The other day I was talking to a technician about a manual transmission problem that he was dealing with. The trans was grinding going into 2nd gear. He was sure the synchronizer was the problem. “But when I opened the trans,” he said, “the teeth on the blocking rings looked fine.”

He was right: The synchronizer was bad. The problem was that he didn’t really understand how a synchronizer worked, so he didn’t know what to look for.

That might sound surprising to you, but I’ve talked to a number of techs over the years that didn’t really have a good grasp on the subject. In fact, I wasn’t completely comfortable with them myself until I was asked to write a manual on the subject a few years ago. And as anyone who’s ever been there before will tell you, if you really want to understand a subject, try teaching it to someone else.

So let’s take a look at synchronizers and see how they work. Once you understand the principles of synchronizer operation, you’ll find diagnosis and repair a snap.

**What Are Synchronizers?**

Synchronizers are devices used in manual transmissions to allow the transmission to shift from gear to gear without grinding. They do this by adjusting the rotation of the shafts within the transmission, so that the gears remain aligned throughout the shift.

Synchronizers consist of three main components:
1. Slider
2. Keys (usually three of them)
3. Blocking Rings (usually brass)

All three of these components work together to adjust the speed of the shafts, and align the gears so the slider can link two of the shafts together.
Overview of a Manual Transmission

In most manual transmissions, all of the gears ride freely on the output shaft. And they’re all constantly meshed with the transmission countershaft. To lock the transmission into a single gear, the slider has to slide over the teeth on one of the gears, locking that gear to the output shaft. This completes the powerflow through the transmission, from the engine to the wheels.

So you’re driving along in first gear. The clutch is applied to the flywheel, and the powerflow is complete through the trans, driving through to the wheels. Now you want to shift into second.

You press the clutch pedal to the floor: This releases the clutch from the flywheel. Now the only thing driving the transmission shafts is the rotation of the wheels, which drives the output shaft. Since the slider still has first gear, the output shaft is still turning the countershaft and input shaft.

You slide the gearshift out of first: This separates the output shaft from the countershaft. Now the two halves of the transmission are still turning at the same speeds, but separately. You want to shift the unit into second gear, but second gear is smaller than first gear, so the second gear teeth are moving by faster than the slider teeth. Which means that second gear, the countershaft, and the input shaft are all turning too fast. If you tried to move the slider over the second gear, it’d grind.

That’s why we have synchronizers: To adjust the speed of the gear, countershaft and input shaft, so they’re all turning at the same speed as the output shaft during the shift.

Synchronizer Operation

As you continue to pull on the shifter, the slider first pushes against the synchronizer keys. These keys, in turn, push against the blocking ring, which pushes the blocking ring into the cone-shaped part of the gear. The blocking ring acts as a brake, grabbing the gear, forcing it to slow down (or speed up, depending on whether you’re upshifting or downshifting).

The two halves of the transmission are now linked together by friction; not enough of a link to drive the vehicle, but enough to keep the two shafts turning at the same speed while you complete the shift.

At the same time, the keys and the notches in the blocking ring have aligned the teeth on the blocking ring with the teeth on the gear. Now, as you continue to push the shifter into gear, the slider rides along the teeth on the blocking ring, using them as ramps to align the teeth on the slider with the gear teeth. This prevents a misalignment problem, so the shifter slides into gear easily and consistently.

Once you have the shifter pushed
all the way into gear, you release the clutch. The two halves of the transmission are now locked in second gear, and you continue driving along... until you’re ready to shift into third, and the process begins all over again.

As you can see, there are a lot of mechanical processes involved with synchronizer operation: Pushing, grabbing, aligning, holding... sounds like shopping the week before Christmas! So let’s see what we need to check to make sure the synchronizer’s working right.

**Synchronizer Checks**

When you push on the shifter, the slider pushes the keys into the blocking ring. So the keys have to be in good shape, and the springs that hold them out against the slider have to be strong. If the springs are weak, the keys will drop out of the way, and won’t put the appropriate pressure against the blocking ring.

Next the blocking ring: Yes, the teeth are important for proper alignment, but even more important - and more likely to wear - is the inside of the synchronizer. This cone-shaped area has to grab the gear, holding it to the slider as the shift begins. If the inside area is worn out, the synchronizer won’t grab the gear, so the gear will grind during the shift.

This is why most manufacturers provide a clearance spec between the blocking ring and the gear. They want you to place the blocking ring down onto the gear, and then check for proper clearance using a feeler gauge. If there isn’t enough clearance, the blocking ring is sitting too low on the gear, so it won’t grab onto the gear during the shift.

What they often don’t tell you is that it’s possible for the blocking ring to have adequate clearance, but still not grab the gear surface. So you should also check for proper friction. Press the blocking ring onto the gear surface, and see if the blocking ring turns freely: It shouldn’t. The blocking ring should grab onto the gear and hold it firmly as you press down.

And check the notches on the blocking ring. If they’re worn, they won’t hold the teeth on the blocking ring in proper alignment with the teeth on the gear. So you could have a gear clash during the shift.

Of course, you also have to make sure the slider and hub are in good shape, and there’s no noticeable wear on the cone-shaped area of the gear. Any wear in any of these locations could cause a problem during shifting.

Last of all, check your assembly: Most shift forks and sliders will fit in either direction, but they’ll only work properly facing one way. The best way to avoid problems during assembly is to mark these components before disassembly. A little notch indicating placement and direction will go a long way toward avoiding assembly problems later.

As you can see, there’s a lot that goes on in a manual transmission during a shift. And it’s amazing how little wear or damage is necessary to cause a problem. Remember the processes involved with synchronizer operation the next time you’re facing a transmission that grinds going into gear.