# The Greasy Hands Garage Guide to Rebuilding the Triumph TR Transmission
# Part 1 – Disassembly

Larry Young and Sam Clark, Green Country Triumphs
Revised: May 5, 2006

Some of the disassembly steps do not have to be in the exact order given below, but this is the order we like to use.

**Step 1 – Drain the oil and remove the top cover**

Before starting, drain the oil out of the transmission. Then remove the transmission top cover by removing the eight bolts.

**Step 2 – Check the Synchros**

Wear on the synchro rings should be checked before disassembly. Remove the slack by pushing the synchro hub toward the ring and then measure the clearance with a feeler gauge. The Service Instruction Manual states that the clearance should be 0.035 to 0.040 for new rings and they should be replaced if the clearance is less than 0.030. Some of the new synchro rings are of dubious quality, so we normally reuse the synchro rings if they meet this criterion.

**Step 3 – Remove the Rear Flange**

If you have an impact wrench, you can usually just hold the flange with your hand while you remove the nut. If you use an ordinary wrench, you'll probably need some sort of flange holding tool. Sam had this nice tool made, but you could also make one by drilling two holes in a piece of angle iron. Once the nut and washer are removed, you can tap the flange off with a small hammer or use a puller if it's stubborn.  The photos show flange removal for an overdrive, which could be done as a later step.

**Step 4 – Remove the speedometer drive**

When there is no overdrive, the speedometer drive must be removed before the rear housing, otherwise you will destroy it (guess how we know this).   If you have an overdrive, be sure to remove the speedometer drive before dismantling the rear housing.  First remove the set screw. Early drives with the brass housing can be removed with a pair of pliers or a thin wrench.  The later drives don't stick out from the case, so they can be removed by prying up on the end of an old speedometer cable.

**Step 5 – Remove the rear housing or overdrive**

Next, remove the rear housing or if an overdrive is installed, remove it (see Overdrive Disassembly).  Remove the bolts that attach the rear housing to the back of the transmission.  The housing has a lip near the end that can be grabbed by a bearing separator and pulled using an assembly like that in the right photo.  This is my poboy puller, since all items in the assembly are from a discount tool house, except for the angle iron plate, which was easy to make.

**Step 6 – Remove clutch shaft and fork**

If you have an early transmission with set screws that hold the clutch shaft in position, remove them. The clutch fork is held on the shaft by a pin which is frequently broken. They usually break where the pin enters the shaft, so you can't get the fork off until you get the remains of the pin out. The orientation of the pin makes it difficult to remove the remains of a broken pin. The trick is to drill through the back side of the fork and knock the pin out with a punch. You must drill at an angle so that the drill bit will intersect the remains of the pin, which goes all the way through the shaft. It is difficult to get the right angle because the ends of the clutch fork interfere with the drill.

Our TR4 project transmission had a broken pin. We first drilled with a 3/16" bit, but only caught the edge of the pin, so we tried again with a 1/4" bit. The second attempt intersected the pin. We've done this successfully in the past, but had trouble this time. Obviously, you can't really see what's going on until you do a post mortem investigation. In this case the fork was loose enough on the shaft that we had difficulty aligning the fork and the shaft so that we could knock the pin out. We finally gave up and cut the shaft. Once we had it out, it was easy to get things lined up and knock the pin out. The photo shows the broken pin next to a new one.

**Step 7 – Remove the front and countershaft covers**

Remove the four bolts holding the input shaft front cover and the two bolts holding the counter shaft cover and remove both covers

**Step 8 – Remove the countershaft**

First, free the countershaft from its retaining mechanism. Early countershafts are retained by a long set screw that holds both the reverse shaft and the countershaft. Later models used a large phillips head screw that holds a retaining plate, which is often broken. This screw is sometimes difficult to remove. If you can't get it loose with a screw driver, you might try using a socket wrench or an impact screwdriver (see photos).

The countershaft can now be pushed out the back of the transmission with a rod. Once it is removed the countershaft gear cluster will fall to the bottom of the case.

The early transmissions used loose needle bearings on the countershaft. In order to retain the needle bearings, cut a 3/4" OD rod or pipe to a length of about 6 1/4". Push the countershaft out with the rod and leave it inside the counter shaft gear cluster.

The photos show some countershafts removed from various transmissions. Most of the wear is at the rear bearing under first gear. The early transmissions with needle bearings usually show less wear than the later transmissions. The shaft on the right came out of our TR6 project transmission. This transmission had fewer than 10,000 miles on a rebuild that used a new countershaft and new shell type bearings. The rear bearing had failed completely - only crumbs remained. The silvery sludge was scooped from the bottom of the rear housing.

**Step 9 – Remove the input shaft**

Now, with the countershaft gears at the bottom of the case, the input shaft and bearing can be driven out with a brass punch.

**Step 10 – Remove the center bearing**

The center bearing can now be removed. Remove the clip and washer (left photo). Drive the main shaft back about ¼ to ½ inch with a block of wood so a bearing separator can be positioned under the clip on the bearing. Use a puller to remove the bearing from the main shaft (right photo below).

**Step 11 – Remove the output shaft and countershaft gears**

The transmission main shaft and gears can now be withdrawn from the case (left photo below). The countershaft gear cluster can then be removed (right photo below).

**Step 12 – Remove Countershaft Bearings**

The following photo shows the three types of countershaft bearings: (1) 24 loose needle bearings, (2) shell bearing with 18 needles and (3) cage with 15 needles. The loose needles were used in early 3 synchro boxes. The shell type bearings were used in early 4 synchro boxes, while the open cage bearings were used in late TR6 boxes. We find that countershafts are almost always galled in late TR6 boxes and are usually in good condition with the loose bearings. The larger number of needles seems to create less wear on the countershaft. Shell bearings seem to be better than open cage bearings and may be used in place of the open cage bearing.

The loose bearings and open cage bearings are easy to remove, but the shell type bearings can be a problem. The shell bearings can be removed with a hammer and cold chisel. Profanity and gnashing of teeth may also be required. A crankshaft pilot bushing puller can also be used. The photo at right shows a SnapOn puller borrowed from our engine builder, Chad Hodges. We've also used a similar tool found at MSC Industrial (catalog no. 00084731) for about $85. We did have to do a bit of grinding on the tool, but it works just fine as long as the bearings are not pressed in too far.

**Step 13 – Remove input shaft bearing**

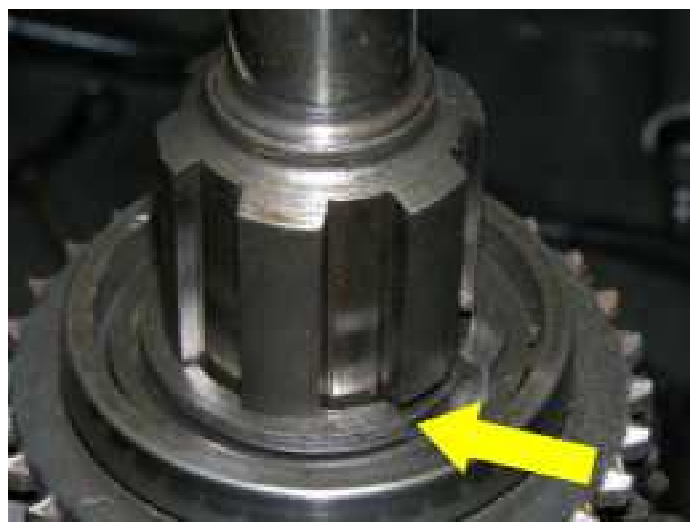
The large bearing on the input shaft can now be removed. Remove the snap ring and press or drive the bearing off the shaft (right photo).

**Step 14 – Input shaft pilot bearing**

Three types of input shaft pilot bearings were used. Early 3 synchro boxes used a bronze bushing. Early 4 synchro boxes used a shell type bearing and late TR6 boxes used an open cage bearing. The OD and ID of the shell bearing are 1.125 and 0.875 in, respectively. The ID of the bronze bushing is the same, so I believe the later bearing could be directly substituted for the bushing. The OD and ID for the cage bearing is 1.209 and 0.833, so it requires a different main shaft and cannot be directly substituted. Close ratio gearsets are designed for the cage type bearing, but come with a sleeve to adapt it for use with a shell type bearing and earlier main shaft.

These bearings do not turn when the transmission is in 4$^{th}$ gear, so are less important than some of the other bearings. You may wish to reuse the old bearing if it is in good condition. The open cage bearings are easy to remove and replace. The other two types require a blind puller like the pilot bearing puller used to remove countershaft needle bearings.

**Step 15 – Remove mainshaft gears**



Removal of 2$^{nd}$ and 3$^{rd}$ gears from the mainshaft requires removal of the circlip indicated by the arrow in the photo. This clip can be removed with a couple of screwdrivers and several sets of hands. You might be able to notch the ends with a Dremel tool and then use expanding snap ring pliers. I've also seen the suggestion to use a small cutoff wheel with a Dremel tool to cut the circlip.

However, if you have a Churchill removal tool the job is much easier. The photo below shows the removal tool on the left and the clip installation tool on the right. The other photos show use of the tool to remove the clip.

Once the clip is removed, the two gears, two washers and two bushings can be removed from the shaft.




# The Greasy Hands Garage Guide to Rebuilding the Triumph TR Transmission
# Part 2 – Reassembly

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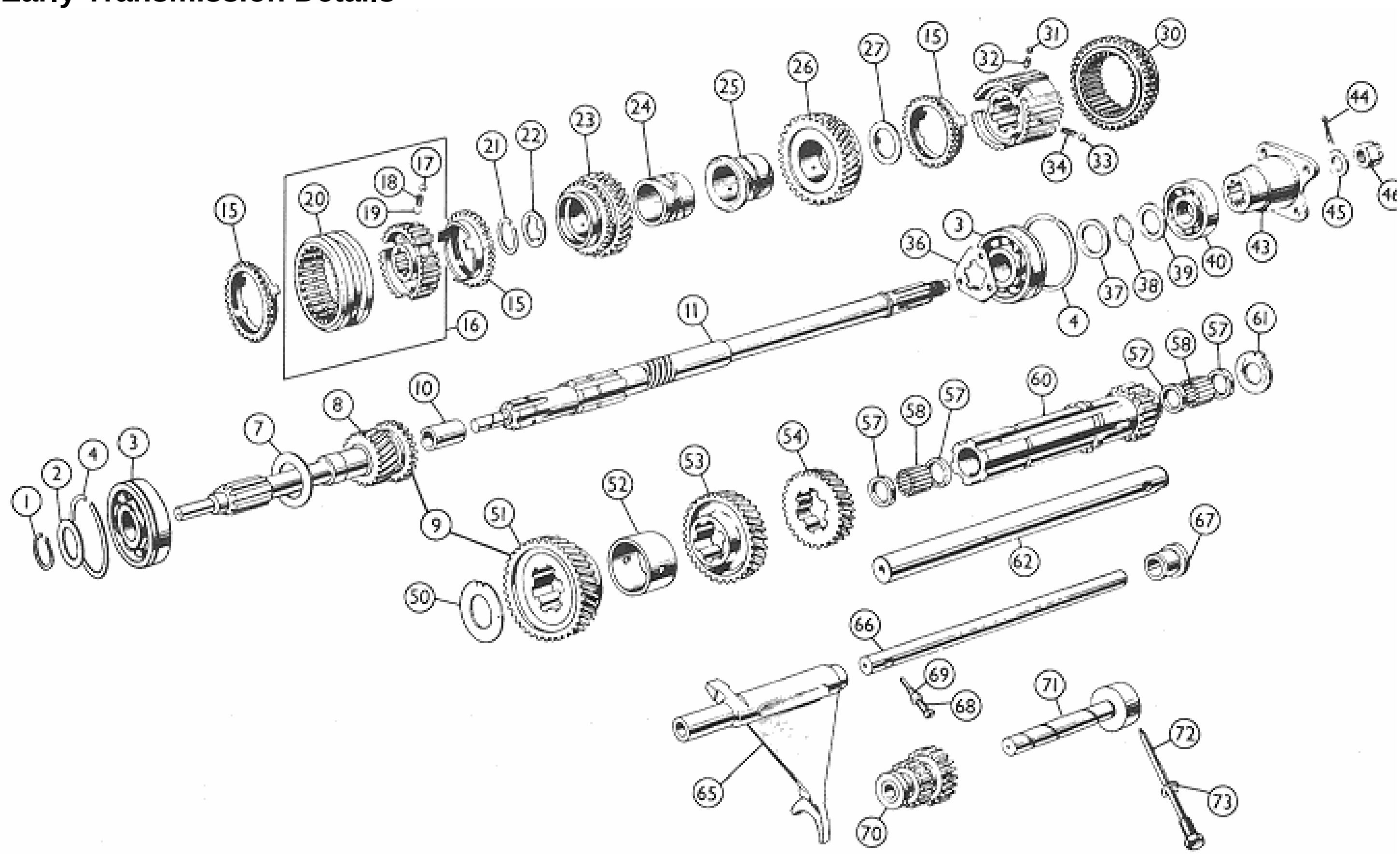
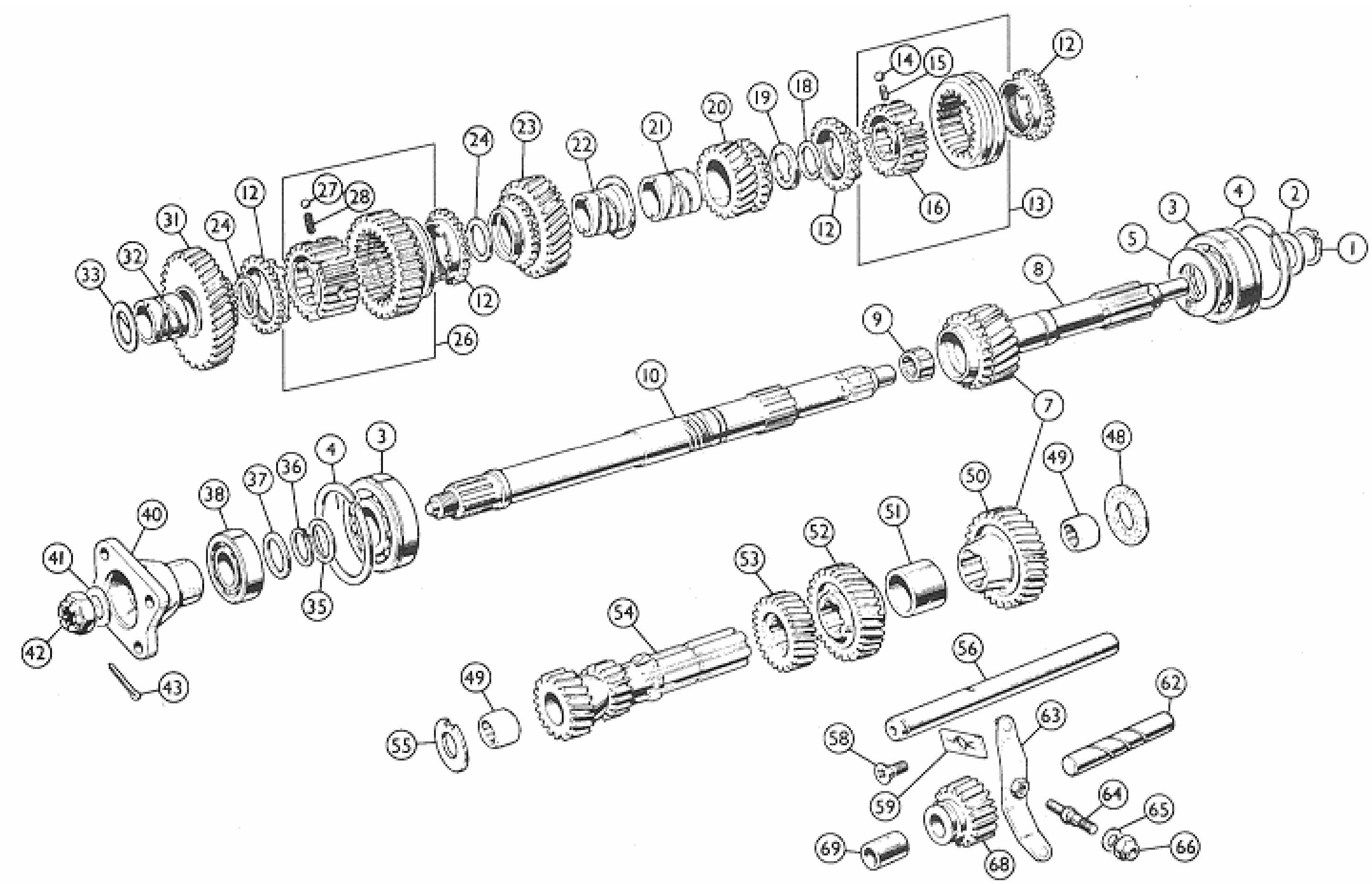
Revised: May 5, 2006

**Early Transmission Details**



| Description | No. | ID | OD | thickness |
|---|---|---|---|---|
| Before front bearing | 2 | 1.251 | 1.645 | 0.063 |
| Behind front bearing | 7 | 1.449 | 2.50 | 0.032 |
| Before $3^{rd}$ gear | 22 | 1.251 | 1.696 | 0.122 |
| Behind $2^{nd}$ gear | 27 | 1.275 | 1.693 | 0.119 |
| Before center bearing | 36 | 1.273/1.340 | NA | 0.140 |
| Behind center bearing | 37 | 1.255 | 1.644 | 0.092 |
| Before $3^{rd}$ bearing | 39 | 1.190 | 1.515 | 0.092 |
| Rear flange | 45 | 0.780 | 1.378 | 0.116 |

**Late Transmission Details**



| Description | No. | ID | OD | thickness |
|---|---|---|---|---|
| Before front bearing | 2 | 1.253 | 1.644 | 0.064 |
| Behind front bearing | 5 | 1.445 | 2.530 | 0.034 |
| Before 3rd gear | 19 | 1.256 | 1.696 | 0.123 |
| Behind 2nd gear (adjust) | 24 | 1.267 | 1.667 | 0.120 (0.118-0132) |
| Before 1st gear (adjust) | 24 | 1.264 | 1.664 | 0.118 0.118-0132) |
| Before center bearing | 33 | 1.259 | 1.888 | 0.141 |
| Behind center bearing | 35 | 1.262 | 1.656 | 0.094 |
| Before 3rd bearing | 37 | 1.188 | 1.521 | 0.094 |
| Rear flange | 41 | 0.757 | 1.505 | 0.126 |

If you are rebuilding an overdrive and transmission, you should **rebuild the overdrive first** so that you can use the transmission mainshaft as a dummy shaft during the overdrive rebuild.

The drawings above are for an early 3 synchro box and a 4 synchro box. To keep you on your toes, the factory reversed the direction of the transmission in the two drawings. The various washers tend to get mixed up during a rebuild, so the photos and tables detail the size and location of all the washers.

**Evaluation and Ordering Parts**

After you have disassembled your transmission you should clean it thoroughly and inspect all the parts. The synchro rings should have been checked for wear before disassembly (see Part 1). Check the bearings and bearing surfaces for smoothness and wear. Countershafts frequently show excessive wear or galling (see photos in Part 1). Check for broken gear teeth and cracked or broken washers. Check the bushings. The second gear "tophat" bushing is frequently broken or cracked along the flange (see photo at right). All of the bushings should be checked for wear when you check for gear float. Also, you may want to order a variety of adjustment washers in order to achieve the correct clearance (see following section).

The following is a list of frequently replaced parts. The numbers given refer to those in the 4 synchro drawing above.

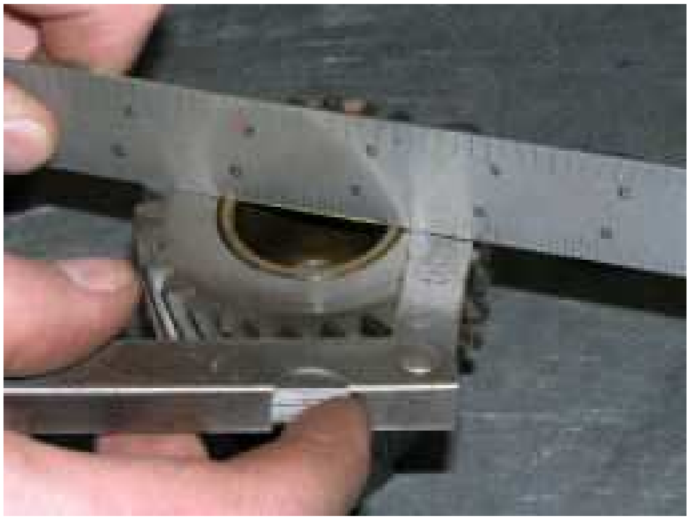
- ☐ synchro rings (12)
- ☐ mainshaft bearings (3, 38)
- ☐ bushings (21, 22, 32) (especially 2nd gear)
- ☐ washers (especially adjustment washers, 24)
- ☐ countershaft (56)
- ☐ countershaft bearings (49) (see note below)
- ☐ 3rd gear circlip (18) (always replace)
- ☐ countershaft retaining plate (59) (always replace)
- ☐ front and rear seals (always replace)
- ☐ gaskets
- ☐ clutch fork pin

If you have a late TR6 transmission with open cage countershaft bearings, you may wish to replace them with shell type bearings. Shell bearings seem to work better.

**Step 1 - Main Shaft Float**

Several measurements must be taken to insure the gears will rotate freely without binding.

**Gear Float:** First, each bushing should be 0.004 to 0.008 longer than the gear that rides on it. For third gear (and 1st in a 4 synchro box), the measurement is easily made as follows. Place the gear on washers so the bushing is held flush with the recessed end of the gear, then measure the protrusion with a feeler gauge and straight edge (left photo below). For second gear, the measurement is more difficult because of the top hat on the bushing. The manuals say to force the feeler gauge under the top hat (right photo below). It is probably just as accurate to measure



the gear and bushing with a micrometer (see photo). For example, if second gear measures 1.155 wide, and the bushing is 1.283 in long with a 0.123 thick top hat, then the gear float is 1.283 – 0.123 – 1.155 = 0.005. The gears seem to wear very little. All that I've measured are within the original specs: 1.218 ± 0.001 for third and first and 1.155 ± 0.001 for second. A quick measurement of the bushing gives a good indication of gear float, i.e. first and third should be greater than 1.222 and second should be at least 1.159 (excluding the top hat).

**Overall Float:** Once you've got the correct gear float, you must insure the overall float for the gear cluster is correct. The early manual specifies an overall float of 0.007 to 0.012, while the later manuals specify 0.003 to 0.009. The variation in these specs makes you wonder how critical the numbers really are.

The overall float is measured by mocking up the assembly. For the second and third gear cluster, install the two washers and two bushings on the main shaft with a circlip. To allow for easy removal, we've cut the end off an old circlip. Now measure the overall clearance with a feeler gauge as shown in the right photo above.

For a four synchro box, you must also check the clearance for the first gear assembly. Install the washer (24), the bushing and the washer (33) on the shaft. Press the center bearing onto the shaft as shown in the photo, then install the washer (35) and the circlip. Once the circlip is positioned, you must turn the shaft around and press the bearing back until it is firmly against the circlip. Now the clearance can be measured with a feeler gauge.

The washers (24) are available in a variety of sizes, so the specified float is achieved by selecting washers of the correct size. Normally, if your bushings are not excessively worn, a 0.118 to 0.121 thick washer will be adequate.

**Step 2 - Synchro Hubs**

The left photo shows a synchro hub. Taking them apart is easy. In fact, they like to come apart on their own. Just be careful not to lose any pieces. To put them back together is more of a problem. We usually clamp the hub on the work bench with a C clamp and then work the balls in while tighten down on the clamp (right photo).

We had not paid much attention to synchro hubs until we worked on a club member’s transmission which was popping out of 2nd gear. We suspected a broken 2nd gear bushing, but that was not the case. In fact, we could see nothing to indicate a problem. Finally, we replaced all the springs in the synchro hubs and top cover. Problem solved.

The manuals describe a more systematic way to test the synchro hubs. Using a scale, arrange a fixture to measure the force required to move the hub from its detents (see photos). The specs vary from one manual to another. We recommend a force of at least 25 lbs for the 1st/2nd hub and at least 20 lbs for the 3rd/4th hub.

If your hubs do not meet this spec or if you do not want to bother with this measurement, you should replace the springs.

**Step 3 - Mainshaft Assembly**

The mainshaft cluster can now be assembled. This is just like the mock up to measure overall float, except this time the bushings are first installed in the gears. Then, install the washer (24), 2nd and 3rd gears, the washer (19) and the clip. Since you're not likely to have the Churchill installation tool, you can use an old top hat bushing or a piece of pipe to force the clip down into its groove.

Next, install the synchro rings, both synchro hubs, 1st gear with its bushing, and the rear washers. The front synchro hub is installed with the large boss forward and the small boss toward 3rd gear. Wire everything together, so it will be ready for installation into the case. The right photo shows the assembly for a three synchro box.

**Step 4 - Input Shaft Assembly**

The input shaft bearing can be pressed on as shown in the photo. The large washer (5) goes between it and the gear. Then install the washer (2) and the snap ring as shown in the right photo. If you're replacing an open cage pilot bearing, just slide it in. A shell bearing should be installed with a bushing driver (see photo of counter shaft shell bearing installation)

**Step 5 - Countershaft End Float**

A washer is used at each end of the countershaft assembly (see photo at right). The larger washer is used at the front. They are numbered 50 and 61 in the early drawing above and 48 and 55 in the later drawing. Originals are made with a bronze facing on a steel backing. The counter shaft diameter is 0.791 (early) and about 0.811 (late). The ID of the washers is approximately 0.01 to 0.02 greater than the shaft diameter. The OD of the larger front washer is about 2.00, while it is about 1.57 for the rear one. The thicknesses are approximately 0.068 and 0.107 for front and rear respectively. The current reproduction washers are of inferior quality without the steel backing. The current crop of reproduction rear washers are also about 0.007 thinner than the originals. Reuse your old washers if they are in good condition.

When the countershaft gears are assembled and installed with the washers, the end float should be checked with a feeler gauge (see left photo). Make sure there are no burrs on the washers or the face of the transmission housing. The specs for this measurement are 0.006 to 0.010 (early manual) and 0.007 to 0.012 (later manual). If the end float is too small, remove some material from the distance piece (item 51 in late drawing), e.g. using a belt sander. If the end float is too great, a shim must be added. You can make your own shim or use shims from a rear axle. The right photo below shows a homemade shim positioned next to the distance piece. Shims for the differential carrier bearing fit nicely at this location. You can also add a shim behind the small washer. Front pinion adjustment shims will work in this position.

**Step 6 - Countershaft Assembly**

First install the bearings. If you have a late model box with open cage style bearings (see part 1), the bearings are replaced by sliding in the washer, bearing and clip. We believe the shell type bearings are better and recommend they be substituted for the open cage bearings. You must use a shell bearing if the inner surface is damaged. Shell bearings are a press fit and should be installed with a bushing driver as shown in the right photo.

To install the loose needle bearings in an early box, refer to the three photos below. First coat the inside surface with grease to hold the bearings. Then place 24 bearings in each end. You will need a ¾ inch OD rod or pipe to hold the bearings in place. This rod should be long enough to hold the bearings, but should not protrude out the ends (about 6 ¼ in long). Slide the rod in place.

Make sure all the gears are in their correct position. Apply some thick wheel bearing grease on the two washers to hold them in place and install the washers and countershaft into the case. Let the countershaft assembly fall to the bottom of the case.

**Step 7 - Putting it together**

Put the mainshaft assembly into the case and slide the center bearing onto the shaft. It is a good idea to wire the reverse gear out of the way (lever back, gear forward) and to use masking tape or some other method to insure the reverse shaft does not slide out. Now drive or press the center bearing onto the shaft. In the photo below, the hub of the center bearing is resting on a pipe bushing, while the shaft is pressed into the bearing. The bearing should go on easily. As the bearing goes on, check the gears frequently to make sure nothing is binding. **Don't forget to remove the wire** before pressing the bearing all the way home. Now install the washer (37) and the snap ring. You now must pull or press the bearing back until it is firmly against the washer and snap ring, otherwise the first gear bushing will have no float. The bearing should slide easily into the case.

Now install the input shaft assembly and 4th gear synchro ring by driving the bearing into the housing. Then turn the transmission top down and work the countershaft gear assembly into position. Make sure the brass washers are in place and slide the countershaft into position. For an early box, this operation will displace the dummy shaft which holds the needle bearings in place. Lock the countershaft and reverse shaft in place. Your transmission should now look like the one below.

**Step 8 - Front cover installation**

Use a hammer and chisel to remove the old front seal, and then install a new one. The left photo shows installation with a tool turned to match the outside diameter of the seal. You can also use a short piece of 1 ¾ in OD pipe. Now install the front cover with its four bolts and the countershaft cover with two bolts.

**Step 9 – Install rear housing or adapter**

**Overdrive:** If you have an overdrive, install the adapter plate on the back.

**Nonoverdrive:** If you do not have an overdrive, attach the rear housing to the back of the transmission. Then slide the washer (39 in early drawing, 37 in later drawing) onto the end of the mainshaft and drive the 3rd bearing into place.

**Step 10 – Install speedometer drive gear**

The speedometer drive gear can now be installed in the rear housing of a nonoverdrive transmission. For an overdrive, the speedometer drive gear is installed after the annulus and bearings are installed in the rear case.

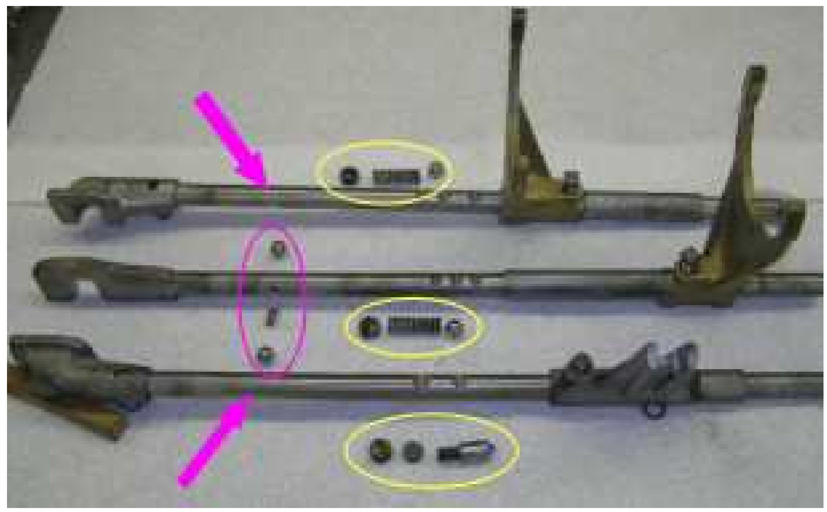
**Step 11 – Install rear seal and flange**

Smear a little grease on a new rear seal and drive it into position in the housing. Then, tap the rear flange onto the splines, install the washer, and tighten the castle nut to 100 ft-lbs. Secure it with a cotter pin.

**Step 12 – Top cover**

The top cover is probably neglected in most rebuilds. However, you should at least check the condition of the detents. You should also renew those rock hard 40 year old o-rings that seal the shift rails and you may need to add or modify the location of the switches in the cover.

There were numerous changes of the top cover during the production of the TR models. The biggest change was between the 3 synchro box (left photo) and the 4 synchro box (right photo). The only obvious difference is the reverse selector, but the other forks, distance pieces and the aluminium casting are all different. Most of the other changes were to do with the number and location of the switches for overdrive, back up light, seat belt interlocks, etc.



Regardless of these changes the basic mechanical features are similar for all of the top covers.  Each of the rails has a detent for each gear and a spring and ball (or plunger) and sometimes a small distance piece or spacer (yellow circles).  The detents are to hold the transmission in the selected gear.

There is also an interlock mechanism to insure that two gears aren't selected at the same time.  The interlock consists of two balls and a small shuttle rod (circled in pink). The balls are free to move laterally within a bore in the cover. The center rail has a hole for the shuttle which is chamfered to form a detent.  There are also detents in the sides of the outside rails (pink arrows).  The interlock detents are all located at the neutral position.  The clearances are such that at least two of the three rails must be in the neutral position.  For example, when second gear is selected, the shuttle and balls are shoved toward the reverse rail and into its detent.  This action holds the center and reverse rails in the neutral position.

The detents and springs are probably the most important parts in the top cover.  If these are not working properly, the transmission can jump out of gear, with 2$^{nd}$ gear being the most common problem.  There were several variations of springs and balls/plungers used in the various models. The TR2 through early TR4 boxes used the arrangement shown in the photo above, i.e. a plunger, small spring and spacer for the reverse rail and a larger spring and ball for the other two rails. According the Moss catalog, after CT9848 (early TR4) the center rail components became like those for reverse.  With the TR250, the springs were changed for the 1$^{st}$/2$^{nd}$ and 3$^{rd}$/4$^{th}$ rails and a spacer was added for 1$^{st}$/2$^{nd}$.  In mid-1971, the 1$^{st}$/2$^{nd}$ and 3$^{rd}$/4$^{th}$ components became exactly like the early TR2-4 boxes, except that a spacer was used.  An original spacer measured 0.194 inch. This should be enough to increase the release force about 10 lbs.  I question whether the springs for late TR6s were really the same as TR2/3.  How can the two have the same release force (see table below) when one uses a spacer and the other doesn't?  You should check the release force if you are using replacement springs.

The table below contains the detent release force specs from the manuals, while the photo shows how to check it with a scale. The specs differ between the manuals. In some cases the specs are different even though the ball and spring arrangements were the same. You should definitely honor the $1^{st}/2^{nd}$ gear specs, but a lesser force is probably adequate for the other two rails. The spec can be achieved by either changing springs are by shimming the spring to achieve a greater preload.

| Manual/Rail | First/Second | Third/Fourth | Reverse |
|---|---|---|---|
| TR2 & 3 | 32 to 34 lbs | 17 to 20 lbs | 21 to 23 lbs |
| TR6 & TR250 | 32 to 34 lbs | 32 to 34 lbs | 26 to 28 lbs |


The detent components (spring, ball, etc.) are removed by unscrewing the slotted plugs as shown in the photos below. Late TR6 covers have pressed in plugs, which must be drilled out. The o-rings which seal the shift rails are beneath a cover plate where the rails emerge from the housing. Replacement of the o-rings requires removal of the shift rails. To remove the shift rails, unscrew the set screws which secure the shift forks and withdraw the rails from the case. The small shuttle rod should come out with the center rail, but the interlock balls will be loose in the housing, so work them out by tilting the housing. Reassembly is done in the reverse order. The interlock mechanism is a bit tricky. You must have the interlock balls positioned in their detents in order to get all the rails in.

**Adding cover switches:** You will also have to dismantle the cover if you need to add switches. In most models, the switches are tripped by the top of the shift fork when it is beneath the switch, and the switches are easily located by the boss in the top of the cover. To add switches, you will need a 16mm x 2mm metric tap and a 35/64 inch drill. Some of the later TR6 models have switches at other locations, e.g. those activated by the interlock mechanism. We have never added or modified switches of that type.

**Installation:** To install the cover, first put the gearbox in neutral and position the shift rails to neutral. Then slide the shift forks into their respective locations in the box as shown in the photo. Secure it with the 8 cover bolts.