The transmission has a whale of a job to do in providing the kind of car performance most drivers demand. For instance—think of the times you've winced as you heard gears being clashed into low before the car stopped rolling ... and then watched the driver zoom away from the stop light!

Sooner or later, some of those transmissions that have been jammed into gear or allowed to run dry are going to act up. The owner is going to show up in your shop with some troubles that, to him, seem mighty queer. Maybe his transmission jumps out of high—or maybe it takes two men and a boy to get 'er into gear. Maybe it's got a bothersome little clicking sound. Or maybe when he shifts, it makes a sound like a New Year's Eve noisemaker!

The owner drops his problem into your lap. But you're all set for him—because this little book tells you how the transmission operates, what can cause trouble, and what to do about it.

*Let's see how she performs, first.*
The transmission plays a big part in car performance. And because it has such an important part, some mechanics think the transmission is a pretty complicated subject. You probably know better if you've ever done much work on this unit. Actually, it's just a collection of gears that gives the driver three combinations of speed and power to meet traffic and road conditions. That's why we call it a three-speed transmission. These three speeds are all forward speeds, of course. Just add a reverse gear and you know all that the gear box can do.

Before we get into what can happen to a transmission after many thousands of miles of driving, maybe we should see why the driver needs these combinations of speed and power.

**The engine is powerful**

*But...*

Although the gasoline engine is a powerful machine, it doesn't put out its maximum power until it's going fairly fast. Yet the driver needs power to pick up his car's weight and start it moving. So to get that engine power and still
have an easy, smooth start, the low gear combination takes
the power developed by the engine speed, and delivers it in
the form of slow-moving power to the rear axle.
That's what happens when the driver starts off in low
gear. Now he has plenty of push but not much speed. Once
he's moving, he shifts into second, allowing a higher car
speed while not requiring an increase in engine speed.
Finally, with the car well under way and no need for the
advantages of second and low gear, the driver shifts into
high. When this happens the transmission sends the engine
speed directly from the crankshaft to the differential. Then
the driver can go as fast as the engine will allow.

THE SHAFTS THAT CARRY
THE GEARs

The power is brought from
the clutch to the transmis-
sion gears by the drive pin-
ion. Whenever the clutch is
engaged, the drive pinion is
turning.
The drive pinion is supported in the front of the transmission case by a ball bearing, enclosed in a housing. The splined end of the pinion runs through the clutch and into the bushing in the crankshaft.

The main shaft carries the gears which are shifted to give the driver the different power combinations. The front of the main shaft rotates on needle bearings in a pocket in the rear of the drive pinion. The balance of the main shaft is supported by two ball bearings—one at the front and one at the rear of the transmission case extension. The rear end of the main shaft is connected to the propeller shaft by the universal joint.

(The transmission case extension is bolted on the rear face of the transmission case to enclose the speedometer gears and the extreme rear end of the main shaft.)

The countershaft, in the bottom of the case, carries the countershaft gear—actually a cluster gear. A lock key at the rear of the countershaft prevents the shaft from moving forward and from rotating. The cluster gear rotates on two sets of needle roller bearings. One set is at each end of the gear, and they’re separated by a spacer inside the cluster gear. Steel and oilite washers between the transmission case and the cluster gear take the end thrust of the gear.
HOW THE TRANSMISSION GIVES SPEED-POWER COMBINATIONS

As we’ve already noted, the drive pinion is turning whenever the clutch is engaged. Now we’ll discuss the gears and the combinations of gears which send that drive pinion movement to the prop shaft in different ratios of speed to power.

The main shaft carries a sliding gear for driving the car in low or reverse, a gear for second, and a synchronizer which is part of the second and high shifting mechanism.

The constant mesh gear of the cluster gear is always in mesh with the drive pinion. Keep that in mind, because that constant mesh arrangement is one step in getting the power through low, second, and reverse gear combinations.

THE DRIVER SHIFTS INTO LOW

The main shaft low and reverse sliding gear is splined to its shaft. When the driver depresses his clutch pedal and shifts, he slides the gear forward to mesh with the low gear on the countershaft. Then, when the low gear on the countershaft turns the low gear on the main shaft, the main shaft turns the prop shaft. You can follow this flow of power in the illustration at the left.
NOTE: You probably know that when the driving gear is smaller than the driven gear, the driven gear turns more slowly but more powerfully than the driving gear. Notice the difference in size between the countershaft low gear (driving), and the main shaft low gear (driven). And note the difference between the drive pinion and its mating gear on the countershaft. Now you can see how the transmission makes the prop shaft turn more slowly but more powerfully than the crankshaft turns.

THE DRIVER SHIFTS INTO SECOND

In second, the power again comes through the drive pinion to the countershaft cluster gear. The second speed gear of the countershaft cluster is always in mesh with the second speed gear on the main shaft. The main shaft second speed gear rotates freely on the shaft, so the shifting process must lock the gear to the shaft. That's done through the synchronizer. The two driving parts of the synchronizer are the clutch gear, which is splined to the main shaft, and the clutch gear sleeve, which is splined to the gear. When the driver shifts into second, the clutch gear sleeve slides to the rear to mesh with the clutch teeth on the shoulder of the second speed gear.

When the sleeve is meshed with the clutch teeth, the second speed gear is locked to the main shaft. The flow of
power in second gear comes through the countershaft second speed gear to the main shaft second speed gear. Then it's carried through the clutch gear sleeve to the clutch gear, and out the main shaft to the prop shaft.

The ratio of engine speed to rear wheel driving force in second is obtained through two gear combinations. One is in the meshing of the drive pinion and cluster gear. The other is the smaller countershaft second speed gear driving the larger main shaft second speed gear. You can see how the gears mesh in second in the illustration on page 7.

THE DRIVER SHIFTS INTO HIGH

When the transmission is in high, we sometimes say it's in “direct drive.” That's because the power comes directly from the drive pinion to the main shaft. It does this without going through the countershaft cluster and without changing the ratio of crankshaft speed to prop shaft speed. When the driver shifts into high, he slides the clutch gear sleeve of the synchronizer forward, to mesh with the clutch teeth on the shoulder of the drive pinion. Illustration at left shows the flow of power in high gear.
A reverse idler gear, mounted on its own shaft, is located in the rear of the transmission case. It is always in mesh with the reverse gear of the countershaft cluster.

When the driver shifts into reverse, he slides the main shaft low and reverse gear to the rear. Here it meshes with the reverse idler. The idler, then, makes the main shaft turn in the same direction as the cluster gear rotates. Illustration at left shows how the main shaft rotates in an opposite direction to that of the crankshaft.
WHY DON'T THE GEARS CLASH?

When the car is running in second gear, the drive pinion (which is running at crankshaft speed) is going faster than the clutch gear sleeve (which is running at prop shaft speed). You might expect that when you shift into high there would be quite a bit of clashing and grinding—to say nothing of tooth wear—when the slow-moving sleeve tries to mesh with the fast-moving pinion. The synchronizer prevents this clashing.

THE SYNCHRONIZER

The main parts of the synchronizer are a clutch gear which is splined to the mainshaft, and a clutch sleeve which rides in splines on the outside of the clutch gear. There are three shifting plates riding in slots in the clutch gear. A rib in the top surface of each plate rides in a circular groove in the sleeve. Two expanding synchronizer springs hold the plates in place against the sleeve.
There is a bronze stop ring at each end of the clutch gear. Each ring has three slots, into which the ends of the shifting plates fit. The inner surface of the ring is shaped like a cone. This matches the conical shape of the shoulders of the drive pinion and the second speed gear. The cone-shaped surface of the stop ring has fine threads cut in it. These threads break through the oil film on the mating cone surface, permitting the stop ring to create enough friction to synthesize the speed of the gear to the speed of the stop ring.

(On Dodge transmissions, you’ll find a synchronizer spreader spring between the clutch gear and the drive pinion stop ring. It provides initial drag to help the ring slow the movement of the heavier fluid drive unit.)
THE SYNCHRONIZER AT WORK

As the driver starts his shift into high, the clutch sleeve moves forward. The sleeve carries the shifting plates, which push the stop ring forward. The cone-shaped inner surface of the stop ring contacts the cone-shaped shoulder of the drive pinion, and rides up on the cone as forward movement continues.

To prevent a complete meshing of the clutch sleeve teeth with the clutch teeth on the drive pinion before synchronization occurs, the slots in the stop ring have been made a little wider than the shifting plates which drive the stop ring. This means the stop ring teeth rotate slightly ahead of the teeth on the clutch sleeve.
It also means that the teeth on the ring and the teeth on the sleeve are butted on the chamfered ends of the teeth.

While the teeth are butted, the stop ring prevents the clutch sleeve from passing over the ring and meshing with the pinion under normal pressure from the driver. His efforts to complete the shift produce a drag which slows the pinion down to synchronizer speed. When the two are rotating at the same speed it's safe to complete the shift without clashing, and another action takes place.

You'll see in the illustration below that the ring teeth and the sleeve teeth are chamfered. After the pinion slows down, the chamfer action of the sleeve teeth on the ring teeth forces the ring to a position where the sleeve teeth can pass through the ring teeth and mesh with the clutch teeth on the drive pinion. When this happens, the transmission is in gear.

LET'S REVIEW THAT ACTION..
The stop ring drags hard on the shoulder of the drive pinion in order to slow the pinion down. The dragging action of the pinion on the ring makes the ring teeth butt with the sleeve teeth, preventing completion of the shift. When the pinion has slowed down, the chamfer action of the sleeve teeth on the ring teeth forces the ring into a position where complete meshing can take place.

When shifting from high into second gear, the synchronizing action is reversed, because the synchronizer is going around faster than the second speed gear on the main shaft. And that’s because the synchronizer is being carried around by the momentum of the car, through the wheels, rear axle shafts, prop shaft, and main shaft. Once the clutch has been disengaged, the second speed gear is being carried around only by the relatively light countershaft gear, drive pinion, and clutch disc. The function of the stop ring then, is to bring the second speed gear, cluster gear, pinion, and clutch disc up to synchronizer speed before the shift is completed.
SLIDING THE SLIDING GEARS

The clutch gear sleeve and the low and reverse gear are moved back and forth by shifting forks. The forks are mounted on shift rails, which control their movement. A single guide rail helps hold the forks steady so they won’t bind in the grooves of the sleeve and gear.

HOLDING THE RAILS IN PLACE

Each shift rail has three notches, or detents, into which a spring loaded ball (the detent ball and the detent ball spring) fits to prevent the rails from moving out of their selected positions. The lower rail has detents for holding it in high, neutral, or second; while the upper rail has detents for holding it in low, neutral, or reverse.

One of the causes of an old transmission jumping out of gear may be weak detent springs. Replacing them is a simple job, but make sure you use the proper spring.
The transmission would lock up and stall the engine if the two forks were shifted at the same time. An interlock between the rails prevents this. When one rail is shifted either way, the interlock is forced into the detent of the other rail, locking it in place.
SELECTING THE PROPER RAILS

The forks are actually moved by a gearshift lever. This lever fits into a notch in the part of the fork that is fastened to the rail. A spring holds the lever in the high-second fork. When the driver wants to shift into low or reverse, the gearshift lever is forced into the low-reverse fork by the gearshift selector cam.

Two levers attached to the outside of the gearshift housing control the gearshift lever and the selector cam. The selector lever rotates forward to operate the cam and force the gearshift lever into the upper fork. The operating lever moves the gearshift lever back and forth so that the forks—and gears—are moved.
LINKING THE TRANSMISSION TO THE STEERING COLUMN

The selector lever is connected to the base of the steering column by the selector rod. The operating lever is connected by the front and rear control rods. These latter rods are connected to each other by a bellcrank on the clutch housing.
When the gearshift lever on the steering column is in neutral and the driver lifts it toward the wheel, he moves the remote control rod up. This action rotates the lower end of the column jacket selector lever forward. The movement is transferred along the selector rod to the selector lever on the transmission, placing the transmission gearshift lever in the low and reverse shifter fork notch.

When the driver pulls the gearshift lever down in order to get into low, the remote control rod and the remote control gearshift rod lever are moved. This pushes the operating rod and the operating lever to the rear, shifting the fork into the low gear position. The action is similar when shifting into reverse.

Shifting into high or second does not make use of the selector lever linkage, of course. The driver merely pushes his gearshift lever up or down, and the operating lever on the transmission moves the second and high shifter fork, which pushes the synchronizer clutch sleeve into high or second.
ADJUSTING THE LINKAGE TO FIT

The gearshift lever should be in a horizontal position when the transmission is in neutral. If it is not horizontal, it may be positioned by loosening the stud nut on the end of the control rod, moving the lever to the horizontal, and tightening the nut.

If the nut on the control rod should loosen there may be too much travel in the gearshift lever. To correct this put the transmission in neutral, put the lever in a horizontal position and tighten the nut.

When a driver cannot get his transmission into gear, yet there is no gear clash indicating trouble inside the transmission, the trouble may be in the selector linkage. The linkage should be checked when he can get into low and reverse but not second and high. Or when he can get into second and high but not low and reverse.

NOTE: A border line selector rod adjustment which will allow shifting into low may still prevent shifting into reverse.
The trouble may be in the movement of the selector lever. Start the adjustment by putting the transmission in neutral. Then check the adjusting nut on the front end of the selector rod. If the driver cannot get into low and reverse, the nut is too loose. Tighten it until there is no play in the rod. Then back it off ½ turn and tighten the lock nut. Make sure you don’t get the adjusting nut too tight, or you’ll make it impossible to get into second and high.

If the driver can’t get into second and high, you’ll have to loosen the nut just enough to allow him to get into gear easily, but not so much that there is end-play. When this point is reached, back it off another ½ turn and tighten the lock nut.

**MISALIGNMENT OF THE CLUTCH HOUSING**

When the face of the clutch housing, or when the housing bore, is not true with the crankshaft, the transmission may jump out of high gear. If the condition is not corrected as soon as the gear jumping develops, the drive pinion and possibly the clutch sleeve are liable to wear badly enough to need replacement.
Clutch housing misalignment causes jumping out of gear. That's because it makes the drive pinion enter the transmission and mesh with the clutch sleeve at an angle. This may cause the gears to walk right out of mesh—and the transmission jumps into neutral.

**NOTE:** When you assemble a clutch housing and an engine that have not been used together previously, always check the alignment of the housing.

The amount of run-out is read from a dial indicator, which is mounted on a clutch arbor. Install the arbor in the crankshaft drive pinion pilot bushing.

**CAUTION:** Tighten the wing nut of the arbor to expand the collar in the bushing. The arbor must be rigid, or the dial readings will be wrong.

**NOTE:** When checking housing alignment on Dodge cars you'll have to remove the fluid drive unit. Otherwise you would have to fit the arbor in the runner hub. The normal clearance in the runner hub ball bearing would give a false reading. The dial gauge extension is used in checking cars equipped with fluid drive. Fasten this extension to the driver flange stud holes in the crankshaft flange. Mount the dial indicator and proceed with the following checks and adjustments.
Mount the indicator on the arbor rigidly. Check the bore by placing the indicator plunger on the inner surface of the bore. Turn the crankshaft over and take readings at ninety-degree intervals.

The bore should be centered on the crankshaft within .005" total indicator reading. The amount of run-out is determined by taking the total difference between the top and bottom readings, or the readings from side to side. For instance: If you get a reading of minus .020" at the top of the bore and plus .020" at the bottom, the total indicator reading is .040". Since the housing must be centered within .005" total indicator reading, you'd move the housing up about .020" and re-check.

After checking the bore, check the alignment of the housing face. Then if adjustments are necessary for both housing face and bore, you can make them at the same time.

To check the housing face, place the dial indicator plunger against the face. Take your readings at ninety-degree intervals again, but this time you have only .003" total indicator run-out allowed. Determine the amount of run-out by taking half the total difference between the high and low readings. Correct the alignment if the housing face is more than .003" out of line with the crankshaft.
CORRECTING BORE ALIGNMENT

Tap out the dowels that align the housing to the engine block. Loosen the mounting bolts slightly, and tap the housing (with a rawhide mallet) to center it in line with the crankshaft. The normal clearance in the bolt holes will give you enough room to tap the housing into its proper position.

Snug up the bolts to 30-35 foot-pounds, and re-check with the dial indicator. When you're sure the housing is aligned, hand-ream the dowel holes with a straight reamer to align the holes. Dowels are available in .010" oversize. When the holes are reamed to the proper size, drive in the new dowels.
CORRECTING HOUSING FACE ALIGNMENT

Run-out of the housing face should be brought within the .003" limits by shimming up the low side. If you have to remove the clutch housing in order to correct bore alignment, the best place to shim is between the clutch housing and the engine block.

Figure out the shim thickness you’ll need. Cut it from brass shim stock. Put the shim on the portion of the engine block that is directly under the low reading you got on the housing face. If there’s a housing mounting bolt in the way, cut a notch in the shim to straddle the bolt.

When the bore is in line but you have to correct face alignment, you’ll find the easiest place to shim is between the clutch housing and the transmission. Install the shim at the point of lowest reading.
BACKLASH IN THE SYNCHRONIZER

Excessive backlash between the clutch gear and the clutch gear sleeve may cause the transmission to jump out of gear. Before the clutch gear and clutch gear sleeve are assembled, they are mated to obtain a maximum of .001” backlash. The two parts are then scribed across the face. Line up the marks when you assemble the gear and its sleeve. You’ll be able to hold to that tolerance.

This means, of course, that when you replace either the gear or the sleeve for any reason, the other part should be replaced, too.
SHIFTING SHOULD BE SIMPLE

When a transmission is hard to shift, and clashes, the trouble may be in the clutch.

If the clutch or the clutch pedal does not allow full disengagement, the engine will continue to drive the pinion after the clutch pedal has been depressed. This dragging clutch condition will make it very difficult to shift either into or out of gear.

To check for a dragging clutch, put the transmission in neutral, start the engine, depress the clutch pedal, and try shifting. If you get gear clashing you’ll know that the clutch isn’t fully released. Check the free-play adjustment of the clutch pedal.

BATTERED TEETH

The stop ring tooth angle is important. If the ends of the teeth have become worn or flattened, the chamfer action with the sleeve teeth cannot take place and the transmission will not shift properly.
ALL'S QUIET IN A GOOD TRANSMISSION

Noise does creep into transmission operation sometimes. In general, it's due to either insufficient lubrication or damaged gears and bearings.

Clashing can be caused by any number of reasons. It can be caused by gear teeth failing to mesh properly during the shifting operation. A dragging clutch could cause clashing when the driver shifts. Gears will clash if the threads on the inside of the stop ring are so badly worn they won't cut the oil film on the shoulder of the drive pinion or the second speed gear. This prevents the rings from doing their synchronizing job.
WHAT CAUSES PARTS TO WEAR AND BREAK?

Under normal conditions, when properly used and correctly lubricated, the transmission should last the life of the car. Since we know that many transmission parts are replaced, you may be interested in the reasons why.

The transmission was built for normal conditions. When a great deal of shifting is done for the miles traveled, such as in taxicab service, some parts may wear.

Correct lubrication is important. When the oil level is above the bottom of the filler plug hole, it may be thrown out along the drive pinion and onto the clutch plate. Too little grease means that the gears will soon run dry, of course.
Cleanliness is also important. A chip from a tooth, or dirt that you may leave in the case when you overhaul the transmission, will be carried through the gears and bearings by the lubricant, wearing the parts and resulting in noise.

Improper use is probably the greatest cause of the wearing and breaking of transmission parts.

The driver who tries to shift into low or reverse before he stops rolling, or the one who guns the engine before he's fully in gear, is apt to end up with broken gear teeth.

The driver who always shifts between second and high so fast that the synchronizer can't do its job is going to wear the parts until he has no synchronization at all.
SHIFT INTO HIGH FOR 10 TRANSMISSION QUESTIONS

1. The constant mesh gear of the cluster gear is in mesh with the drive pinion in first and second gear only.  RIGHT □  WRONG □

2. The reverse idler gear is in mesh with the reverse gear of the countergear cluster only when the transmission is shifted into reverse.  RIGHT □  WRONG □

3. Shift rails are prevented from moving out of their selected position by detent balls and springs.  RIGHT □  WRONG □

4. An interlock between the shift rails keeps the transmission from jumping out of gear.  RIGHT □  WRONG □

5. The selector linkage should be checked in cases where trouble is experienced in getting into gear.  RIGHT □  WRONG □

6. Clutch housing misalignment can cause a transmission to jump out of gear.  RIGHT □  WRONG □

7. When you assemble a clutch housing and an engine that have never been used together, always check the alignment of the housing.  RIGHT □  WRONG □

8. A dragging clutch can cause hard shifting because the drive pinion continues to turn even though the clutch pedal is pushed down.  RIGHT □  WRONG □

9. Gears will clash if the threads on the inside of the stop ring are so badly worn they won't cut the oil film on the shoulder of the drive pinion or the second speed gear.  RIGHT □  WRONG □

10. The function of the synchronizer is to see that the speed of the drive pinion or second speed gear is the same as the speed of the clutch sleeve before the shift is completed.  RIGHT □  WRONG □