

FD Transmission Rebuild

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With credit to forum members JD To Rescue and RotariesRule for their tips, NewbernD (Dave) for his suggestions, and ZKeller (Zach) for his loaner tools.

This article is a compilation of my notes and pictures from rebuilding the transmission on my 94 R2. I determined to try my own teardown when it started making audible bearing noise in neutral with the clutch out, that it shifted a little rough, and because in its past life it saw some very tough autocrossing.

This job IMO is about a week of evenings and weekend days. Although I had the benefit of unlimited time, my tiny garage, freezing winter temps, lack of power tools, lack of transmission rebuilding tools, and working alone presented some challenges. I spent many days not working due to the cold or waiting for parts/tools to arrive. Expect that there is a chance you might miss something or make a mistake and repeat some work. Because of that, I suggest you double-check everything before installing each bearing or bolting any housings back together. I feel the FSM information is sufficient, but on a task of this size human error is always a risk. For these reasons, I would never attempt this job for the first few times on a fixed time schedule.

Disclaimer:

I am providing this for information only. I accept no responsibility for inaccuracies in the information presented here, or for damage, loss, or injury caused or implied by the information in this document. I claim no responsibility if reading this monstrous document gives you a headache, or you choke of boredom from reading my ramblings laden with dry humor. When it comes to rebuilding transmissions seriously, there is no substitute for proper training, documentation, or paying someone else to do it. This is just me writing some of what I know, take it or leave it.

I performed the following tasks:

1. replaced 1st-5th synchros
2. replaced 5th clutch hub sleeve
3. replaced the back-up switch, 1st-2nd switch, and neutral switch due to hardened and broken wiring, and reinforced the wiring of the new switches with self-fusing silicone tape.
4. replaced the throwout bearing, pilot bearing and seal, input shaft main bearing, and input shaft/output shaft bearing.
5. replaced front and rear oil seals
6. replaced all 3 shift forks (1-2, 3-4, 5-R)
7. replaced mainshaft rear bearing
8. removed the flywheel and verified engine block bolt torques
9. changed to Neo 75W-90 Synthetic Gear Oil
10. installed new Mazda studs and nuts at the turbo manifold/downpipe connection
11. installed a stainless steel clutch line
12. installed a new steering wheel and new R1 lip
13. replaced the differential bushings
14. installed a Racing Beat Dual-Tip Muffler

Some other common tasks to do with a tranny job are:

- replace shift select spindle with stiffer version (the 94+ use an updated part, so this is a nice upgrade for a 93)
- change clutch, flywheel (always resurface the flywheel)
- install reinforced or upgraded powerplant frame
- replace shifter bushings and boots
- change fuel filter
- install updated 2nd synchro and 1-2 clutch hub set (93s and early 94s)
- install shorter ratio 5th gear set

Why rebuild?

There are several major reasons why a manual transmission requires a rebuild.

- 1) Worn or damaged bearings
- 2) Worn or damaged synchros/shifting components
- 3) Damaged gears or shift mechanisms (“hard parts”)

Worn bearings are frequently diagnosed by noise. A worn input shaft bearing, for example, will make a howling/whirring/rotating noise whenever the car is in neutral and the clutch is engaged. In many cases, the noise is loudest when the car is cold and the gear oil is thick and not well distributed through the moving parts. Lastly, dirt in the oil, particularly silvery metal flakes, indicate worn bearings.

Bearings are wise to replace anytime you take apart a transmission. This is because 1) they are very important and not too costly, and 2) removing them usually damages them, especially in the case of ball bearings, which the FD transmission uses extensively. While Mazda bearings ensure you get the exact make and model of bearing, you can save some money without sacrificing quality by buying your bearing and seal kit from a source other than Mazda. These kits usually have the exact same brand the type of bearings as supplied by Mazda.

If you have poor shifting in one or all gears, you should consider replacing the synchros. While synchros are not the only parts responsible for smooth shifting, they are the first to wear out and arguably the most important. As well, they aren’t terribly expensive to change “while you’re in there”. I particularly recommend replacing 5th synchro if you have the original one, and 2nd and 3rd synchros since they typically suffer the most abuse.

Also affecting shift performance, the actual gears and clutch hub and sleeves play a significant role. The dog teeth can wear and lose sharpness; these are the bits that make the grinding and clunking when a shift doesn’t engage smoothly. Replacing these parts gets expensive quickly, since each gear or clutch set costs about \$300 and Mazda is the only source for a replacement.

Damaged gears are straightforward – if you have a gear that you can’t shift into, or a gear that transmits no torque, it’s safe to say something more substantial has failed. It’s hard to say what the cost will be until things are taken apart and inspected. I do NOT recommend driving a car with damaged hard parts at all, unless you intend to completely junk the transmission.

Rebuild or Replace?

This is the next logical question when faced with transmission repair. Currently, imported transmissions of low mileage are available for less than the cost of a rebuild. In most cases they are in good condition and can provide many miles of trouble-free service. You will have minimal downtime. However, it pays to be careful. If you choose to buy a used tranny, I strongly recommend taking it to a transmission shop for a quick inspection. With the bottom cover removed, much can be learned about the state of the tranny in a short amount of time. First through 4th gears are easily viewed and the magnet is accessible

to look for chips of gear or bearing flakes. It's much better to find a problem before installing the tranny in the car.

Tools and Preparation

This is a job that requires the appropriate tools and techniques. It doesn't require a mechanic, but you must use your head and stop when you don't have the ideal tool. I am willing to rent the specially-made tools (super-long socket, puller and extensions, pilot bearing puller, etc) for a refundable deposit minus shipping and \$20 per every 2 weeks you keep them. Email me at geesaman@newsguy.com if you are interested.

I also recommend buying the book *How to "Rebuild and Modify your Manual Transmission"* by Robert Bowen. The pictures, warnings, procedures, and tips are invaluable. This book fills in much of the theory and information that is important to know but not discussed in the Factory Service Manual.

- Torque wrench (up to 120ft-lb is ideal, and if you're removing the flywheel nut a 400ft-lb wrench is also useful)
- Floor jack and transmission jack (or just 2 floor jacks). I bought one of those transmission jack attachments for a regular floor jack – it works, but it adds about 8" to the jack height. You will need extra tall jackstands to use one of these adapters.
- 4 jackstands
- Breaker bar, extension pipe, PB Blaster Penetrating oil
- Gloves and good safety glasses.
- a couple rolls of paper towels
- Inside and Outside Micrometer or Dial Calipers
- bore gauge is nice to have, but not strictly necessary
- 2 Feeler Gauge sets including gauges in the .001 to .005" range.
- 3/8" drive x 24" long extension and pivoting adapter for reaching the top bellhousing-to-engine bolts.
- 41mm (1-5/8") socket
- 1-1/4" socket wrench
- clean workspace with excellent ventilation and good lighting.
- oil drain pan
- snap ring pliers with the pin tips (\$12).
- "Inside" snap ring pliers. These are pliers that squeeze open and have flat textured tips for stretching open the snap rings that don't have holes. (\$20)
- 5T press (or access to one for a couple hours)
- 2-Jaw Gear Puller and extensions. I used an Autozone #25914 (\$35) and only needed to grind down the ends a little bit. The extensions are made from steel stock .125" thick.
- Pry bars. I haven't tried it, but I'm told they work well for removing the bearings in the gearbox housing. They would need to be less than 1/2" wide to fit in the housing cutouts.
- 10, 12, 14, 16, 17, 18, 21mm short and deep sockets. 10, 12, 14, 16mm ratcheting box wrenches were also very handy.
- Rolling creeper
- A dremel tool or engraver can be handy for marking the alignment of some parts.
- A parts washing bin would be awesome since there are dozens of oil-covered pieces to handle. Instead, I used brake cleaner. If you're working indoors in winter like I was, be VERY careful with the ventilation – I gave myself a pretty nasty head cold from the fumes and I'll never make that mistake again.
- A box of Ziploc quart-sized freezer bags, and a few gallon-sized freezer bags. The bags with the writeable labels are best. **For each component you remove, put it and its bolts and nuts in that bag, and label it clearly with a Sharpie marker.** This is the only way to get through this job without losing

things – you would need a long open table to lay the parts out, and I didn't have space for that. **Any time you take off a spacer or shim of any kind, put each shim in its own bag and keep the bags in order.** Shims and spacers assembled in the wrong location cause major problems, and while it's important to verify the play created by any shim set, it goes a lot easier this way.



Parts Bag



Ein hefe, bitte!

Don't forget your favorite beverage and random snack foods.

I recommend printing the entire transmission section of the FSM completely and putting it into a 3-ring binder, and maybe also this document. During the job I basically followed the FSM. Although this write-up is long, **there are also many important notes in the FSM I did not repeat.** As you go along, it helps to cross out everything that you've completed so you know you've covered everything.

The issue of replacement parts requires a strategy. There are some parts which you can buy in advance to replace regardless of the condition of the original (t/o bearing, pilot bearing, mainshaft pilot bearing, locknuts, etc). There are adjustable shims and washers, which size you need won't be known until reassembly – they are expensive to buy a complete set, but it would be disappointing to wait an extra week for a couple of washers. One option is to buy the largest size of spacers and take them to a machine shop for grinding when you figure out what size is needed. Another option is to see how your parts supplier feels about returns - if they really don't mind taking returns, buy one in each size and return what is not used. I did not need to change the size of any shims or thrust washers - I think this unlikely to happen unless you replace big parts like housings or shafts. The most affordable strategy is to plan a week in between disassembly and reassembly to evaluate all of the parts and purchase only what you need.

What not to do:

There are a number of components inside a transmission that require special handling and care. Fortunately, some basic understanding and knowledge will save you expensive mistakes.

Handling Gears

While gears have been around in the same basic form for a couple centuries, many people have no knowledge of them. While gears are strong, they do chip easily and they must be kept very clean. When you remove a gear from the tranny, I suggest that you clean it, inspect the bearing journals and gear teeth, give it a light coat of gear oil to prevent rust, wrap it in a paper towel and store in a Ziploc bag.

The clutch hub and slider is a pair of sliding components that should be marked so that they are reassembled in the exact same alignment. (The sliding teeth wear together and work best if you

reassemble them the same way). They should be handled and stored similar to gears to avoid corrosion or chipping.

Handling Bearings

Bearings look sturdy, but they are particularly sensitive to handling. Keep them in the package until it's time for installation to keep them clean. Pay attention to which race ring (inner or outer) has the tightest fit. With ball bearings, never apply a load from the inside race to the outside race. On the FD tranny, the main ball bearings on the mainshaft and input shaft are a tight fit on the inside ring, and a close but not tight fit on the outside. This means that you cannot drive on the outside ring when the inside race is the one resisting the installation. Also never apply force to the rolling elements, plastic oil shield, or metal cage. Ideally you should use a tool that applies load to the inside and outside simultaneously and equally, but in practice it's generally safe to carefully drive against the tightly fit (inside) race only. If you have access to a hydraulic press, it's best practice to use the press to install the bearing. If you don't have a press handy it's generally safe to use a punch and hammer to drive the bearing onto the tight fit, but take your time, advance it in small amounts, and drive at locations all around the race to keep it well aligned.

Handling housings

Aluminum transmission housings are precision parts that must be handled with care. First, watch your fingers since the castings can have invisible but sharp edges. Second, after getting the tranny completely disassembled, I recommend taking the housings to a transmission shop for a washing in their hot solvent parts washer. Third, be careful to not bump or scratch any machined surface that will be sealed or bolted against another part.

If you see a gouge or scratch, carefully use a grinder to remove the high spot so that the mating parts fit with no gap. Use a hard non-metallic scraper to remove the old sealant. After washing, completely inspect all bearing bores for wear, flaws, or cracks.

Handling shafts

Shafts should be handled and stored like gears, but they have another important element: bearing journals. Journals are the surfaces that touch bearings. Care must be taken to not scratch or damage the journals, and especially keep them clean and free of corrosion. I emphasize this since the shafts are exposed to accidental damage during much of the rebuild process. For storage, I like to wrap the journaled parts of the shaft with paper towels and secure them with zip-ties.