Subject:

Diagnosing shift problems in manual transmissions

Essential Reading:

- ☑ Rebuilder
- ☑ Shop Owner
- ☑ Center Manager
- ☑ Diagnostician
- ■ R & R

Author:

Mike Weinberg, Rockland Standard Gear Contributing Editor

Why Doesn't It Shift Correctly?

There is never an end to tech-line calls. We keep a written log of all inquiries made on the tech line and break them down into categories based on the type of problem. The two largest groups of perpetual questions are noises and shift complaints. We review shift complaints in this article and try to set up a clear path to analyzing and understanding the causes and effects that generate so much confusion and wasted time.

The first step to any diagnostic solution is to understand the theory of operation of the components involved in the problem and how they relate to each other. What is involved in making a shift with a manual transmission? The clutch set and related components (hydraulics, pilot bearing, release bearing, motor and body mounts etc.) and the transmission internal components and shift mechanism.

To initiate a shift there has to be a disconnect between the transmission input and output shafts. This is achieved by releasing the clutch disc from contact with the pressure plate and flywheel. When this happens the engine is still producing speed and torque, but the input is no longer connected to the engine and is freewheeling. The output shaft is still turning and producing torque because it is being driven by the drive wheels.

At this point the driver can select another gear with the shifter. Here the internal components of the transmission begin to work. The shift rails and forks begin to move the synchronizer slider onto the selected gear. The outer sleeve or slider of the synchronizer moves the synchronizer keys with it. The keys push the synchronizer ring onto the cone of the speed gear being selected.

The synchronizer ring (blocking ring) is a wet-cone-type clutch. As the ring grabs the cone of the speed gear it will slow or speed up the gear depending on whether an upshift or downshift is being made. The teeth on the synchro ring prevent the slider from moving onto the acceptance teeth of the speed gear until the speed gear and output shaft are rotating at the same speed. Remember that the input shaft is disconnected, the output shaft is being driven by the drive wheels and the speed gears are freewheeling on the output shaft. Once the speed gear is rotating at the same speed as the output shaft, the synchro ring will relax and allow the slider to completely engage the acceptance teeth of the speed gear, and the shift is complete.

Once you understand how this is supposed to work, it is easy to see what happens if you are not getting a proper clutch release. If the input is still turning under power, the counter shaft, which is driven by the input gear (main drive gear), also is turning. The speed gears, which freewheel, are in constant mesh with the counter gear and are under power. Trying to shift at this point means that the synchronizer ring does not have enough coefficient of friction to get the speed gear to match the speed of the output shaft, and the shift will be notchy, grinding or blocked out altogether.

A poor clutch release can be caused by many things, and checking all possibilities is important. To save time in deciding where to start with a car that is hard to shift or notchy getting into gear, lift the drive wheels off the ground and try going through the gears. If the shifting improves with lower effort, start with adjusting or bleeding the clutch. There will be

many instances in which you correct the clutch release and still have shift problems. Unless you have been inside the transmission and are sure it is good, you may find that the transmission has collateral damage from the car being driven with a poorly releasing clutch.

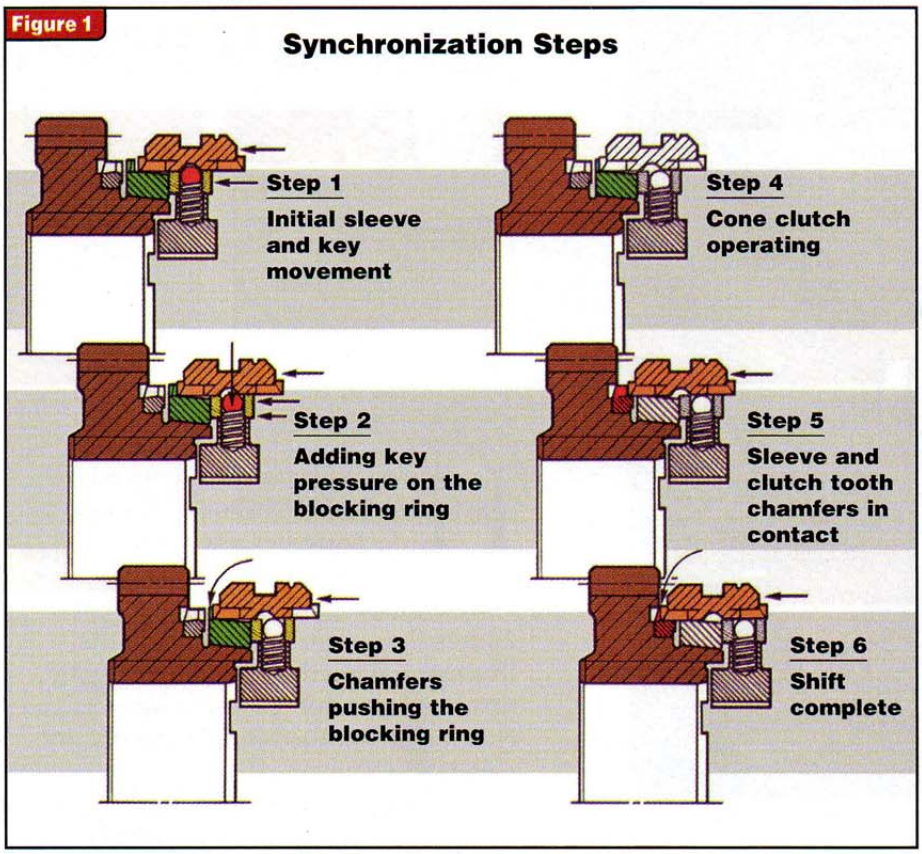
We have discussed gear synchronization, and now we should look at the clutch. When the driver steps on the clutch pedal to begin a shift, there is a time lag, called clutch inertia, before the clutch's rotation slows. It takes time for the disc to separate from the flywheel and pressure plate and for the speed of the flywheel and pressure plate to drop to near idle speeds. If the driver does not allow a few seconds for this spin-down during a garage shift, the shift will have high effort or grind, particularly going to reverse.

A disc that is bent or rusted, twisted splines on the input shaft, or a release bearing and clutch fork not making full travel because of wear or damage will prevent a good clutch release. The standard for a proper clutch release is to measure with a feeler gauge the air gap between the disc and the flywheel/pressure plate, which should be in the range of 0.050 inch. Because of modern designs, you may not be able to make that measurement with the unit in the vehicle.

You should always examine the entire clutch system carefully. This will include the hydraulics; cables; grommets; cable quadrants; flexing of the firewall; bent, worn or deflected pedals; missing or damaged springs; damage to the bellhousing; powertrain mounts; and accident damage to cross members. I have seen more than one customer who used thick pieces of household carpet to cushion the floorboards, restricting clutch-pedal travel and causing a poor release.

Is the problem temperature sensitive? Does the car shift well cold and then have problems when it warms up? Check the routing of all hydraulic lines to make sure they are not exposed to enough heat to boil the fluid. Make sure all heat shields are in place. Seals in the master and/or slave cylinder may be leaking and allowing the fluid to bypass when it is warm and the viscosity decreases.

Figure 1



Does the car shift well when warm and badly when cold? Make sure that the proper fluid is in the transmission. A high-viscosity fluid will create cold-shift complaints. An incorrect fluid will create high shift effort, noise, overheating and damage to the synchronizer components.

Make sure that the correct clutch set is installed. Many times we have found that the clutch set installed did not match the design specified. This can happen easily when a customer installs a performance upgraded clutch set. The clutch will work in that it handles more torque and horsepower but will cause other problems such as neutral gear-rollover noise or clutch chatter during engagement. Sometimes the clutch set will include a flywheel to eliminate the dual-mass flywheels found in the stock vehicle.

If the disc-damping characteristics are not correct you will get neutral gear-rollover noise. This usually occurs when the car is idling in neutral with the clutch engaged (pedal up) and will continue in gear until drivetrain speed increases. This is NOT a noise caused by the transmission but a gear rattle induced by engine harmonics that are flowing into the transmission because the clutch-damping system is worn, damaged or modified, or there are engine-tune problems that need to be resolved. This is particularly common on diesel-powered vehicles because of worn or defective dual-mass flywheels, out-of-time fuel-injection pumps or worn injectors.

No amount of work on the

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transmission will change this. It is not harmful to the transmission although it sounds ugly. The usual test for gear rattle is to keep the vehicle in neutral with the clutch engaged and slowly increase engine speed until the noise leaves. This is usually in the range of 2,500 to 3,500 rpm. If the noise abates at higher speed it is caused by engine harmonics being transferred to the driveline and is not an internal transmission problem.

You may face a problem with shifting caused by modification or abnormal use of the vehicle. The clutch set and synchronizers are matched to the design intention for the engine. Shift issues are common in cars that have been modified for more horsepower and torque. For instance, if the driver wants to shift the vehicle at very high engine speeds (redline or higher), the clutch and transmission may not be up to the job. A transmission designed to shift at 6,000 rpm will not be happy at 8,000 rpm.

A common problem with people who want to get more performance starts with the belief that just adding horsepower and torque will do the job. They have failed to understand that all parts of the vehicle are related and a change in one area affects many others. The usual routine is adding 100 or so horsepower to the engine and then chasing the problem through the entire driveline. First they destroy the clutch, then the transmission, then the halfshafts or driveshaft, then the differential, and finally, when they are going really fast, they discover that the brakes and suspension are not up to the job.

Ask questions of your customer and find out whether any modifications have been made or are anticipated and, if so, what they are. You can save your customer a great deal of money and relieve yourself of future warranty issues by really understanding in advance what your customer will do with the vehicle.

An example of an internal transmission problem created by the customer is loss of the 3-4 synchro keys in a T56. These transmissions are used in performance vehicles such as Camaro, Firebird, Mustang, Corvette, Viper, Cadillac CTS-V and Pontiac GTO. The complaint will be stuck in 4th or 3rd and/or inability to shift into or from one of those gears. If the clutch release is correct and is not creating the problem, an internal inspection of the transmission will show that the 3-4 synchro keys are shattered, jamming up the slider.

How did this occur? One of two things had to happen: The clutch release was not correct or the customer rushed the shift, getting the synchro sleeve to move before there was a disconnect of engine torque to the input shaft. This also will happen if the driver is trying to "power-shift" the unit without stepping on the clutch. Having this type of damage means you must communicate with the driver to make sure he either changes his driving style or knows that if it happens again it is outside the warranty and on his wallet instead of yours.

Another source of transmission damage is worn or improperly adjusted shifters and linkage. It is very common for customers to install or have installed aftermarket "short-throw" shifters. These are designed to shorten the distance the shift lever moves to select gears. They work well when installed and adjusted properly. They also alter the shift-timing sequence, and having a proper clutch release is even more critical as the elapsed time designed into the stock setup is now shortened by mechanical advantage. Some of these shifters have adjustable "stops" that control how far the stick can travel. These need to be adjusted to prevent over-travel of the stick during shifting, which will damage the shift forks and synchro components. Under-travel of the stick due to improper shifter-stop adjustment will lead to gear jump-out and synchro and speed-gear damage.

The customer has basic knowledge of how to make the car go and does not understand how the clutch and synchronizers are related. You have to understand these systems completely to fix them right the first time. You then have to educate the customer and communicate the proper use of the equipment under your warranty. It never hurts to take a test drive with the customer to understand their driving habits. Be gentle and discrete in advising them of their faults if any, but make sure you note in writing any habits they have that will cause a comeback. If you do this consistently, it will be an eye opener and a way to cut your warranty losses.

A careful observation of the condition of the vehicle also will make you aware of certain issues. When a young driver comes in with bald tires on the drive wheels and good tread on the others, it is for sure that he leaves hard from a stop. Let him know that you know and that we all did it more than once. Let him also know where the financial responsibility rests. TD