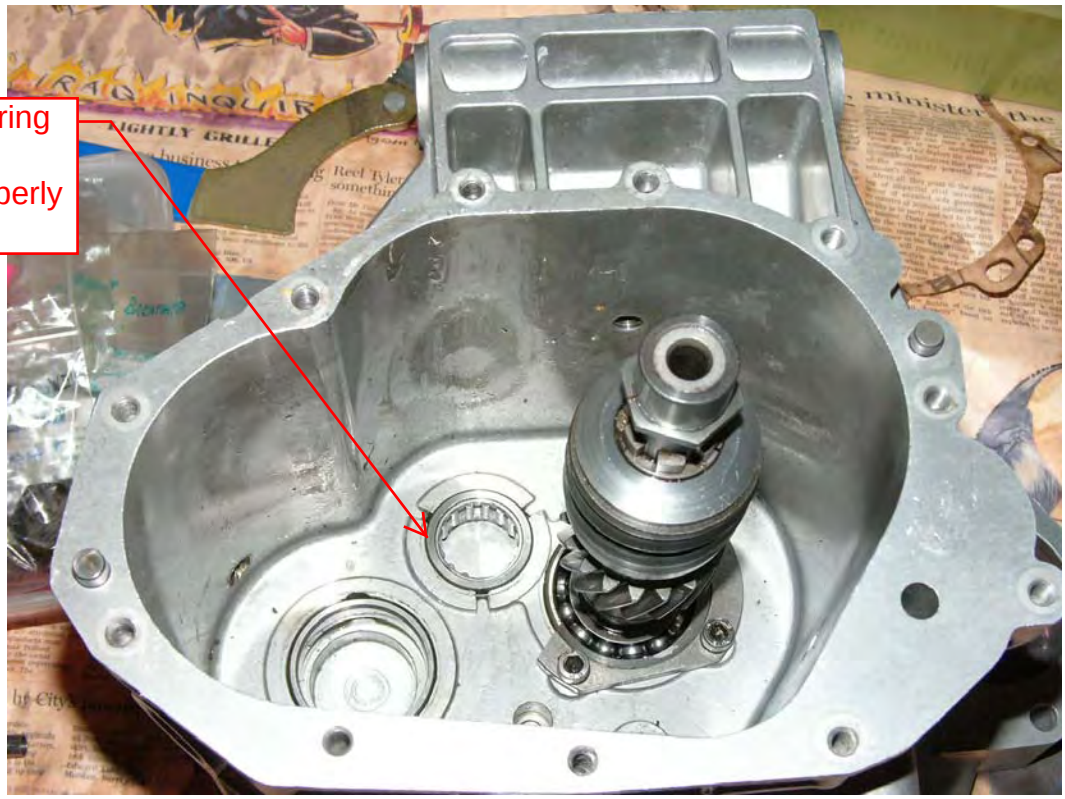
Holding the shaft in position put the gearcase on its side and insert the thin O ring that goes on before the clutch hub.



Push the hub on and install the finger type lock washer. This has a tab on the inside diameter that mates into a slot on the shaft. Install the peg nut, I did not find a torque setting in the manual, so I done it up with a rattle gun so it would be tight. Finally knock down the tab that aligns with the gap on the peg nut. Only one tag will line up with one slot correctly.

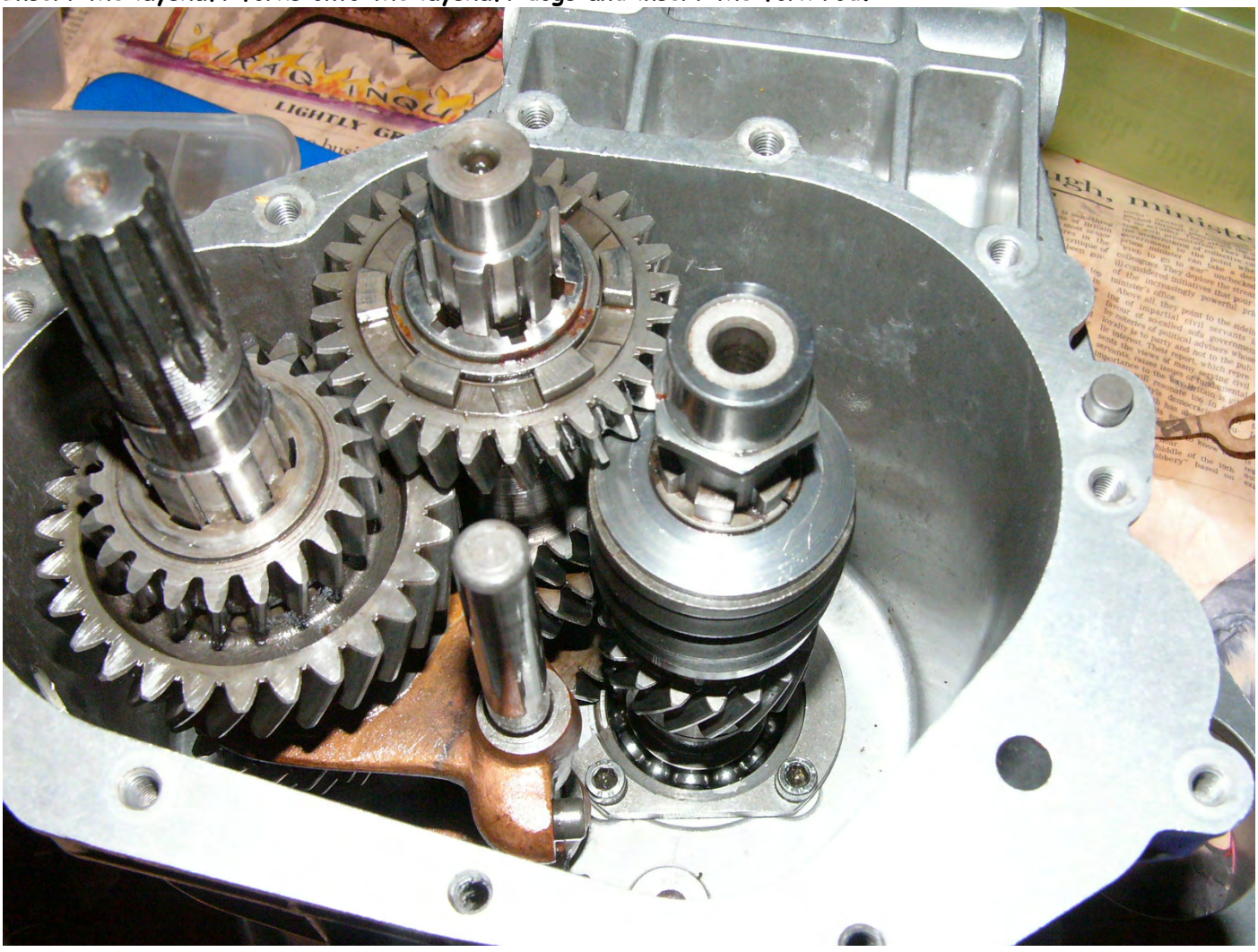


Turn the box back over bellhousing down check all the needle rollers on the mainshaft bearing in the box are in place and insert the mainshaft, the 5th gear dog doesn't need to be on the shaft. The shim and thrust bearing mentioned earlier can be held on the shaft with some grease, or placed into the box first. The shaft should just drop in with a bit of wiggling, if it's reluctant take it out to ascertain why, any bashing will probably damage the cage that retains the rollers in the bearing in the case and they may drop out, the consequences would not be good.



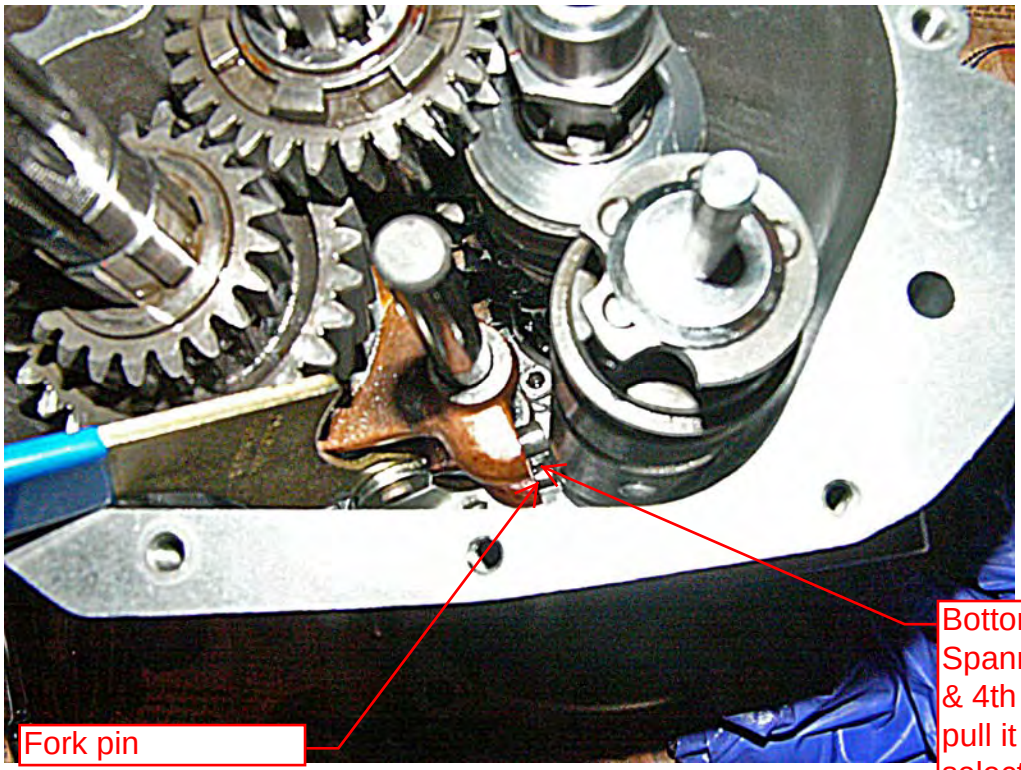
Next insert the layshaft, it may be necessary to lift the mainshaft a little and turn it until you get the layshaft in the box. After it's actually in the case, some more wiggling, lifting and partial turning may be required to get the layshaft into its bearing race. The long spline that the speedo locking ball sits in (later in the assembly) can also be clearly seen in this picture.

Insert the layshaft forks onto the layshaft dogs and insert the fork rod.

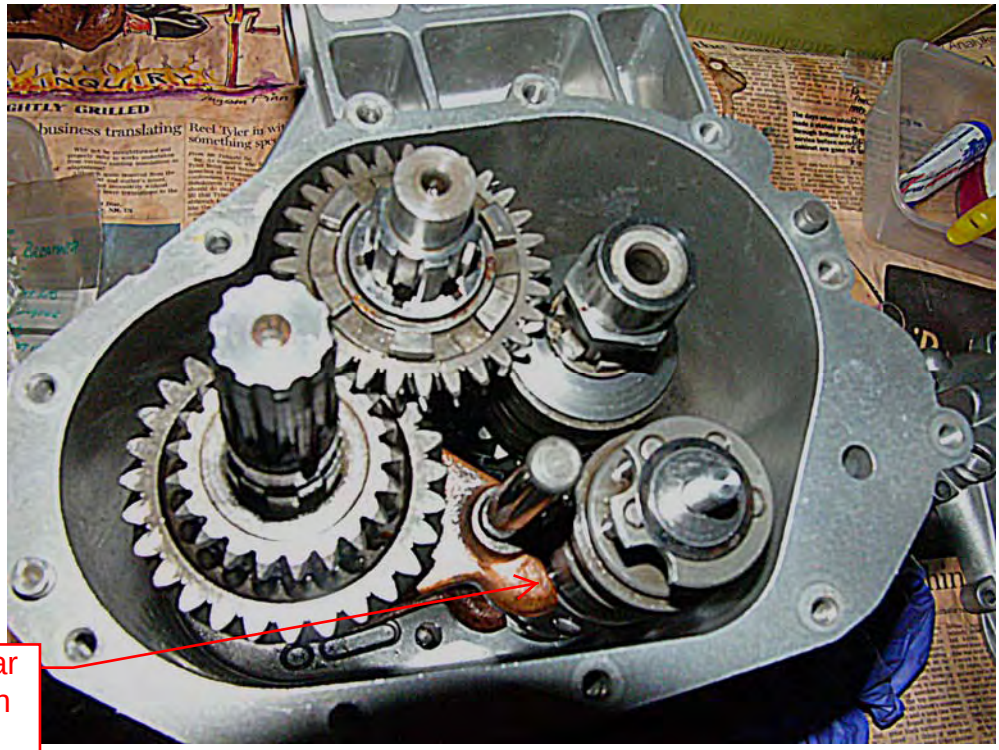


Insert the selector drum, remember the shim on the base, it's best to put a bit of grease on it to hold it in place and insert the drum rod, don't try and place it in the hole in the case just place it in next to the selector forks. The first thing is to try and get the fork pins into the drum slots. The reason for putting in the rod in is that as you move the drum to get the rod into the hole later, the rod drags the base shim with it.

Make sure the drum has the slots opposite the fork pins, then push the drum against the pins. Using some sort of hook, I used an adjustable C spanner that fitted, but a hook made from a wire coat hanger would work even better. Pull the bottom fork up until it slots into the drum, you'll probably need to hold the drum against the fork.



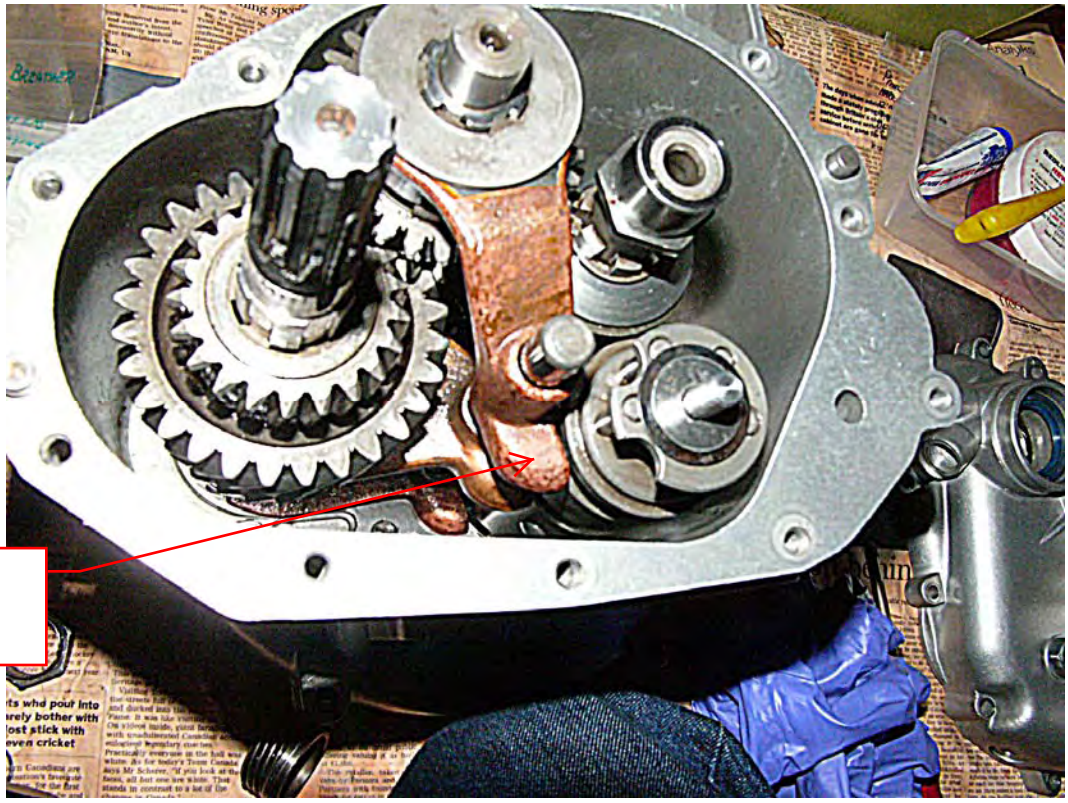
Next lift the top fork with your finger and insert it into its drum slot.



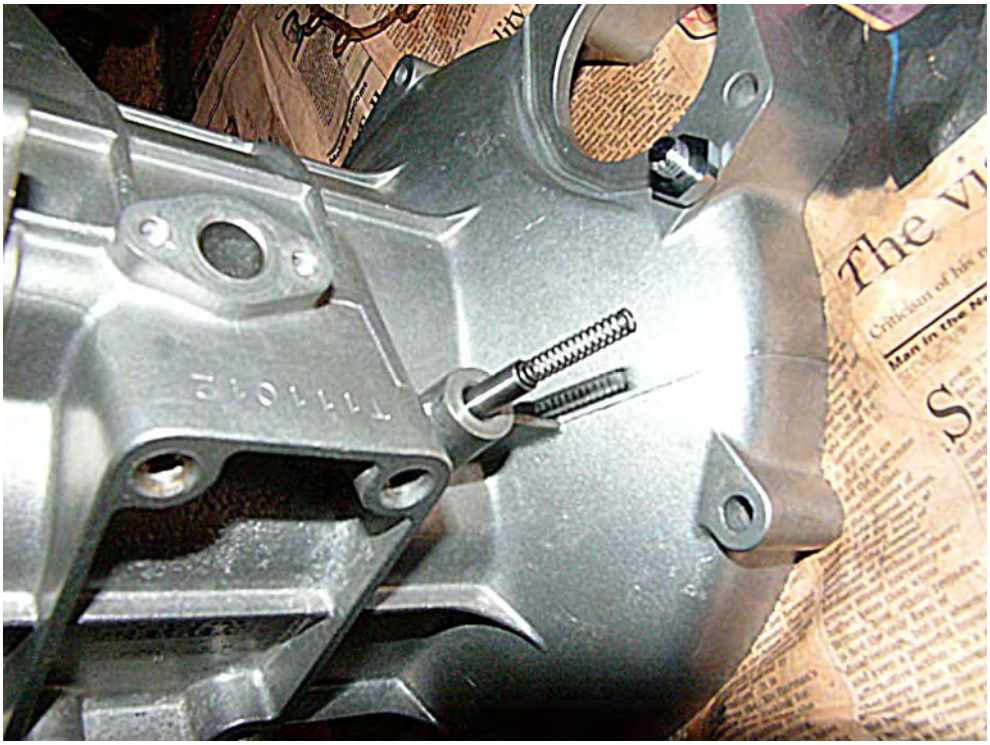
Now carefully remove the drum rod without disturbing the drum and shine a light down the hole, from that you should see how far out the drum hole is out from the hole in the gearcase it slots into. It will be very close. Note which direction to move the drum, reinsert the rod move the drum in the desired direction and presto the rod can be pressed in. Remember the washer to hold in the pins on the top of the selector drum and the top shim or shims and it should pretty much look like the preceding picture.

Next is to insert the 5th gear dog and selector fork. Place the dog over mainshaft, dogs downwards, and insert the fork. The fork pin will foul on the top of the drum as shown.

Lift the drum rod just until it clears the locating hole in the gearcase then angle the drum out until the fork pin clears the drum and moves into its slot on the drum, also making sure the dogs engage with 5th gear on the mainshaft. Then push the drum rod back down into the locating hole in the case.



Install the detent.

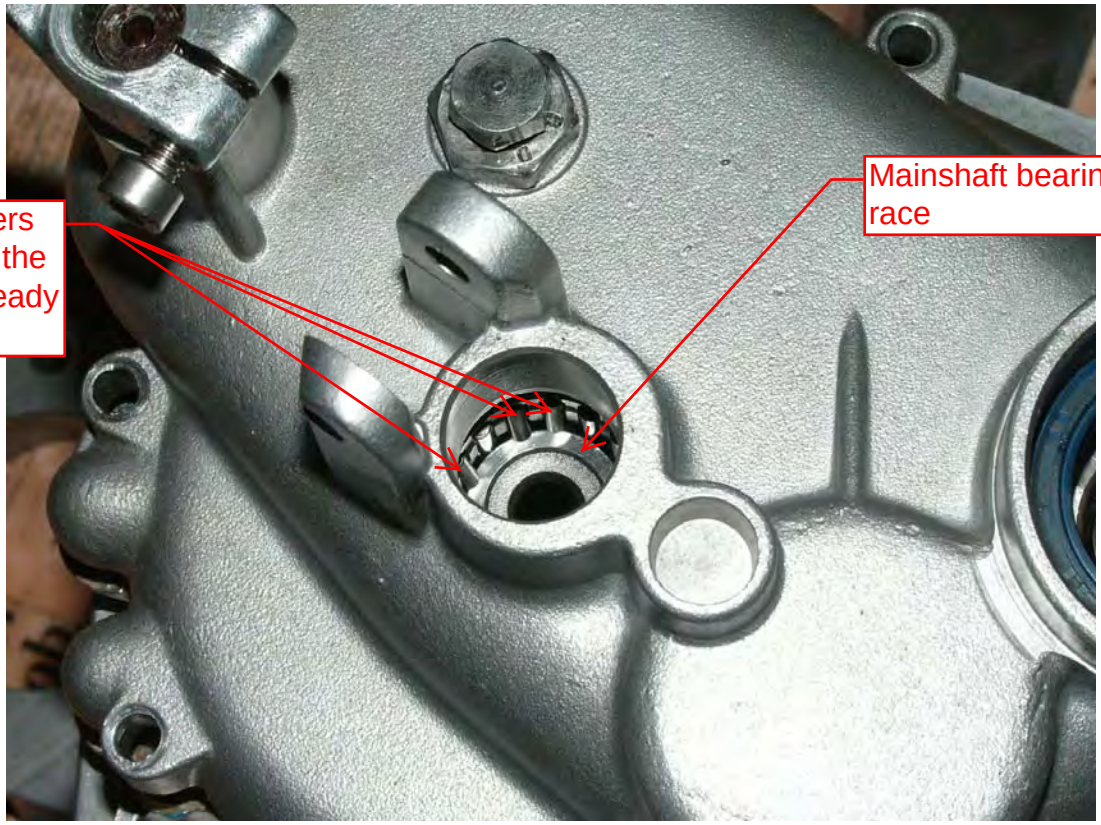


Remember the crush washer.

Turn the selector drum until you are in neutral. To do this you may have to lift the layshaft marginally just enough to take the weight off it and lift it off the gearbox case where it's resting. Then gradually turn the shafts as you turn the selector drum until you get into neutral.

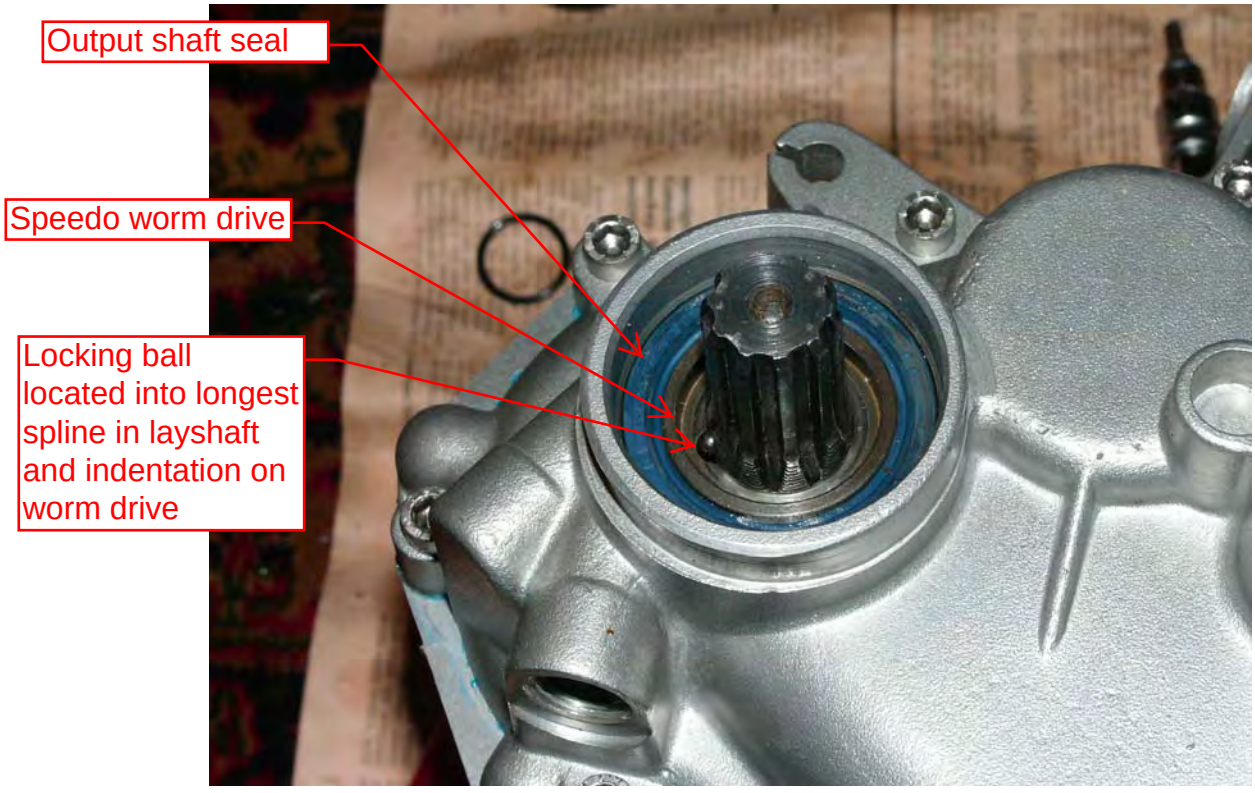
Place the gasket on the case, oil the gasket, or whatever your particular preference is when fitting gaskets, I like Hylomar but it's not really necessary in this case. Place the end case over the shafts and align it using the dowels and screw holes as a guide.

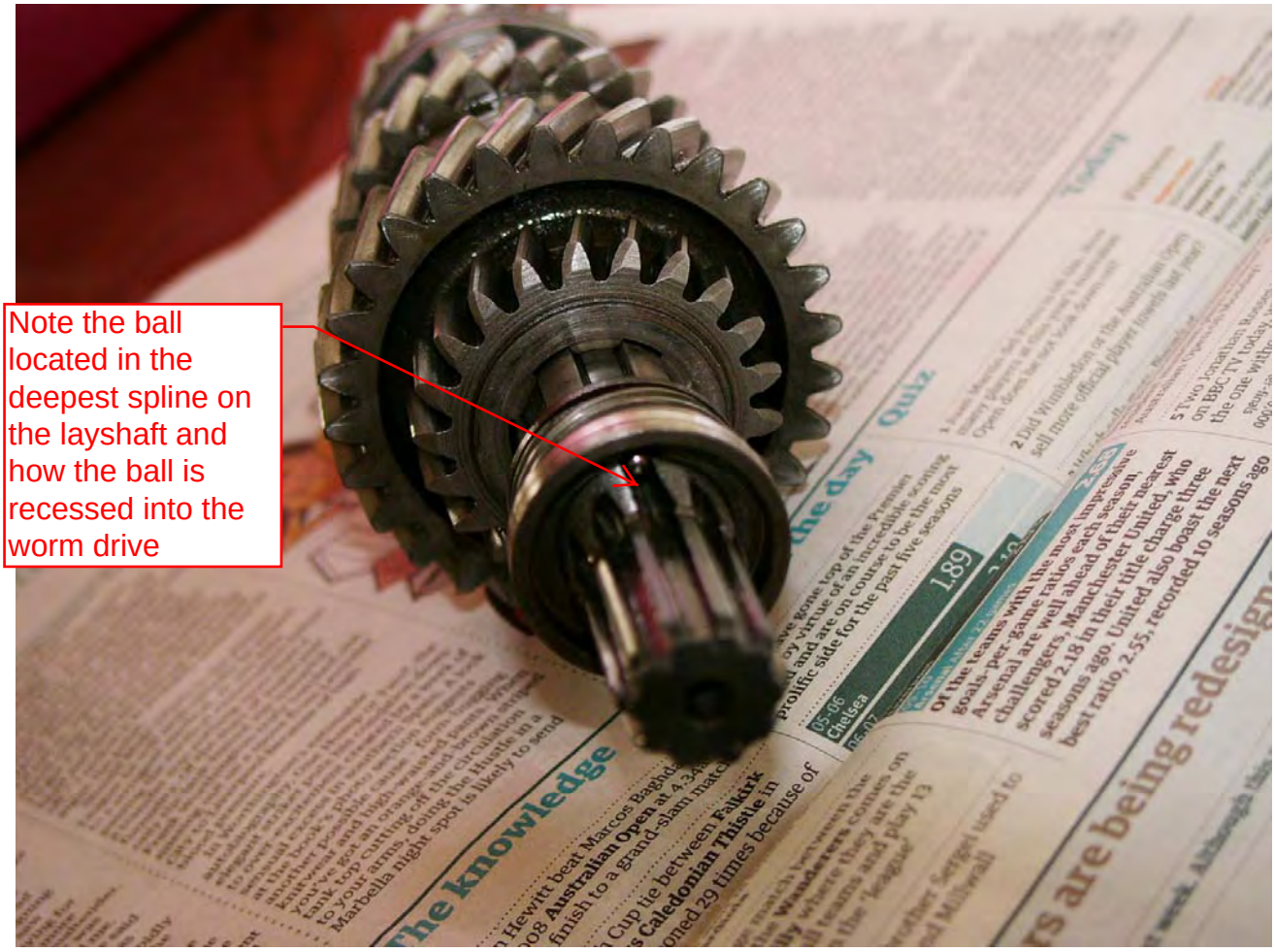
After the endcase is placed on the gearcase check the mainshaft rollers in the bearing. It may be necessary to seat the rollers onto the mainshaft bearing race. If they are proud run your finger around the rollers so they pop into the race. On the photo on the top you can see some of the rollers sitting proud fouling the race edge and below that the rollers seated into the race. If you don't do this the rollers will jump out, possibly into the box, definitely not a good thing and the bearing cage damaged when you seat the endcase.



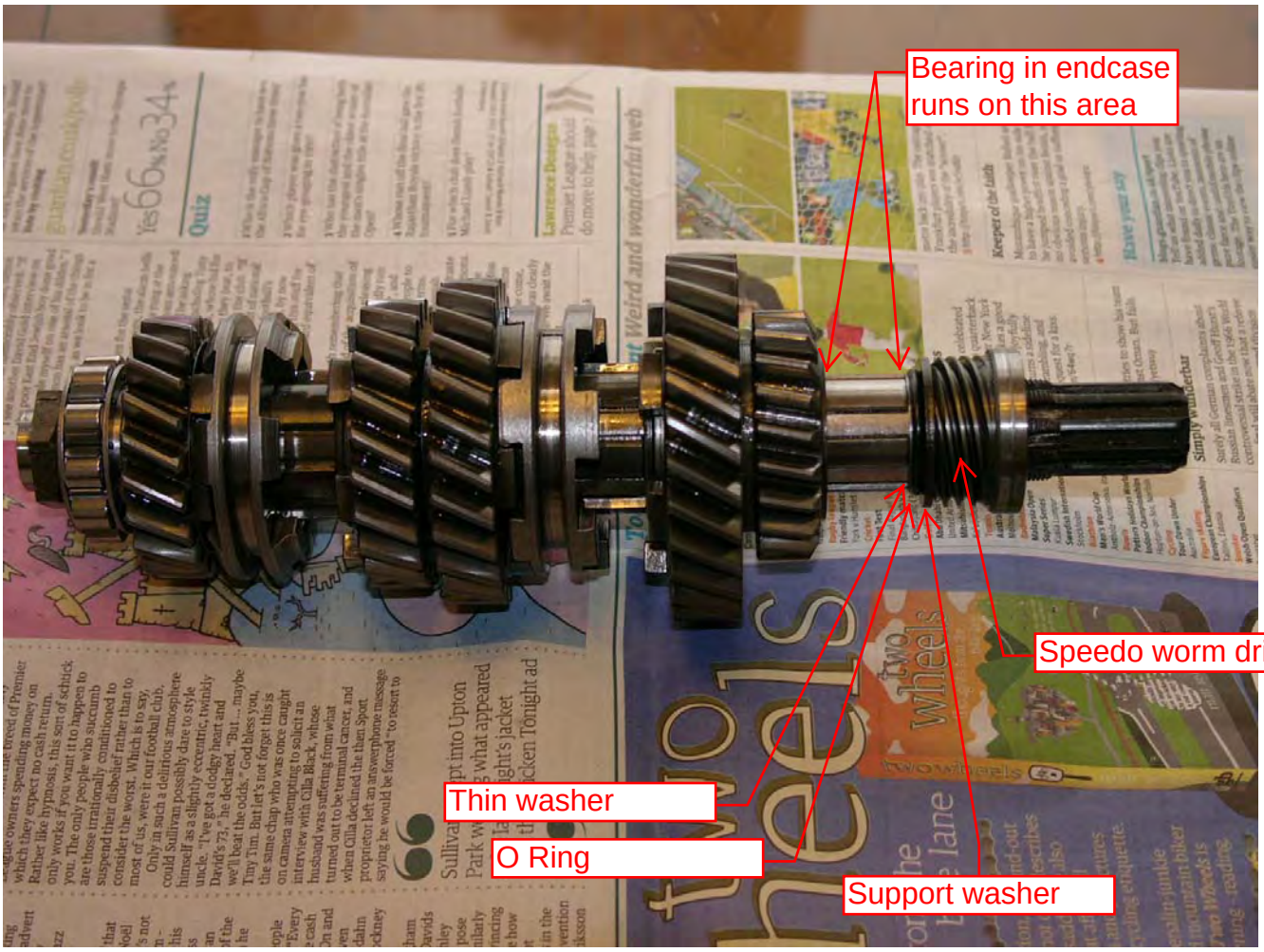
Tap down the end case, start at the mainshaft bearing shown above using a soft or plastic mallet. Tap all around the case and make sure it's lined up using the screw holes and dowels as guides. It should go down reasonably easily you may have to tap a bit more around the case at the layshaft, but not on it. Keep your eye on the gear selector area, if it refuses to seat check the box is in neutral. If it does not go down, lift the case up and just taking the weight of the layshaft tap on it to free it from it's bearing and the case should lift off. Check to see what the problem is and then refit the case. When the case is down install all the cap screws. The cap screws are all the same length with the exception of one which is slightly longer and fits into the hole that is behind the speedo drive hole.

Place the narrow washer, the O ring, the support washer and the speedo worm drive onto the layshaft and push them home. The cutout on the inside of the speedo worm needs to align with the longest spline on the layshaft to allow the locking ball to fit correctly. These are shown in the following photographs.

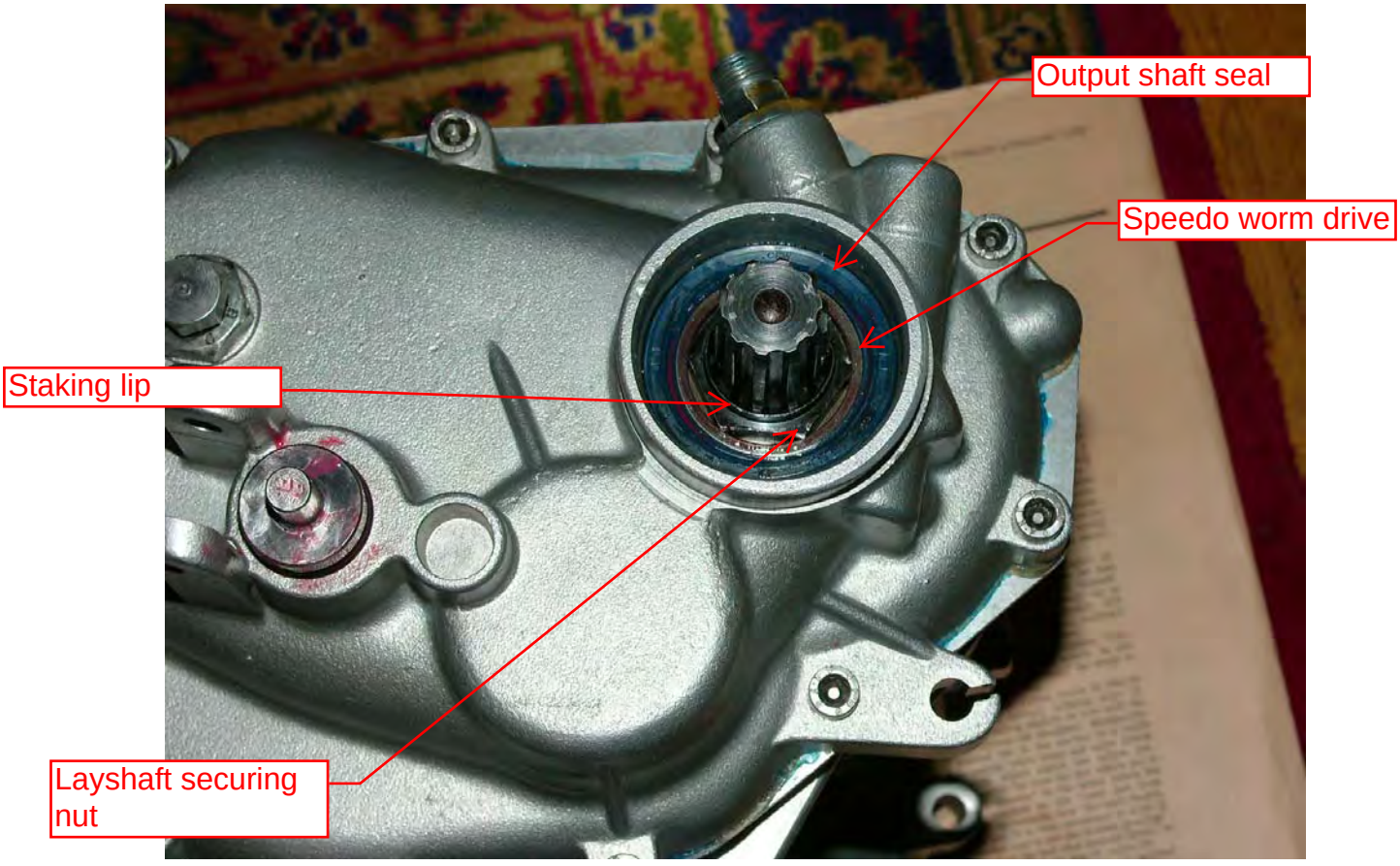



Note the ball located in the deepest spline on the layshaft and how the ball is recessed into the worm drive


Thin washer
O ring
Support washer
Locking ball
Speedo worm drive



Install the output nut, Guzzi quote a torque of 16-18 kg-m (115-130 ft-lbs), once more I whizzed mine up with the rattle gun. Lock the nut in place by making an indentation on the stake nut lip into one of the shaft splines, make sure you don't crack it, use something blunt to make the indentation.



Change the box up down as a final check that all is well and the shafts both turn freely. Some fine tuning of the change can be also be achieved with the pawl adjuster. If the box has been shimmed then you will probably have done this already.

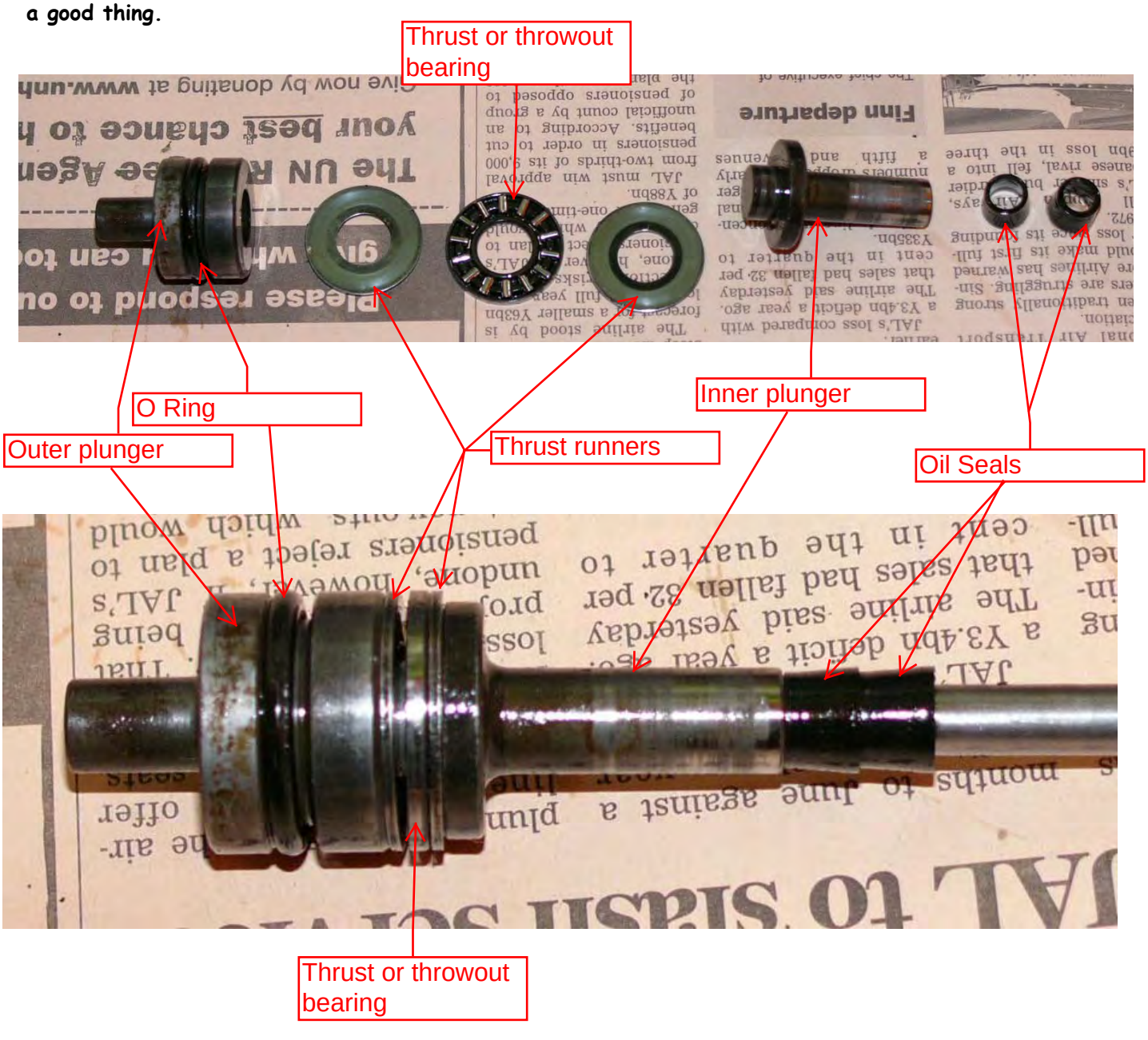
Nearly finished, just the ancillary stuff which can be done in almost any particular order.

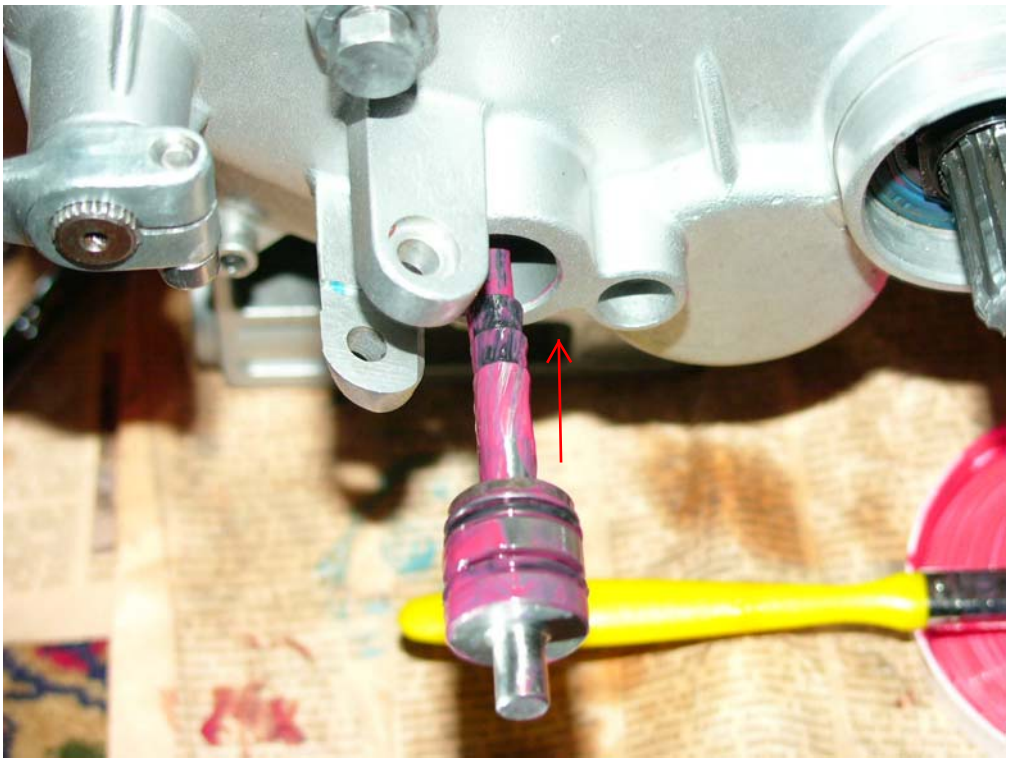
Speedo drive, insert the lower washer and make sure it sits on the base and doesn't foul on the speedo worm drive. Drop in the gear and seat it, remember the top washer, followed by screwing in the external housing on to the endcase. See my comments on page 5 make sure after it's all tightened up the layshaft still spins freely.

Clutch pushrod, push 2 conical oil seals (or O rings if you have purchased them refer to Pages 6 & 7) onto the end of the pushrod (doesn't matter which end it's interchangeable) the narrow end of the seals go nearer the end of the pushrod, then push on the rod onto the inner plunger. On the other end of the plunger place on the thrust runner, the throwout bearing, the other thrust runner and the outer plunger. Make sure the O ring is on the outer body plunger. You'll probably have to hold it all together with your fingers. Push the whole assembly through the hole in the mainshaft in the gearbox endcase.

These photographs are from the strip. The throwout bearing and its runners were replaced with new items

I put some assembly lube on the whole lot but WRONGLY got it on the pushrod upstream of the seals. That should not have any lube on it as it could move up the rod and contaminate the clutch, which is not a good thing.

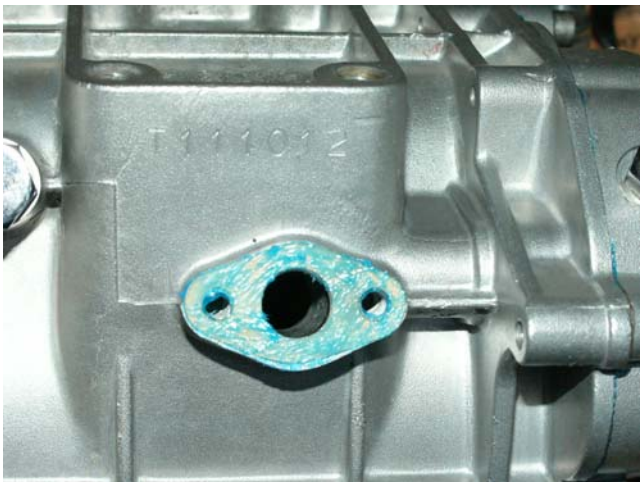




After that place on the clutch arm, drop in the pivot pin from the top, put the washer on the bottom and holding it in place push in a cotter (aka split) pin through the hole and bend the ends around the pin. Although I don't cover fitting or checks once the box is back in the frame, a word of advice. The pin on the clutch arm that strikes the pushrod is adjustable with a screw and locknut. When the clutch cable is in place and adjusted make sure there is a small gap between the striker, on the arm and the pushrod, in the endcase approx 0.5 to 1mm. If this is not done the arm will load the rod and may result in the throwout bearing failing.

Install the gearchange linkage on the splines, which you matchmarked at the beginning Right?

Place a new gasket on the neutral switch hole and install the neutral switch, it goes in with the bent end facing downward. Pete Roper in his shimming article mentions that Guzziology recommends gasket sealant on this gasket as it's prone to weeping, the choice is yours, again I used Hylomar, it may not be necessary.



Screw in the oil breather and remember to install a crush washer below it.

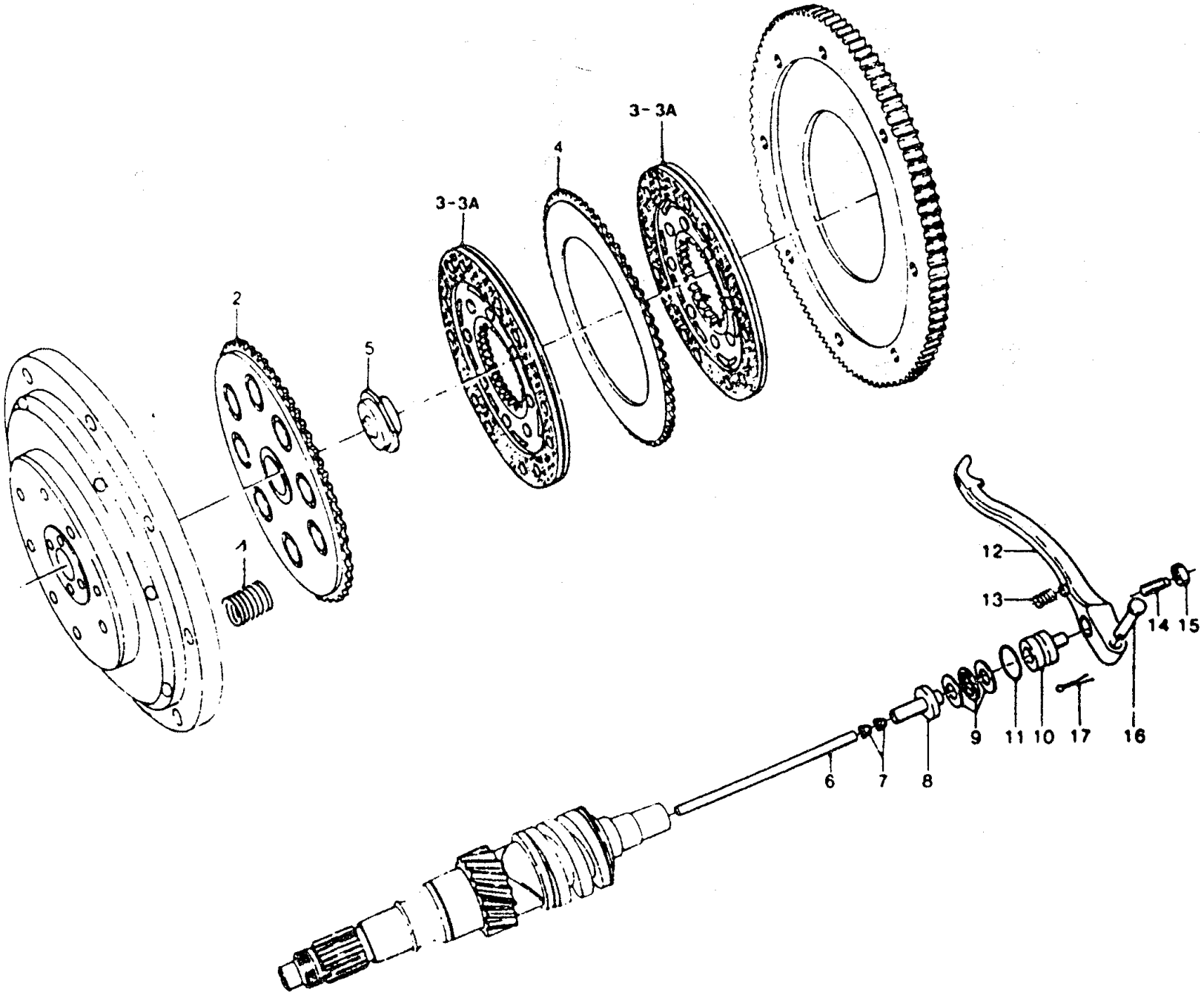
Make sure the drain plug and crush washer is in, it's up to you if you install the level plug or not at this point. Fill the box, some like to put in the factory requirement 0.75 litres, I prefer to fill the box with whatever I am putting in and wait for the lube to start running out of the level hole, with the box level. As far as WHAT you put in that's up to you, you will probably have problems finding Guzzi's recommended lubricant, if you want advice just check any of the Guzzi forums they are awash with oil threads.

That's it, mine still changes slowly, but fairly cleanly and if I had taken more time on shimming it may have been better, it seems an improvement, but I'll not be sure until it's in the bike and that's a long away yet.

GLOSSARY

CLUTCH SHAFT	**Input shaft to the gearbox. Contains shock absorber spring & one gear which permanently drives third gear on the Mainshaft.**
DETENT	**Indexing plunger or pin. The plunger is forced onto the selector drum by a spring and mates into recesses on the selector drum. When the selector drum turns, through the action of changing gear, the plunger is forced out of the recess and drags along the drum until it slots into the next recess. The plunger and recess help ensure the selector drum indexes sequentially (one gear at a time) and remains positively locked until sufficient force through the action of changing gear is applied to turn it. Assembled externally into the gearbox and consists of plunger, spring and bolt.**
DOG CLUTCH	**Device for engaging or disengaging a component. The dog clutch uses an indented ring for the forks, which has rectangular tabs on the outside (the dogs). These tabs mate with similarly shaped slots on the component to be driven. It should be noted that a dog clutch can only positively engage or disengage a component, it cannot slip to allow a gradual component engagement as a friction clutch can.**
LAYSHAFT	**Output shaft of the gearbox. Contains 5 gears of differing sizes which mate to the Mainshaft providing the gear ratios. The Layshaft also contains 2 dog clutches which allow engagement/dis-engagement of 1^{st} and 2^{nd}, and 3^{rd} and 4^{th} gears respectively.**
MAINSHAFT	**Centre shaft, internal to and floating in, the gearbox, driven off the Clutchshaft Contains 5 gears of differing sizes which drive mating gears on the Layshaft. The different sizes of gears which mate on the Mainshaft and Layshaft provide the different gear ratios in the gearbox. The Mainshaft also includes the dog clutch for 5^{th} gear allowing it to be enganged/dis-engaged.**
OIL SEAL	**Component which allows a rotating shaft to pass through a stationary component or casing but prevents matter passing from one section to the other. The contaminants may be solid, like dust, or liquid like lubricants. Oil seals are usually either rubber or some composite Buna, Viton etc: and have various types of lip or lips that run on the shaft. Larger seals have a metal ring on their outer to maintain rigidity.**
PAWL	**Mechanism which allows a positive indexed movement in one direction. The box contains 2 pawls on the gear selector mechanism (up and down) on the endcase. These ratchet type devices hook into pins on the selector drum and turn the drum a given number of degrees, clockwise or anticlockwise as required. This helps select one gear at a time. When one pawl is operating by pushing on the selector drum pins to force the drum around, the other pawl slides over another drum pin by virtue of its shape and the spring loaded mounting. After the gear has been selected the non active pawl springs back into position in order to be available for any given gear selection.**
PAWL ADJUSTER	**An eccentric pin welded to a bolt which sits in the gearbox endcase. As the adjuster is turned it does 2 things, first it moves the pawl mechanism from side to side, due to the pin being eccentric; secondly it moves the pawl mechanism deeper or shallower along the drum pins on the selector drum. Using these 2 actions the pawls and the drum pins can be fine tuned to allow the correct indexing of the selector drum by the pawls in either direction (changing up or down). The pawl**

	adjuster also has a lip on the end, this holds the end of the gearbox return spring in position and helps prevent it sliding off the adjuster.
PUSHROD	Self-explanatory, a rod which transmits force from one area to another i.e. a rod that pushes. In the gearbox it is used to transmit, the movement of the cable actuating mechanism for the clutch on the output casing of the gearbox, through the gearbox to the clutch which is on the input side of the box.
RACE	Solid outer or inner collar of a bearing on which the bearing runs. A bearing allows 2 components to run at different speeds, including stationary. The bearing with the balls, rollers etc: sits on one component the solid race on the other.
SELECTOR DRUM	Cylindrical drum with 4 pins circumferentially spaced on the top, 3 separate slots of differing shapes at different depths around its circumference and 6 indentations circumferentially arranged at the same depth near its base. The pins are turned by the action of pawls in the desired direction. The slots are shaped in such a way to move the 3 selector forks in a specific sequence to move the dogs to engage and disengage the relevant gears as the drum turns a specific number of degrees. The indentations operate with the detent plunger to assist the drum to turn one gear at a time and be positively held until the next gear is selected. The selector drum is the choreographer or conductor in the box ensuring everything operates in the appropriate direction at the appropriate time.
SELECTOR FORK	Components which transmit the requested movement from the selector drum to the dog clutches mounted on the main and layshaft. The forks are moved by short pins which are mounted into slots on the drum. The forks have a pitchfork (2 pronged) shape at the other end. These prongs mate onto the slot cut into the circumference of the dog clutch and move them back and forward as required.
SHIM	A piece or pieces of metal of specific thickness. The purpose of a shim or shims is to achieve a specific dimension for a component or assembly by adding or removing shims to achieve that dimension. In other words a spacer. In the case of the gearbox, the most common item to be shimmed is the selector drum. Discs of varying thicknesses can be added or removed to the top and bottom of the drum in order achieve the correct positioning and gap in the casing. This allows the forks to operate optimally on the selector drum slots.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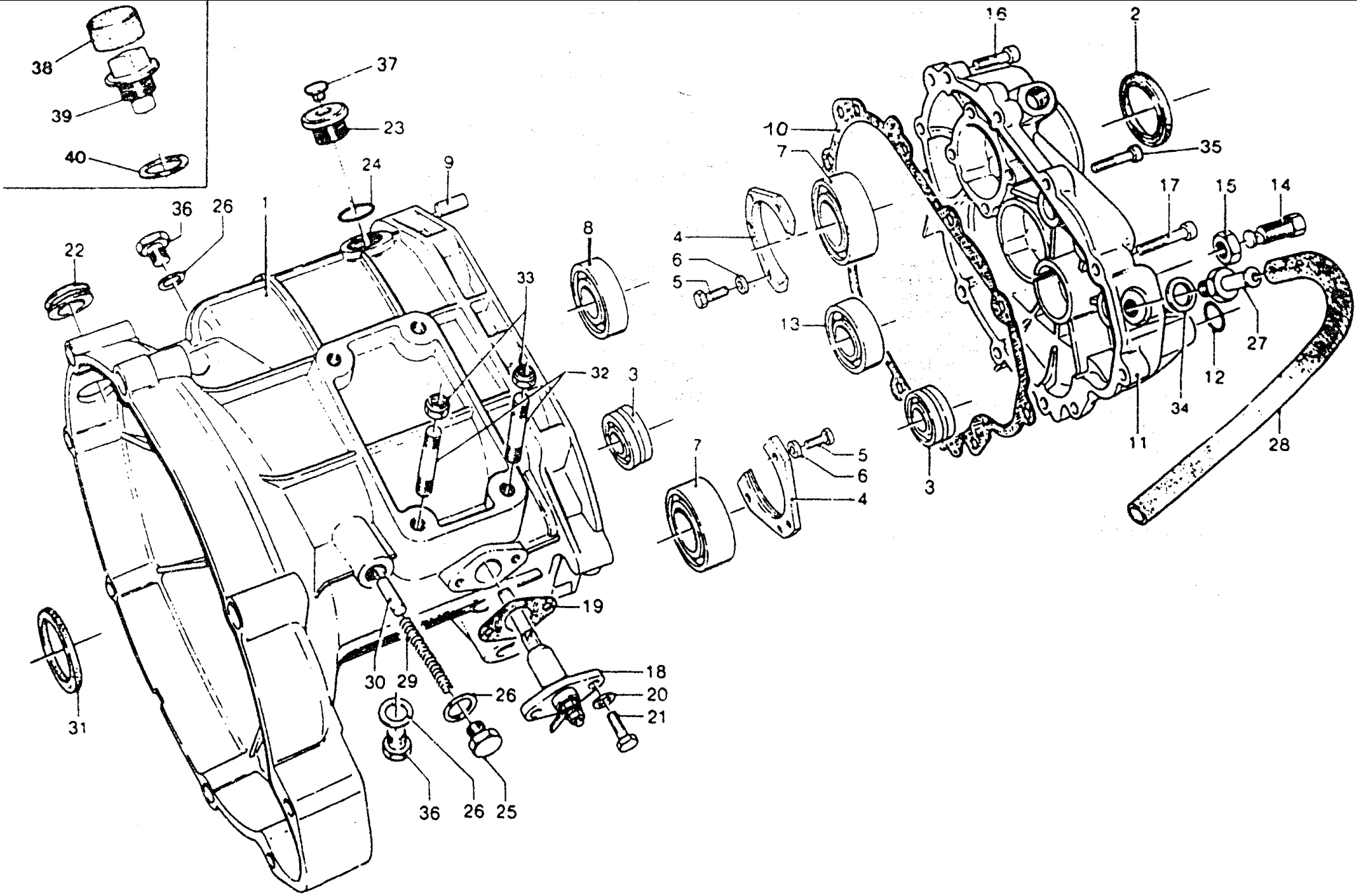
EMBRAYAGE CLUTCH					EMBRAYAGE KUPPLUNG	Tavola - Drawing Table - Bild	9
NOTE	N°	REFERENCE	QTY	DENOMINAZIONE	DESCRIPTION	DÉSIGNATION	BEZEICHNUNG
	1	13 08 41 00	8	Molla per frizione	Spring	Ressort	Feder
	2	12 08 29 01	1	Piattello spingimolle	Pressure plate	Plateau de pression	Druckplatte
jusqu'à mot. VV 16374	*3	28 08 44 60	2	Disco frizione completo	Clutch plate. complete	Disque garni	Kupplungsscheibe kpl.
A partir mot. VV 16375	3A	29 08 44 50	2	Disco frizione completo	Clutch plate. complete	Disque garni	Kupplungsscheibe kpl.
	4	12 08 23 00	1	Disco frizione intermedio	Intermodiate plate	Disque lisse	Zwischenscheibe
	5	12 08 28 00	1	Scodollino	Cup	Butée	Manschette
	6	14 08 57 00	1	Asta	Rod	Tige de débrayage	Druckstift
	7	14 08 59 00	2	Bussola conica	Bush	Joint conique	Gummibuchse
	8	14 08 60 00	1	Corpo interno	Inner body	Butée : partie interne	Innengehäuse
	9	12 08 70 01	1	Cuscinetto reggispinta	Thrust bearing	Butée d'embrayage	Drucklager
	10	14 08 61 00	1	Corpo esterno	Outerbody	Butée : partie externe	Aussengehäuse
	11	90 70 61 70	1	Anello di tenuta	Seal ring	Joint torique	Dichtring
	12	14 09 02 02	1	Leva disinnesto frizione	Operating lever	Biellette	Ausrückhebel
	13	94 32 11 05	1	Molla ritorno leva	Counter spring	Ressort de rappel	Gegenfeder
	14	14 09 04 00	1	Vite registro leva	Adjusting screw	Vis de réglage	Stellschraube
	15	92 60 25 08	1	Dado	Nut	Ecrou	Mutter
	16	95 78 02 71	1	Spina	Pin	Axe	Stift
	17	95 50 02 22	1	Copiglia	Split pin	Goupille	Splint
*	Ad esaurimento - Till depletion - Jusqu'à épuisement - Solange vorrätig						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SCATOLA E COPERCHI CAMBIO GEARBOX ANDE COVERS				BOÎTE DE VITESSE ET CARTERS GETRIEBGEHÄUSE UND DECKEL		Tavola - Drawing Table - Bild	10
NOTE	N°	REFERENCE	QTY	DENOMINAZIONE	DESCRIPTION	DÉSIGNATION	BEZEICHNUNG
	1	14 20 02 11	1	Scatola cambio	Gearbox	Boîte vitesse	Getriebegehäuse
	1	29 20 02 50	1	Scatola cambio (nero)	Gearbox (black)	Boîte vitesse (noir)	Getriebegehäuse (scwarz)
	1	28 20 02 78	1	Scatola cambio (grigio)	Gearbox (gray)	Boîte vitesse (gris)	Getriebegehäuse (grau)
	2	90 40 35 47	1	Anello di tenuta A.S.	L.S. seal ring	Spi A.S.	Dichtung für Ab.W.
	3	92 25 62 18	2	Cuscinetto A.P. e A.F.	Main shaft and clutch shaft bearing	Roulement arbre primaire et arbre d'embrayage	Lager für Antrieb- und Kupplungswelle
	4	14 21 38 03	2	Piastra di sicurezza	Lock plate	Plaque de blocage	Schliessblech
	5	98 62 23 16	6	Vite	Screw	Vis	Schraube
	6	14 21 79 01	6	Rosetta di sicurezza	Lock washer	Rondelle frein	Sicherungsblech
	7	92 21 84 24	2	Cuscinetto A.F. e A.S.	C.S. - L.S. bearing	Roulement A. d'E.-A.S.	Lager für K.W.a Ab.W.
	8	92 23 47 17	1	Cuscinetto A.S.	L.S. bearing	Roulement A.S.	Lager für Ab.W.
	9	95 51 20 81	2	Spina di riferimento	Dowel	pion de centrage	Dübel
	10	14 20 11 10	1	Guarnizione	Gasket	Joint	Dichtung
	11	18 20 08 01	1	Coperchio per scatola	Cover	Carter	Deckel
*	11	29 20 08 50	1	Coperchio per scatola (nero)	Cover (black)	Carter (noir)	Deckel (schwarz)
	11	28 20 08 78	1	Coperchio per scatola (grigio)	Cover (grey)	Carter (gris)	Deckel (grau)
	12	90 70 61 40	1	Anello di tenuta	Sealring	Bague d'etancheité	Dichtring
	13	92 20 14 17	1	Cuscinetto per A.P.	M.S. bearing	Roulement A.P.	Lager für An.W.
	14	14 23 78 00	1	Vite eccentrica	Eccentric screw	Vis excentrique	Ausmittige Schraube
	15	92 60 25 12	1	Dado	Nut	Ecrou	Muttf
	16	98 62 23 25	9	Vite corta	Short screw	Vis courte	Kurze Schraube
	16	98 61 23 25	9	Vite corta (nero)	Short screw (black)	Vis courte (noire)	Kurze Schraube (schwarz)
	17	98 62 03 35	1	Vite lunga	Long screw	Vis longue	Lange Schraube
	17	98 61 03 35	1	Vite lunga (nero)	Long screw (black)	Vis longue (noire)	Lange Schraube (schwarz)
	18	12 20 72 00	1	Corpo contatti	Contact holder	Contacteur de point mort	Kontactträger
	19	12 20 77 00	1	Guarnizione	Gasket	Joint	Dichtung
	20	14 21 79 01	2	Rosetta piana	Washer	Rondelle	Scheibe
	21	98 82 23 16	2	Vite	Screw	Vis	Schraube
	22	93 18 02 20	1	Tappo in gomma	Rubber plug	Bouchon en caoutchouc	Gummistopfen
	23	19 35 12 00	1	Tappo olio	Oil filter plug	Bouchon de remplissage d'huile	Ölverschraubung
	24	90 70 62 03	1	Guarnizione	Gasket	Joint	Dichtung
	25	95 98 06 10	1	Tappo	Plug	Bouchon	Stopfen
	25	95 98 06 11	1	Tappo (nero)	Plug (black)	Bouchon (noir)	Stopfen (schwarz)
	26	10 52 89 00	3	Guarnizione	Gasket	Joint	Dichtung
	27	14 20 49 55	1	Tappo sfitatoio	Breather	Reniflard	Entlüfter
**	28	823 942 070		Tubazionne	Breather pipe	Tuyau de reniflard	Entlüfterschlauch
	29	94 32 10 67	1	Molla	Spring	Ressort	Feder
	30	17 23 47 60	1	Nottolino fermo marce	Pawl	Bonhomme de vérouillage	Sperrlinke
	31	90 40 35 48	1	Anello di tenuta A.F.	C.S. seal ring	Spi A. d'E.	Dichtring für K.W.
	32	96 50 80 32	2	Prigionero scatola	Stud bolt	Goujon prisonnier	Stiftschraube
	33	92 63 01 08	1	Dado autobloccante	Self-locking nut	Ecrou freiné	Sicherungsmutter
	34	12 15 42 00	1	Guarnizione	Gasket	Joint	Dichtung
	35	98 82 23 25	2	Vite	Screw	Vis	Schraube
	36	95 98 02 14	2	Tappo livello/scarico olio	Plug	Bouchon de niveau/vidange	Stopfen
	36	95 98 02 13	1	Tappo livello/scarico olio (nero)	Plug (black)	Bouchon de niveau/vidange (noir)	Stopfen (schwarz)
	27	93 18 02 45	1	Tappo in gomma	Plug	Obturateur en caoutchouc	Stopfen gummi
	28	39 61 68 00	1	Tappo in gomma	Plug	Protection en caoutchouc	Stopfen gummi
	29	29 00 37 50	1	Tappo introduzione olio (nero)	Plug (noir)	Bouchon de remplissage (noir)	Stopfen (schwarz)
	40	95 10 07 09	1	Guarnizione	Gasket	Joint	Dichtung
		28 99 15 60	1	Cambio completo	Gearbox assy	Boîte de vitesse complète	Getriebegehäuse kpl.
		29 99 15 50	1	Cambio completo (nero)	Gearbox assy (black	Boîte de vitesse complète (noir)	Getriebegehäuse kpl. (schwarz)
		28 99 15 78	1	Cambio completo(grigio)	Gearbox assy (grey)	Boîte de vitesse complète (gris)	Getriebegehäuse kpl. (grau)
*	Ad esaurimento - Till depletion - Jusqu'à épuisement - Solange vorrätig						
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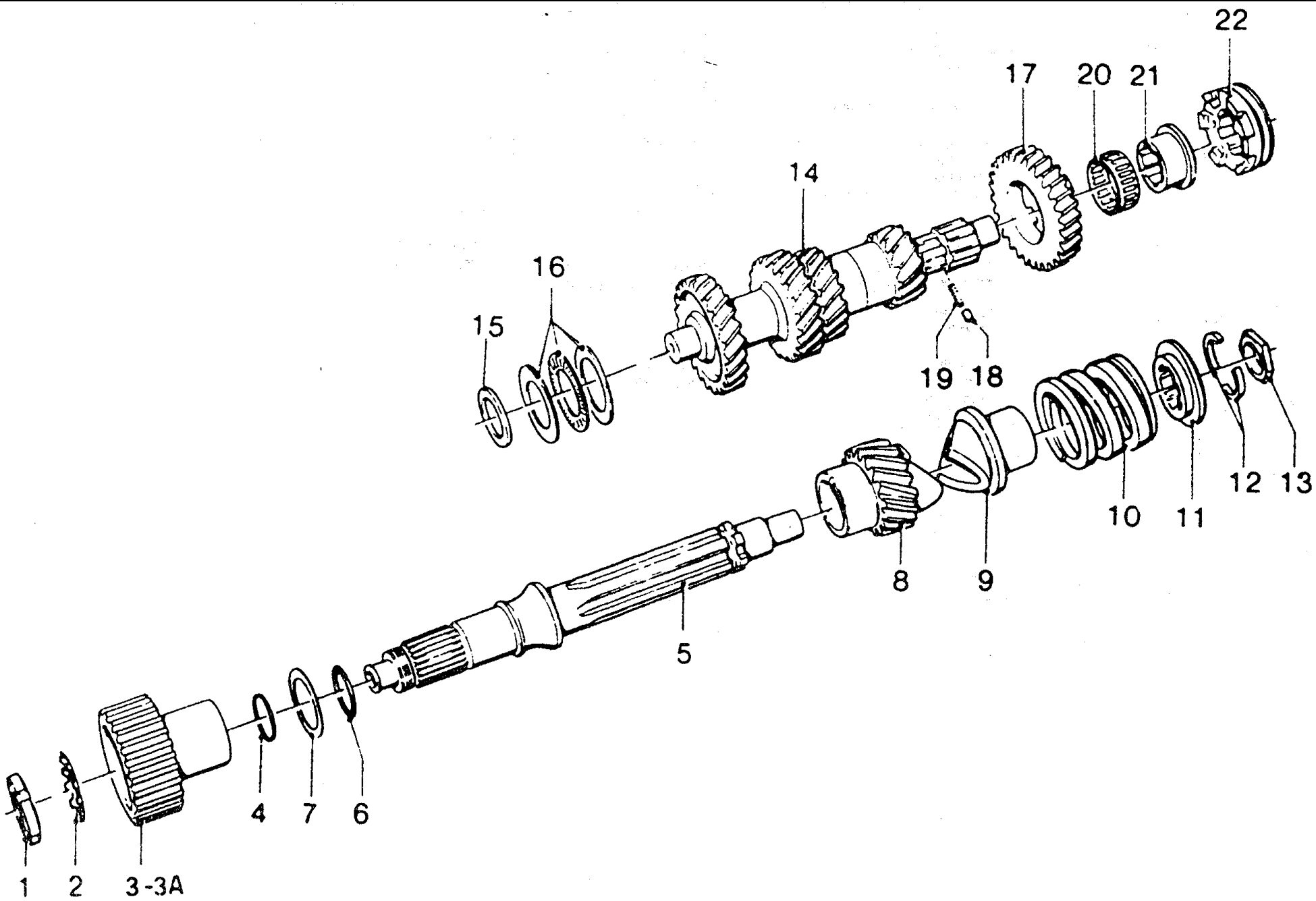
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ALBERO PRIMARIO CAMBIO - ALBERO FRIZIONE
MAIN SHAFT - CLUTCH SHAFT

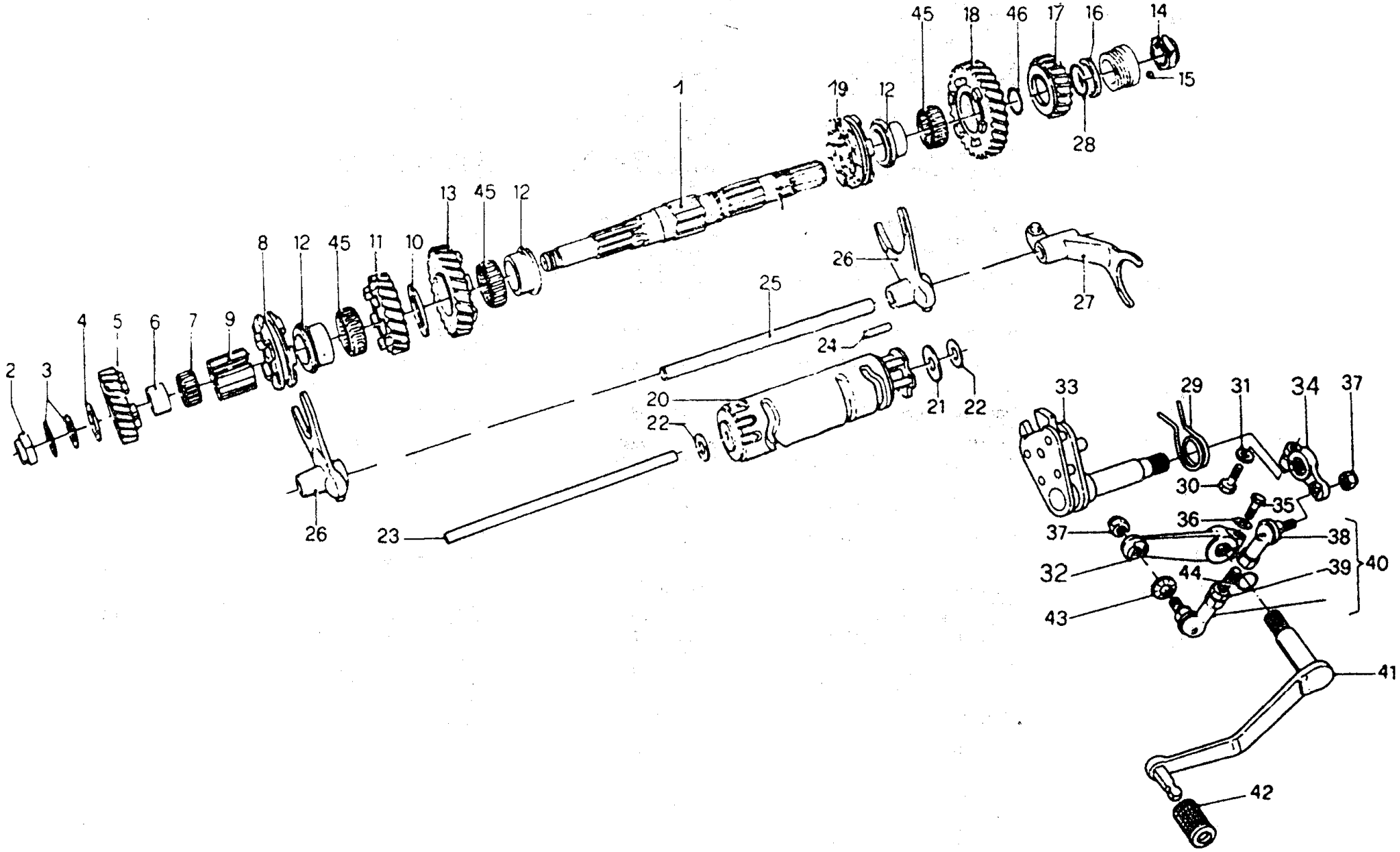
ARBRE PRIMAIRE - ARBRE D'EMBRAYAGE
ANTRIEBWELLE - KUPPLUNGSWELLE

Tavola - Drawing
Table - Bild

11

NOTE	N°	REFERENCE	QTY	DENOMINAZIONE	DESCRIPTION	DÉSIGNATION	BEZEICHNUNG
	1	93 60 10 22	1	Ghiera	Locking sleeve	Écrou de blocage	Sicherungsring
	2	95 02 80 22	1	Rondella di sicurezza	Lock washer	Rondelle frein	Sicherungsblech
jusqu'à mot. VV 16374	3	14 08 18 11	1	Corpo inter. frizione	Clutch gear	Noix d'embrayage	Kupplungswelle
A partir mot. VV 16375	3A	30 08 18 10	1	Corpo inter. frizione	Clutch gear	Noix d'embrayage	Kupplungswelle
	4	90 70 62 35	1	Guarnizione	Gasket	Joint	Dichtung
	5	14 21 07 02	1	Albero frizione	Clutch shaft	Arbre d'embrayage	Kupplungswelle
	6	90 70 62 03	1	Anello di tenuta A.F.- A.S.	Seaal ring (C.S.-L.S)	Bague d'étanchéité (A.d'E.-A.S.)	Dichtung für D.W. Ab.W.
	7	14 21 84 01	1	Rondella spandiolio	Oil spreading washer	Rondelle ép. huile	Ölwergerscheibe
	8	14 21 11 10	1	Ingranaggio rinvio (Z=17)	Idle gear (Z=17)	Pignon intermédiaire (Z=17)	Zahnradvorgelege (Z=17)
	9	14 21 12 01	1	Manicotto ad innesti	Coupling muff	Dent de loup	Eingreifmuffe
	10	13 21 15 00	1	Molla	Spring	Ressort	Feder
	11	14 21 16 00	1	Piattello	Cup	Coupelle	Manschette
	12	12 21 17 00	2	Semisettori	Semi-collar	Clavette	Halbsektor
	13	14 21 94 01	1	Spessore	Spacer	Écrou	Distanzstück
	14	14 21 05 13	1	Albero primario	Main shaft	Arbre primaire	Antriebwelle
	15	18 21 10 50	1	Rosetta di rasamento mm 2,0	Support washer mm 2.0	Rondelle de calage mm 2,0	Stützscheibe mm 2,0
	15	18 21 10 51	1	Rosetta di rasamento mm 2,1	Support washer mm 2.1	Rondelle de calage mm 2,1	Stützscheibe mm 2,1
	15	18 21 10 52	1	Rosetta di rasamento mm 2,2	Support washer mm 2.2	Rondelle de calage mm 2,2	Stützscheibe mm 2,2
	15	18 21 10 54	1	Rosetta di rasamento mm 2,4	Support washer mm 2.4	Rondelle de calage mm 2,4	Stützscheibe mm 2,4
	16	92 25 85 25	1	Cuscinetto rullini reggispinta	Needle bearing	Roulement à aiguilles	Nadellager
	17	14 21 20 13	1	Ingranaggio 5a A.P. (Z=28)	5th gear (M.S) (Z=28)	Pignon 5e (A.P.) (Z=28)	An.W. Schaltrad 5. Gang (Z=28)
	18	92 29 67 50	1	Rullo di fermo boccola	Bush lock	Pion de blocage	Buchsenanlagstift
	19	94 32 10 51	1	Molla	Spring	Ressort	Feder
	20	92 25 10 30	1	Gabbia a rullini	Needle cage	Cage à aiguilles	Nadelkäfig
	21	14 21 22 10	1	Boccola per 5a (A.P.)	5th gear bush (M.S.)	Douille 5e (A.P.)	Buchse 5. Gang (An.W.)
	22	14 23 15 10	1	Manicotto scorrevole 5a	5th gear sliding sleeve	Baladeur 5e	Schiebenmuffe für 5. Gang

ALBERO SECONDARIO CAMBIO LAYSHAFT	ARBRE SECONDAIRE ABTRIEBWELLE	Tavola - Drawing Table - Bild	12



ALBERO SECONDARIO CAMBIO LAYSHAFT					ARBRE SECONDAIRE ABTRIEBWELLE	Tavola - Drawing Table - Bild	12
NOTE	N°	REFERENCE	QTY	DENOMINAZIONE	DESCRIPTION	DÉSIGNATION	BEZEICHNUNG
	1	14 21 36 12	1	Albero secondario	Layshaft	Arbre secondaire	Abtriebwelle
	2	14 21 74 10	1	Dado di sicurezza A.S.	Nut (L.S.)	Écrou (A.S.)	Bundmutter (Ab.W.)
	3	43 08 38 10	2 à 4	Rosetta di aggiustaggio	Shim	Rondelle de réglage	Passcheibe
	4	14 21 54 00	1	Rosetta di spallamento	Support washer	Rondelle d'épaulement	Stützscheibe
	5	14 21 51 10	1	Ingranaggio 4a A.S. (Z=20)	4th gear (L.S.)(Z=20)	Pignon 4e (A.S.)(Z=20)	(Ab.W.) Schaltrad 4.Gang (Z=20)
	6	92 25 90 17	1	Anello interno 4a	4th gear inner ring	Anneau interne 4e	Innenring für 4.Gang
	7	92 25 10 22	1	Gabbia a rullini 4a A.S.	4th gear needle cage (L.S.)	Cage à aiguilles 4e (A.S.)	Nadelkäfig für 4.Gang (Ab.W.)
	8	14 23 10 12	1	Manicotto 3a-4a A.S.	3rd-4th sliding sleeve (L.S.)	Baladeur 3e-4e (A.S.)	Schiebenmuffe für 3-4 Gang (Ab.W)
	9	14 23 25 12	1	Manicotto fissa A.S.	Sleeve (L.S.)	Manchon (A.S.)	Muffe (Ab.W)
	10	14 21 80 11	1	Rosetta di spallamento A.S.	Support washer (L.S.)	Rondelle d'appui (A.S.)	Stützschwbe (Ab.W.)
	11	14 21 48 10	1	Ingranaggo 3a A.S. (Z=22)	3rd gear (L.S.)(Z=22)	Pignon 3e (A.S.)(Z=22)	(Ab.W) Schaltrad 3.Gang (Z=22)
	12	14 21 30 01	3	Boccola 1a-2a-3a A.S.	1st-2n-3rd bush (L.S.)	Douille 1re-2e-3e(A.S.)	Buchse für 1.2.3. Gang (Ab.W.)
	13	14 21 45 10	1	Ingranaggio 2a A.S. (Z=25)	2nd gear (L.S.)(Z=25)	Pignon 2e (A.S.)(Z=25)	(Ab.W) Schaltrad 2. Gang (Z=25)
	14	14 21 93 10	1	Dado bloccaggio A.S.	Locking nut (L.S.)	Écrou de blocage (A.S.)	Bundmutter (Ab.W.)
	15	92 29 57 02	1	Sfera	Ball	Bille	Kugel
	16	14 21 73 00	1	Rosetta di spallamento	Support washer	Rondelle d'épaulement	Stützscheibe
	17	14 21 52 13	1	Ingranaggio 5a A.S. (Z=21)	5th Gear (L.S.)(Z=21)	Pignon 5e (A.S.)(Z=21)	(Ab.W.) Schaltrad 5. Gang (Z=21)
	18	14 21 42 10	1	Ingranaggio 1a A.S. (Z=28)	1stgear (L.S.)(Z=28)	Pignon 1re (A.S.)(Z=28)	(Ab.W.) Schattrad 1. Gang (Z=28)
	19	14 23 07 11	1	Manicotto scorrevole 1a e 2a A.S.	1st-2nd sliding sleeve (L.S.)	Baladeur lre-2e (A.S.)	SchMïbenmuffe fur 1-2 Gang (Ab.W)
	20	14 23 44 05	1	Tamburo scanalato	Splined drum	Tambour de sélection	Keilwelle
	21	14 23 55 00	1	Rosetta	Washer	Rondelle	Scheibe
	22	55 23 50 00	3	Rosetta di aggiustaggio mm 0,6	Shim mm 0.6	Rondelle de réglage mm 0.6	Passcheibe mm 0,6
	22	55 23 50 01	3	Rosetta di aggiustaggio mm 0,8	Shim mm 0.8	Rondelle de réglage mm 0.8	Passcheibe mm 0,8
	22	55 23 50 02	3	Rosetta di aggiustaggio mm 1,0	Shim mm 1.0	Rondelle de réglage mm 1.0	Passcheibe mm 1,0
	22	55 23 50 03	3	Rosetta di aggiustaggio mm 1,2	Shim mm 1.2	Rondelle de réglage mm 1.2	Passcheibe mm 1,2
	23	14 23 43 00	1	Asta	Rod	Tige	Keilwellestange
	24	14 23 46 00	4	Pioto per tamburo	Drum pin	Goupille de tambour	Keilwellestift
	25	14 23 24 00	1	Asta per forcellini	Shiftfork rod	Axe de fourchette	Schaltgabelstange
	26	14 23 05 01	2	Forcellini 1a-2a-3a-4a	1st-2nd-3rd-4th shift fork	Fourchette 1re-2e-3e-4e	Schaltgabel für 1-2-3 Gang
	27	14 23 12 01	1	Forcellino 5a	5th shiftfork	Fourchette 5e	Schaltgabel für 5. Gabel
	28	90 70 62 19	1	Guarnizione O.R.	0-Ring	Joint torique	0-Ring
	29	28 23 82 60	1	Molla richiamo preselettore	Spring	Ressort	Feder
	30	98 82 23 25	1	Vite	Screw	Vis	Schraube
	31	61 01 38 00	1	Rosetta	Washer	Rondelle	Scheibe
	32	28 25 69 60	1	Leva di rinvio comando cambio	Lever	Levier	Hebel
	33	28 23 62 60	1	Preselectore completo	Gear selector assy	Présélecteur complet	Gangwaehler kpl.
	34	19 25 82 20	1	Leva comando settore	Shift lever	Levier de commande	Schafthebel
	35	98 05 23 25	1	Vite	Screw	Vis	Schraube
	36	95 02 11 06	1	Rosetta	Washer	Rondelle	Scheibe
	37	92 63 01 06	2	Dado	Nut	Écrou	Mutter
	38	28 25 81 60	2	Snodo sferico	Ball	Rotule	Knopf
	39	92 60 22 06	1	Dado	Nut	Écrou	Mutter
	40	28 25 78 60	1	Tirante com cambio completo	Shift rod. assy	Tige de commande complète	Schalthebel kpl.
	41	28 25 09 60	1	Leva comando cambio	Shift lever	Levier de commande	Schalthebel
	42	14 25 10 01	1	Pedalino gomma	Rubber protection	Caoutchouc	Gummiüberzug
	43	61 01 38 00	2	Ranella elastica	Spring washer	Rondelle	Scheibe
	44	90 70 51 41	2	Anello OR	0-Ring	Joint torique	0-Ring
	45	92 25 10 30	3	Gabbia a rullini	Gear needle cage	Cage à aiguilles	Nadelkäfig
	46	90 70 62 03	1	Anello di tenuta	Seal ring	Bague d'étanchéité	Dichtring

No	PARTS IN THE MOTORCASE	MG art. no:	Specifications	Remarks	Tools
2	Seals, around the pusher-rod	14085900		2 ea. (Original no: 12085901 is now replaced)	
1	O-ring, “thin”, input-shaft	90706235	OR 2093 Ø23,52 x 1,78	Between the clutch-boss and input-shaft bearing	
4	O-ring, “fat”, input-shaft / output-shaft	90706203	OR 3081 Ø20,30 x 2,62 Parker Ø20,29 x 2,62	Between input-shaft and clutch-boss / Between 1’st and 5’th gear Have also seen Ø20 x 2,5 **Also used at Cylinder head**	
1	O-ring, “thin”, output-shaft (Later models)	90706219	Parker Ø21,95 x 1,78	Between bearing in the cover and the washer under the Speedo-drive.	
1	O-ring, in cover behind throw out bearing	90706170	OR 3068 Ø17,12 x 2,62	Have also seen specified: Ø17 x 2,8 and Ø17 x 2,7	
1	O-ring, in cover for selector-pawls-shaft	90706140	OR 3056 Ø14 x 2,5	Ø13,2 x 2,5 fits tighter due to rod is Ø14,0	
1	Sealing ring, in box	90403547001	35x47x7 VITON (Brown)	VITON (Brown colour)	
1	Sealing ring, in cover	90403547	35x47x7	(ANGUS is a brand) Identical with Sealing in Ø35 front fork	
	Throw out bearing	12087001		Bearing + 2 washers	
	Special-nut, on input-shaft	93601022			Special
	Locking washer, behind this special-nut	95028022		Should be replaced every time, due to the actual ear breaks 2nd-time.	
	Shims, for selector-drum	55235000	0,6mm	55235001 = 0,8mm / 55235002 = 1,0mm / 55235003 = 1,2mm	
	Spring, for selector-pawls	32238210	32238210 is latest version	Orig. No: 14238200 is replaced by 28238260 and further 28238261	
	Bearing, in cover (+ the same in the box) (It’s the bearing in the cover, which is mostly stressed. Remember locking-plate)	92218424	25x52x20,6 (2x14 in steel-housing)	Double row angle contact bearing: INA 3205 / SKF 3205 AC3 / NTN 3205 AC3 / NSK 3205 JC3 recommended alt. by Peter Roper. (2x14 balls in metal house are better then 2x9 balls in plastic house.)	
	Locking-plate, for bearing	14213803	Metal (For 3 screws)	5-speed boxes after 1974. Don’t use plastic plate.	
	Gasket, box/cover	14201110			
	Nut, output-shaft	14219310	Moment: 17kgm	Pipe: Long 27mm, with sharp entrance and angle.	Special