



Sorting Out Synchronizers

By Mike Weinberg
Contributing Editor

The two problems most common to standard transmission repair are noise and shift complaints. These problems comprise 80% of the hotline calls I get. Synchronizers are very much like zippers. Everyone knows how to use them, but few understand how they work. I hope this article will remove some of the mystery and help you to troubleshoot shift problems quickly and correctly.

Synchronize – To occur at the same time. To move or operate at the same rate and exactly together.

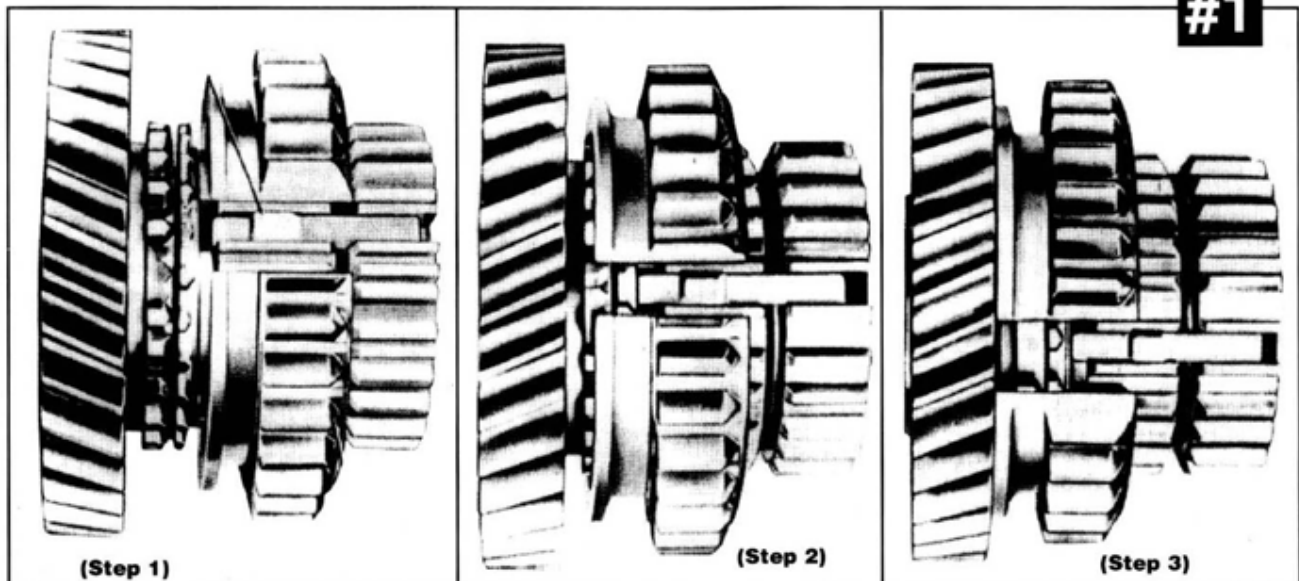
Synchro – short for synchronizer.

All modern car and light-truck transmissions are synchronized to allow clash-free, smooth shifts. Not all gears are synchronized. There still are some truck gearboxes in which 1st, or low gear, is not synchronized, and most units have non-synchronized reverse. The transmission contains two, three or four shafts which, due to the differences in ratio, are turning at different speeds. When the clutch is depressed, releasing the input shaft from its connection to the motor, the front or rear wheels are driving the transmission. In order to select another gear, we must get the different shaft speeds to equalize so that there is no gear clash. As the sliding sleeve of the synchronizer starts to move

toward the desired gear, the synchro keys (dogs, struts, wings, etc.) press the synchro or blocking ring onto the cone of the speed gear. The inner surface of the blocking ring will grab the cone surface of the speed gear and slow down or speed up the gear to equalize the rotational speed of the two components. The blocking ring can grab the cone of the speed gear only after it has exhausted the lubricant on the cone. The blocking ring is so named because until the component speeds are equal, it **BLOCKS** the slider from its engagement with the gear. When the speed of the components is the same, the blocking ring relaxes and permits the slider to complete the shift without a grind (See Figure 1).

There are many variations in synchronizer design, yet all perform the same function. Let's examine causes of synchronizer problems.

Synchronizer Operation



External Problems

1. A misadjusted or worn clutch that does not release fully. Make sure that the clutch is operating correctly before looking into the gear box. A clutch that does not release will keep the input shaft turning and add a new dimension to diagnosing gear clash.

2. Worn or improperly adjusted shift mechanism. An out-of-whack shifter, linkage, cables, shift cover, rails, forks etc. will prevent the synchro components from traveling to full engagement. This leads to clash and accelerated wear or failure.

3. Component endplay. Improper endplay setup due to worn bearings, thrust washers, snap rings, shafts or speed gears will allow the gear train to move away from the synchronizer, creating rake or incomplete shifts or gear jump-out.

4. Improper lubricant or lack thereof. Remembering that the blocking ring can do its job only when it has exhausted the lube from the face of the gear cone, it is clear that the type of lube used must match the design of the synchro. Cold-shift problems have caused most manufacturers to stop using 75-90W gear oil. Newer synchro designs which use paper or synthetic compounds on the inside of the blocking ring necessitate the use of the lube specified for the unit. Lack of lubrication causes immediate damage to the brake surface of the blocking rings, causing excessive wear and early failure. If you are working on a unit that was run dry, it will pay to get a good core and overhaul that. Units that are "blue" from lack of lube can't be saved economically.

Internal Problems

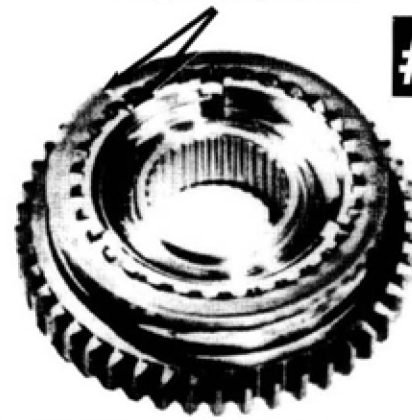
Before we go any farther, let me caution you about disassembly. You cannot inspect a synchro assembly without taking it apart. While the synchro still is on its

shaft, take a die grinder and make an index mark across the top of the slider and the hub (See Figure 2). This serves two purposes: When you reassemble the synchro after cleaning and inspection, the parts will be mated in their original wear pattern for smooth shifting. The other plus for indexing the assembly is you now know which direction it goes back

continues next page

Alignment Marks

#2



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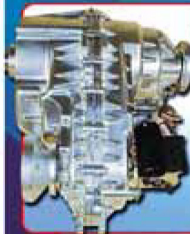
WRANGLER - XJ, TJ, 2-DOOR, 4-DOOR
CHEROKEE - XJ, 4-DOOR, 5-DOOR, 6-DOOR
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GRAND CHEROKEE - ZJ, 4-DOOR, 5-DOOR, 6-DOOR, 7-DOOR, 8-DOOR
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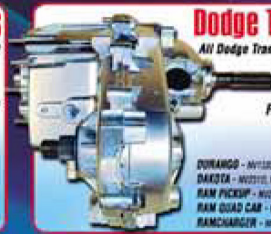
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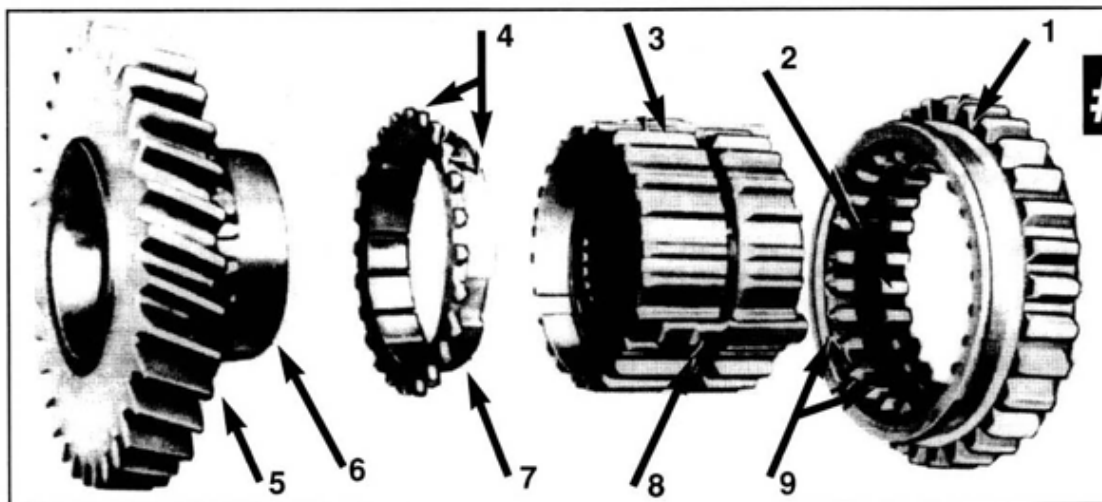
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#3

- 1. Sliding Sleeve
- 2. Detent Groove
- 3. Hub
- 4. Wedge Angle On Teeth
- 5. Gear

- 6. Cone Surface
- 7. Synchronizer (Blocker) Ring
- 8. Key
- 9. Wedge Angle On Spline

in on the shaft. It sure beats a wasted hour looking in books or making phone calls. Also keep the synchro rings properly matched to the synchronizer. Many units have different designed rings for different gears and mixing them up is going to spoil your day.

Gear Damage

Wear on the coupling teeth of the speed gear will cause engagement problems or gear jump-out. Pitting or wear on the cone will prevent the proper operation of the blocking ring. I don't know anyone with good enough eyesight to see a worn taper on the cone of a speed gear. The first check you can make is to place the blocking ring on the cone and measure the clearance from the bottom of the ring to the top of the coupling teeth (See Figure 3). If the specs don't match the repair manual, toss the ring. If the ring sits up high enough, check the taper with some machinist's blue. Paint up the cone and use the ring to make a pattern check. There should be an even pattern from top to bottom around the entire circumference. If the pattern shows gaps or partial contact, the ring is out of round or the cone is not true. Replacement of the ring and gear is the way to go.

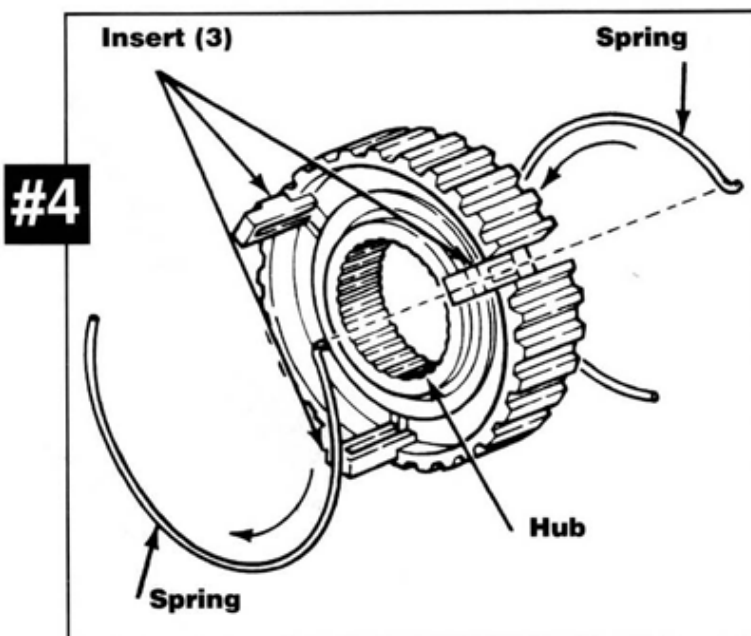
Ring Damage

Check the pointing on the engagement teeth of the ring, then look at the key slots. If there is any wear on the bottom or sides of the key slots, discard the ring. Flip the ring over and examine the brake surface. If the ring is brass or bronze, make sure the threads are clean and sharp, and look for contamination from imbedded particles. Move the ring back and forth under a good light and make sure there is no metallic debris that will prevent it from grabbing the gear. On paper or compound-lined

rings, look for embedded debris, chipping, flaking and burnt material.

Synchronizer Inspection

Disassemble the synchro into its basic parts. A steel bristle toothbrush will come in real handy to get rid of the debris that is built up on the splines. Of course, you have made the index marks so that it can be reassembled from its original position. I won't have to yell at you if you forget. After you play with it for 20 minutes to get it to work



#4

Up To Standards

smoothly, you won't make that error again.

Carefully inspect the splines on the hub and slider for wear and parallel. Make sure the points and the sides of the coupling teeth are free from wear and damage, and make sure they are sharp with no loss of back taper. Check the internal hub splines for wear and make sure they fit tight on the shaft. Look carefully at the keys, checking for wear on the ends and the outside surface that ride in the slider. Remember that the keys perform two important functions: They apply the ring to the cone and then keep the ring from spinning in the synchro assembly. Make sure the key springs hold tension and have no cracks or broken ends. Coat the slider and hub with lube and reassemble. Check for any excess slop or rock between the hub and slider that will cause a bind under load.

After the unit is completely reassembled, make sure it shifts smoothly on the bench. Long experience has taught me to replace all bearings, seals and synchro rings during overhaul. These are the "soft" parts of a standard transmission and are subjected to the most wear. If you do enough standard transmissions, you can rig up a test stand to check your work. A variable-speed electric motor with a coupling that can drive the output shaft (pay attention to the proper direction of rotation) will allow you to shift the transmission through all forward synchronized gears. If you wish to test front-wheel-drives, the fixture becomes more complicated.

Understanding the theory and principles of operation of the units you work on will give you the confidence to make correct diagnoses. Restoring a unit to proper specs will increase longevity and reduce comebacks. The right way always is the easiest way. ■

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