TR250/TR6 Reliable Clutch

Objective: I hate to pull the gearbox to make clutch repairs. It is about 4 hours to take it out, 4 more hours to put it back in and then about 6 trips to the chiropractor. I think it should be possible to get 100 K miles between pulling the gearbox. That is now my objective --- 100K miles. I put about 5 K miles per year on each of my TRs, so that should last me 20 years. By that time I'll probably me too old to drive (some think I'm at that point already).

As a start, I'll rebuild the gearbox, making sure I have a new countershaft and countershaft bearings. It's not much good to fix up the clutch and then have the gearbox fail. I'll also replace the rear engine seal.

The clutch seems to be a constant aggravation for many TR250/TR6 owners. Apparently a few years back there was a quality problem with the standard RHP release bearing. At least one of the big three claim the current RHP bearing is still not of the quality of the OEM bearing and advise against using it. I've used the RHP bearing recently and found no problem, but will do about anything to avoid pulling the gearbox. Other people have had the same reaction and many purchase kits to replace everything in sight. Unfortunately, some of these kits contain components that were not designed for the TR6 application. These components cause other problems, with failure as likely or more likely than with the RHP bearing. I discuss each of these issues in the following and describe what I'm going to do to get the 100K miles.

I'm limiting myself here to the part of the clutch system that goes between the gearbox and engine. The part of the system between the gearbox and the pedal assembly --- the clutch hydraulics and pedal itself are much more easily accessed ---- one-chiropractor visit jobs. Those parts of the system are discussed in the "Clutch Hydraulics" note and the pedal assembly is discussed in the "Pedal Assembly" note in the brake section.

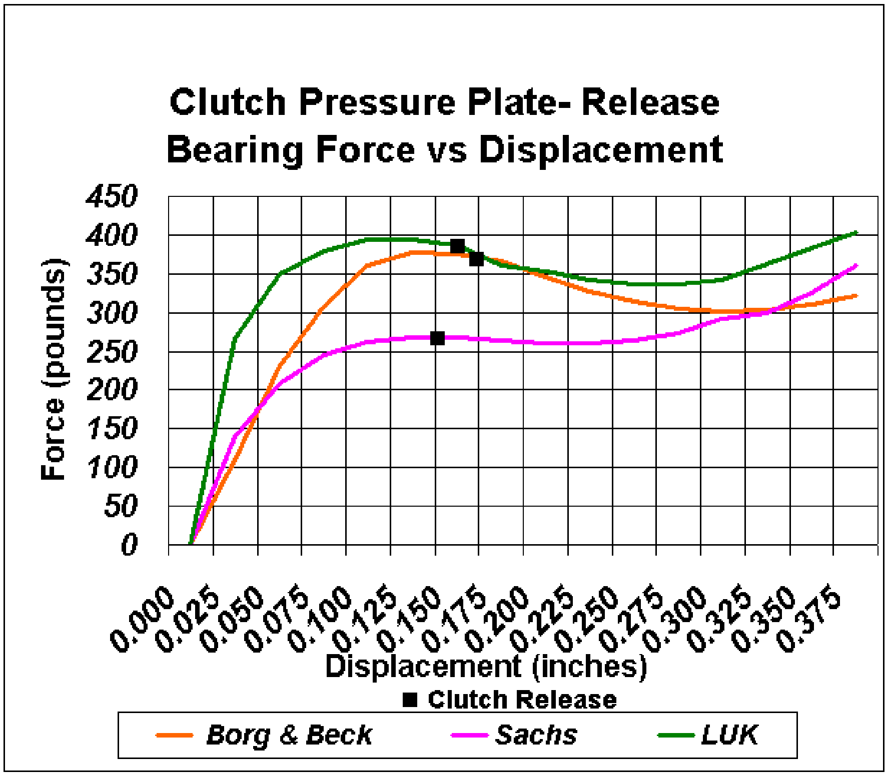
The part of the clutch system that requires removal of the gearbox to get at (the 6 chiropractor visit job) includes:

- The clutch pressure plate & disk
- The clutch operating shaft & fork
- The clutch release bearing &sleeve.

Clutch pressure plate & disk: I've never had a problem with either the clutch pressure plate or the clutch disk. From the comments on the email lists others also seem to have little trouble in this area.

The TR250 & early TR6 were originally equipped with Borg & Beck clutches and the later TR6 was originally equipped with a Laycock clutch. Neither of the OEM clutch models are currently available. I have one of the original Laycock clutches that requires about 300 pounds to release. Mark Riddle reported that the force to release the early style Borg & Beck was a little over 300 pounds. Both these measurements were on used units that may have weakened somewhat. Both the OEM Borg & Beck and Laycock clutches were available during the early 80s and the Borg & Beck had a reputation for being somewhat stiffer.

What I want is a high quality clutch that has sufficient force so that it doesn't slip while not being overly stiff to minimize the forces on the clutch release mechanism. I'm aware of three different high quality clutch pressure plates currently used in the TR250/TR6. The major difference I see is the amount of force needed to release the clutch. I measured samples of each of these pressure plates and reported the results in the "Clutch Measurements" and repeat in the following graph.



The Luk Clutch (#19-030) requires the greatest release force and is probably overkill for the TR6 application. I've had good luck with the current Borg & Beck (AP# HE5132Q) and will not hesitate using it. The Sachs (#3082 100 041 and stamped Type MF215) clutch is very interesting in that it requires much less release force and should have less wear and tear on the release system. With the reduced horsepower on the US version of the TR6, the Sachs is probably the best choice for the long haul. If I had an enhanced HP engine, I'd probably use the Borg & Beck pressure plate.

Most of these clutches are supplied with the Luk brand pressure plate that seems to perform very well and I will use it in my TRs

Operating Shaft & Fork: Overhauling the clutch operating shaft and fork area is discussed at Clutch Operating Shaft Overhaul (and that nasty pin). To fix this area for the 100 K miles I've decided to do the following things that are discussed in that note.

1. Replace the shaft if worn in the bearing area or if chewed up in the area of the fork pin.
2. Install grease fittings on the shaft or purchase the earlier style shaft with grease fittings.
3. Install a double set of shaft bearings or use the longer TR4 bearings.
4. Replace the fork if there is any sign of cracking.
5. Verify that the pins in the fork that push the sleeve are solid and secure.
6. Use a new high quality pin between the fork and operating shaft.
7. Cross drill the fork and shaft and install a backup pin. My favorite choices are a 1/4" or 5/16" bolt or a taper pin threaded on the small end for a nut.

Release Bearing and Sleeve: I'm aware of three different release bearings used in the TR250s/TR6s plus a new addition. The photo below shows the four.

The RHP is the OEM bearing. The TR250/TR6 is designed to have the release bearing held against the pressure plate at all times. There is a spring in the slave cylinder that provides a small preload to keep the bearing against the pressure plate when the the pedal is released. The RHP bearing turns fairly easily and this preload is probably sufficient in most cases to keep the bearing turning . The small preload is integral to the self-adjusting feature. Each time the pedal is released the bearing and hydraulics are positioned with all slack removed from the system.

As mentioned earlier, there have been considerable problems with the quality of the RHP bearing in the last few years. Many have failed after a few thousand miles or less. While I've had not problem myself, I'll not going to use the RHP bearing in the future.

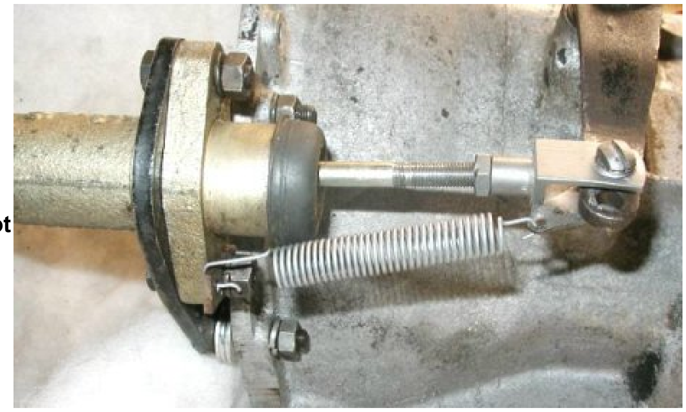
The Green bearing is similar to the RHP. I believe it is an "after market" version sold by local auto stores. I've seen several dozen release bearings and the only one I've actually seen that has failed is the Green bearing in the picture. It had less than 50K miles service. I'm not going to use the Green bearing in my TRs.

Folks started using the KOYO bearing after the flurry of quality problems with the RHP bearing. This KOYO bearing is OEM for the 1975-1986 Toyota Land Cruiser. It has the feel of a very high quality bearing --- a real confidence builder. The KOYO bearing has the same ID as the RHP bearing so it can be pressed onto the standard sleeve. Unfortunately, the KOYO has it's own set of problems.

1. First, if the KOYO bearing is used as a direct substitute, in many cases it won't work properly. The problem is that it is much stiffer (harder to turn) than the RHP bearing. In many if not all cases, the small spring in the slave cylinder provides insufficient preload to overcome the bearing resistance. The net effect is that the bearing is held against the pressure plate but doesn't turn. The symptom of this is a continuous chirp or squeal that goes away if a slight pressure is applied to the pedal. A far more serious consequence is that the squeal or chirp indicates that the bearing is eating through the spring fingers. The photo on the right is of a pressure plate that shows significant wear after less that 5K miles One can easily project broken spring fingers after less than 20K miles. Reports from others suggest that this is typical rather than the exception.

2. Many suggest solving the insufficient preload problem in (1) by changing the design to pull the bearing away from the pressure plate using a spring and adjustment mechanism similar to that shown on the right. This is essentially the TR3/TR4 scheme. With this arrangement, the clutch doesn't chirp or squeal all the time, just every time the clutch pedal is pressed. Friend Dick Taylor says he won't drive a car that squeals every

time he presses the clutch. (Maybe he needs louder mufflers so you can't hear the squeal). I don't like the scheme because it introduces slack into a system that has very little margin and it disables the self-adjustment feature. It is like replacing the front disk brakes with drum brakes from an early TR3. **Not in my car!**



3. OK, so I don't like the adjustable clutch and squeal in (2). How about we increase the preload. That does work and cures all the operational problems. Dick Taylor has found 10 to 15 pounds preload works. One problem I have with this is that the KOYO bearing doesn't rotate all the time in the Toyota application. I don't know whether it is designed for continuous operation. I don't think I'll risk it.

4. Another problem with the Koyo bearing is that the ring which engages the pressure plate spring fingers is a larger diameter than the RHP bearing, so much so that it is near or at the bend in the fingers on the Borg & Beck pressure plate and probably should be not be used with that pressure plate. The larger diameter ring means that it presses against the spring fingers closer to the fulcrum necessitating a greater force to release the clutch. I compared the force required to release one of the clutches using the RHP and KOYO bearings and found that the KOYO requires a little over 8% greater force.

The KOYO bearing is really nice. Unfortunately, **it doesn't match the TR6 application and I won't use it**.

So, I won't use the RHP, Green or KOYO bearings --- what am I to do? I had planned to go to the local transmission shop and look over old release bearings to find something of the correct size from a high quality vehicle where the bearing is preloaded and rotates all the time. I was going to look at pickups first such as the later model Ford Rangers --- I know they are preloaded and seem to last, didn't know about the size. At about this time I became aware of the Gunst Bearing shown on the right in the earlier photo. It meets these requirements. Before talking about the Gunst bearing I want to address the sleeve.

Another common clutch problem is that it sticks when pressure is taken off the pedal and then jumps causing a jerky engagement. I've called it the sticky clutch -- others have called it the binary clutch. In the accompanying note at Sticky Clutch I describe how many of us have traced the problem to rough front covers and sharp edges on release bearing sleeves. I understand that there have been problems in this area for years. However, it seems these problems have been worse recently. The inside edges on the current new sleeves are very sharp and the sleeves seem to be hardened making the situation even worse. (One is probably better off using an old used sleeve that is of softer steel and has smoother edges than one of the new sleeves.) I've had 100% success curing sticky clutches by merely smoothing these edges and the front covers and using a high quality lubricating grease.

Some time in the past I learned that brass sleeves were used someplace (I thought Dick Taylor said he used one, but he says no). Then I noticed that TRF lists a brass sleeve for the TR3/TR4 ----- that must have been where I saw it. Anyway, brass is much softer and less prone to grabbing than steel, a much better choice. Another thought was to wait until I found the bearing I wanted to use and then get some bronze bearing material and machine my own sleeve (I have a lathe in the workshop).

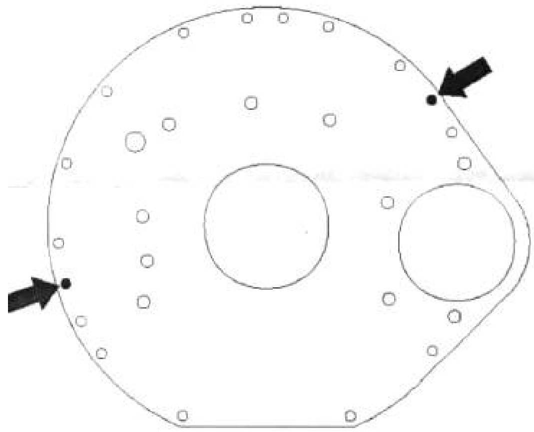
At about the time I reached these conclusions Wiard Pless up in Canada suggested I go to http://www.gunst.de/ and check out the release bearing kit. The site is in German but after some scrambling with online translators I was able to understand the release bearing kit offered by Joachim Gunst. Gunst has a business repairing British Autos -- TRs, MGs, etc. Some time back he had to redo several clutch jobs -- release bearings failed very quickly or the sticky clutch ---- just like us over here. He then had a sleeve manufactured in bronze and fitted a high quality release bearing --- one that he says is used in a high quality automotive application. The Gunst bearing with sleeve is shown on the far right in the earlier photo.

Gunst now provides a kit that contains the bearing and sleeve as well as a pair of dowel pins, a bolt, a steel strap a spring and a packet of grease as shown on the right. The spring, strap and bolt are used to provide a preload of about 15 pounds to keep the bearing spinning when there is no pedal force. The grease is to lubricate the sleeve - front cover interface. The pins serve to align the gearbox with the rear engine plate. The instructions with the bearing kit were in German. Wiard Pless provided the following translation.

Important! Prior to installation make sure the two dowels between the engine plate and the gearbox are present. Missing dowels can cause rough jerky clutch operation as the release bearing is not centric to the clutch (See drawing)

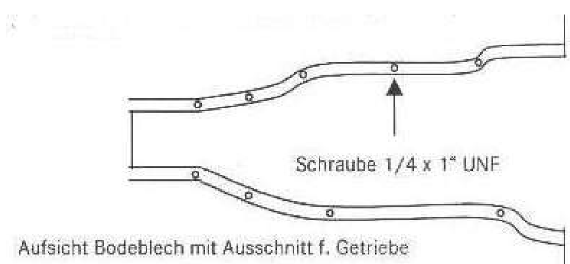
The same applies for the two dowels between engine and engine plate.

When renewing the release bearing we recommend to check the complete hydraulic mechanism. The release bearing should not be used with a clutch having rounded spring tips. In sporadic cases it can cause whistling noises

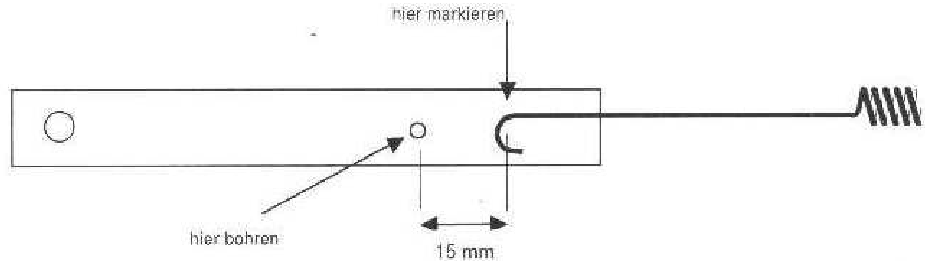


Installation of the Release Bearing

1. When installing a new release bearing make sure the clutch is in a good condition. Especially check that the spring tips are in the same position parallel to the fly wheel and do show not any signs of wear. Worn spring tips restrict the rolling and consequently prevent a soft clutch action. Temporarily install the release bearing without grease on the shaft of the gearbox. If it does not slide smoothly locate high spots and sand down. If considerable force is required to push on the release bearing most likely the tube on the shaft is damaged (crack, out of round)
2. Apply grease supplied (do not use grease containing solids) and install release bearing. Also apply a thin layer of grease to the surface of the release bearing and the spring tips.
3. Install gearbox and clutch slave cylinder. Secure the push rod in the center hole of the clutch cross shaft lever. (Make sure that the extended center line of the push rod is in the center of the clutch slave cylinder.) Don't install the prop shaft yet.
4. Press the clutch pedal several times and then with clutch pedal pressed and in gear turn the exit flange of the gearbox. If you are able to turn the flange the clutch is working properly.
5. Connect prop shaft and install gearbox cover. Change the 2nd gearbox cover securing screw (engine side) on the left side with the supplied ¼ x 1" screw (see drawing).



6. On this screw install from underneath the supplied metal strip in such a way that it is pointing forward.
7. Install spring in lower hole of the clutch cross shaft lever.
8. Now just line up the spring with the metal strip and mark as shown in the drawing.



9. From the marking measure 15mm and at this point drill a 3mm hole, install the metal strip and hook up spring. Now the release bearing will have the necessary consistent pressure on the clutch.

A few weeks before I received the bearing kits from Gunst, Casey Van den Dorpel sent an email describing a clutch problem he had. Casey pointed out that there are two precision drilled holed in the gearbox casting that require 3/8 inch bolts, have very little clearance and serve an indexing function to keep the gearbox centered on the flywheel and clutch. These are the same two holes that Gunst says to use dowels. I measured those holes and found them considerably smaller that the starter mounting holes which also use 3/8 inch bolts. With that advanced notice, I understood Gunst's use of the dowels. I'm not sure if the dowels are really needed, but it's clear that one should as a minimum use 3/8" bolts and not use 5/16" bolts in those two positions. I will follow Gunst's recommendation and use the dowels.

The preload spring is also very interesting. Dick Taylor used something different with the KOYO bearing. He put a much stiffer spring in the slave cylinder. That spring had a force of about 20 pounds. He then used an external spring going the other way to lighten the load. He had a turnbuckle in series with the external spring so that it could be adjusted. He ended up using a net preload of about 10 pounds on the KOYO bearing. (In the note on release bearings I point out that modern vehicles use a substantial preload spring. I also point out that TR250 (1968) was very early to use the self adjusting clutch ---- probably one of the first. By contrast, the Toyota Land Cruiser was still using the obsolete technology in 1986.)

I've cited what other folks have done that is similar to Gunst's scheme not to take anything away from it but rather to support his view. Gunst is the first that I've seen who covers all the bases. As he explained it, he was getting tired of redoing clutch jobs at his own expense. He has a real financial self interest.

The bearing kits are available directly from Gunst. The current price listed on his website is 95 Euros including VAT which is about $95 since the dollar and euro are at about parity now in mid 2002. If he ships the bearings out of the country he doesn't charge the VAT of some 15% or so. Shipping from Germany is very expensive. Ground transport takes a month, so I'd suggest airmail, which will probably cost 15 to 20 Euros per bearing kit. He accepts credit cards and can be contacted via email at Gunst@t-online.de. He has expressed an interest in getting someone in the US to handle the kits. I'm looking into that at the moment and will let you know if I find someone to stock the kit.

Dick Taylor has over 5000 miles on one of these kits and is very satisfied. I have one that I'm going to install in my TR250 but am holding off so that I can show it to people I'm trying to interest in stocking the kit. At this point I plan to use the Gunst kit in my TRs and am confident that it will help me achieve the 100K mile objective.

Thrust Bearings: The small constant preload on the release bearing is transferred to the front crankshaft thrust bearing. While the force is insignificant relative to the force when the clutch is released, it is present all the time. Therefore, one should keep an eye on the crankshaft end float, and replace the thrust bearings as soon as the end float exceeds specifications. (This is true even if you're not using additional clutch preload.) Dick Taylor says he disconnects the preload spring to make the measurement. He says he's seen no measurable wear after about 8K miles on a preloaded KOYO bearing and 5K more miles on a preloaded Gunst bearing. It's probably wise to check it every 10K miles and more frequently if any wear is observed. I plan to check mine a bit more frequently and will plot the wear vs. miles traveled. Don't look for results in the near future as I don't put that many miles on the TRs. We'd be delighted to publish measurement data from any of you folks that install the Gunst kit and are willing to measure and record the change in end float over time.

Pilot Bushing: A number of folks have reported curing various clutch problems such as squealing and stickiness by staking the pilot bushing in the back of the crankshaft. Staking means to rough up the outside of the bushing so that it can't turn in the crankshaft. This forces the gearbox input shaft to turn inside the pilot bush when the clutch is released. I've never understood why it would matter whether the bush rotated or not since in either case it would be bronze against steel. I was also suspicious that the staking might cause a slight misalignment. After learning about the alignment function of those two 3/8' bolts I now suspect that in some of the cases 5/16" bolts had been used in these holes the problem was cured not by staking the bush but by taking the gearbox off and reinstalling it with and by luck achieving a better alignment. Until I'm convinced otherwise, I'm not going to stake the bush in my TRs and risk causing an alignment problem.

International Cooperation: This project has a real international flavor. Wiard Pless is from eastern Canada and I believe is of German background ---- at least he was able to translate the German to English. Casey Van den Dorpel lives in far western Canada and I believe is of Dutch background. Casey helped me translate passstifle to dowel as well as providing input on gearbox-engine alignment. Gunst has his business in Heidelberg, Germany. Dick Taylor is from southern California ---- many of us in the eastern US at times wonder what country that is, and I live in the hills of eastern Ohio. Oh --- I almost forgot --- the TRs are British --- a minor point. The Internet sure eases such communication.

Feedback: We're anxious to receive feedback on this and any other topic presented on the website. We will be happy to publish views that both support and refute any of our data or conclusions. After a lifetime in research and development I learned that the dissenting views frequently contain the most useful information. (I've also leaned that this doesn't apply to the domestic situation.)

Implementation (late July, 2002): I had intended to first use the clutch arrangement described above in my TR250 which will be dismantled for painting later on the summer. However, while painting my '76 TR6 I noticed a big puddle of oil under the engine-gearbox joint. So I decided to pull the gearbox, fix the leak and install the reliable clutch as described above. The leak was from the countershaft end cover. That cover had leaked before so I replaced the end cover and then stood the gearbox on end for a couple days to make sure the cover was really sealed.

What I did for this project was:

1. Replaced the engine rear main seal.
2. Replaced the pilot bush, but didn't stake it.
3. Reused the standard LUK friction disk that had less than 2K miles on it.
4. Installed a new Sachs #3082 100 041 pressure plate (TRF # HP123)
5. Measured and **recorded** the crank end float. Now if I can remember where I recorded it.....
6. Replaced the clutch operating shaft bushes with the TR4 long brass version (#36998)
7. Replaced the clutch operating shaft with the TR4 version that has grease fittings (#108887).
8. Replaced the clutch fork. Didn't grind a flat on the side of the pins that engage the release bearing sleeve. (I never understood why these should be flat as I've seen on most the forks I've removed.)
9. Installed a new clutch fork pin.
10. Cross drilled the fork and shaft and reamed the hole for a #5 taper pin. Threaded the small end of the pin 1/4-28 and used a nyloc nut to secure the pin.
11. Replaced the gearbox front seal.
12. Polished the gearbox front cover with emery cloth.
13. Used the Gunst release bearing and sleeve.
14. Applied a thick coat of the grease in the bearing kit to the front cover. Also applied grease to the front of the bearing where it presses against the pressure plate.
15. Used the alignment dowels supplied with the kit in the holes specified between the gearbox and engine rear cover.
16. Used a small turnbuckle instead of the strap supplied with the kit to secure the rear end of the preload spring. I did this so that I could adjust (play with) the preload force. Initial adjustment was at a little over 1/2" spring stretch with the spring in the upper hole.

The follow photos shows the installation.

That's the Sachs pressure plated mounted on the flywheel. The alignment tool is still in position.

Photo on right shows the polished front cover.

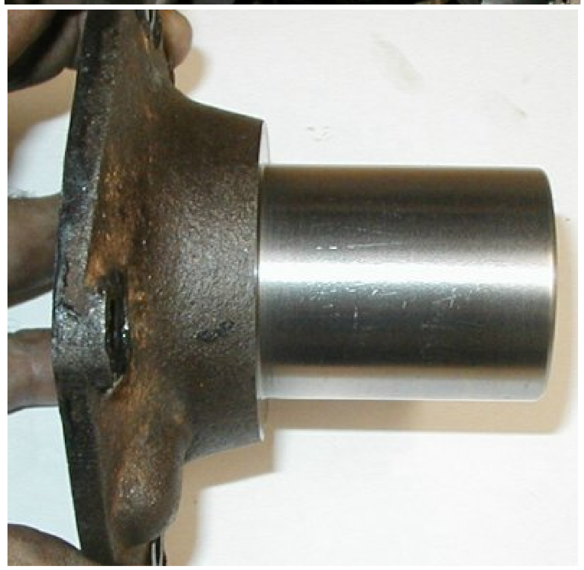
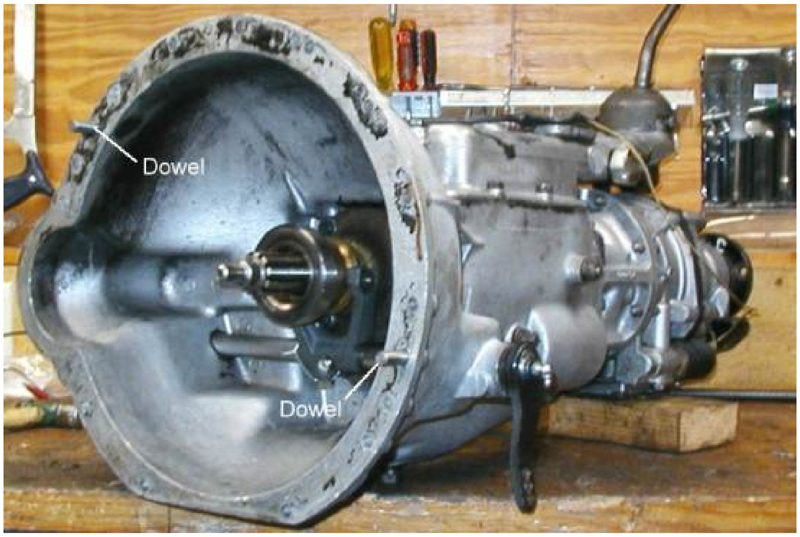


Photo below shows the operating shaft, release bearing and associated components.

That's the gearbox on the bench ready to be installed.   Note the indexing dowels.

Photo below shows the spring and turnbuckle connected to the operating shaft arm. I have the spring in the top hole in the photo. This photo is taken from the right side.



Results: The first test drive was a real shocker --- barely had to press a very soft pedal to release the clutch. I measured the pedal force at ~25 pounds and the motion to release the clutch at about 1.5 inches. I'm using the 0.7-inch MC that was standard for the '76. This is exactly the opposite of most clutch problems -- it requires too little pedal motion and too little force. Interestingly, the actual operation exactly matches that predicted for the Sachs clutch using the measured release force and displacement with the and the graphs in the Clutch Release Calculations note. I increased the pedal motion some by moving the slave cylinder push rod to the lower hole on the operating shaft arm. This however, made the pedal even softer.

Wussy Clutch: This clutch is so soft I decided to call it the **Wussy Clutch.** While the wussy clutch is certainly nice from some perspectives, I prefer a little stiffer operation so I plan to use the Borg & Beck pressure plate in my TR250. Should have feedback on that by mid October.