CHAPTER 7

TRANSAXLE THEORY

OBJECTIVES

After studying Chapter 7, the reader should be able to:

1. Explain the parts of a standard transaxle.
2. Know the purpose of each major part of a standard transaxle.
3. Trace the power flow for the different speeds.
4. Calculate the gear ratio for each gear.
5. Explain differential operation.
6. Discuss the requirements for good transaxle operation.

KEY TERMS

Anaerobic sealants (p. 167)
Axle gears (p. 155)
Clutch shaft (p. 155)
Countershaft (p. 155)
Differential (p. 155)
Drive pinion gear (p. 155)
Extension rod (p. 165)
Final drive ring gear (p. 155)
Input shaft (p. 155)
Intermediate shaft (p. 155)
Mainshaft (p. 155)
Pinion gears (p. 155)
Reverse idler shaft (p. 155)
Room-temperature vulcanizing (RTV) (p. 167)
Stabilizer bar (p. 165)

INTRODUCTION

The development of the transaxle has, in part, made the modern, fuel-saving FWD vehicle possible. Early FWD vehicles included the American Cord of the 1930s, the French Citroen, and the Oldsmobile Toronado and Cadillac Eldorado of the mid-1960s. Each of these designs had rather limited markets. A large majority of the vehicles sold today are FWD with a transaxle that is transverse or longitudinally mounted. A transverse engine points across the vehicle; this is often called *East-West* positioning. A longitudinal engine is commonly used in RWD vehicles and is often called *North-South* positioning.

Many features of the transmission part of a transaxle are similar to those of an RWD transmission. There are differences, however, in the number of shafts and the power flow. There is also the addition of the final drive gears and differential (Figure 7-1). This is the drive axle part of a transaxle.

CONSTRUCTION

Most transaxles are made with four parallel shafts: the **input shaft**, the **mainshaft**, the **differential**, and the **reverse idler shaft**. Except for the reverse idler shaft, each of these shafts is supported by a pair of bearings (Figure 7-2). The input shaft is sometimes called the **clutch shaft** because it is splined to the clutch disc. The driving gears are positioned on the input shaft, and there is one for each forward speed.

The mainshaft, also called a **countershaft** or an **intermediate shaft**, also includes a gear for each forward speed; these are the driven gears. The mainshaft also includes the **drive pinion gear**. The drive pinion gear is the transmission output and the input for the final drive. The **final drive ring gear** is mounted on the differential case.

The differential divides the power flow between the two CV joints coupled to the driveshafts and on to the wheels. The **pinion gears** and **axle gears** in the differential allow for speed differences when the vehicle turns a corner.

All of the gears in a transaxle, with the exception of the reverse idler, are in constant mesh, and each of the gear pairs

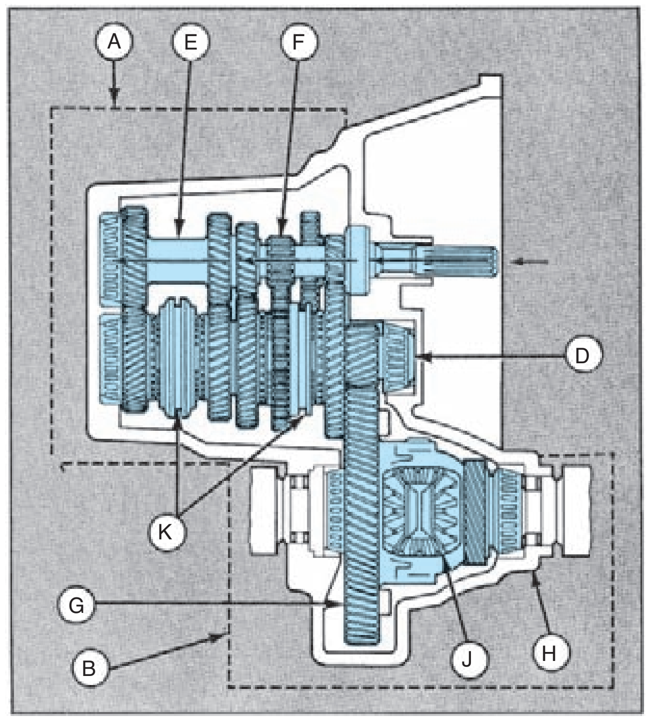


FIGURE 7-2 The transmission portion of many transaxles uses the top two shafts (E and D). The differential and ring gear are at the bottom shaft (G and J). *(Courtesy of Ford Motor Company)*

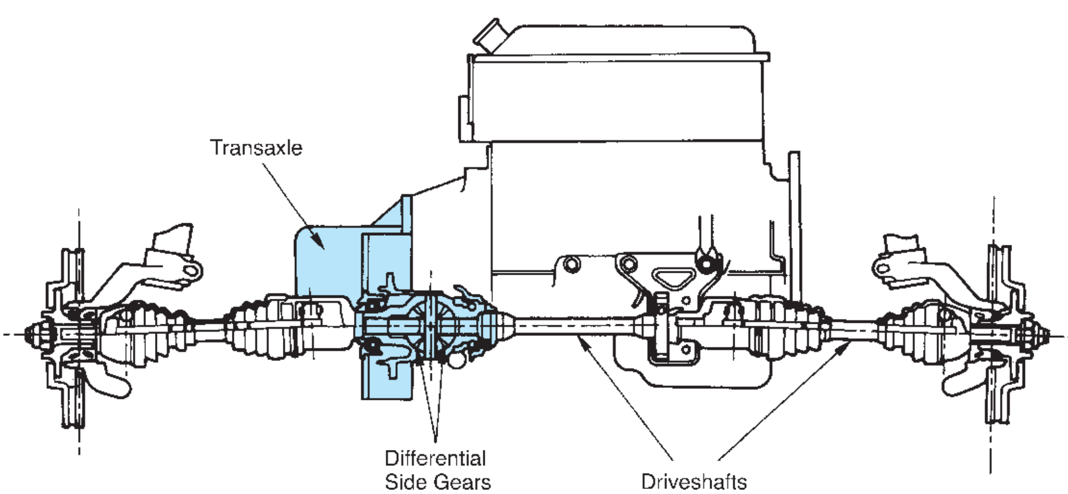


FIGURE 7-1 A transaxle is a transmission plus the final drive and differential. The inner CV joints of the front driveshafts connect to the side gears in the transaxle differential. *(Courtesy of Ford Motor Company)*

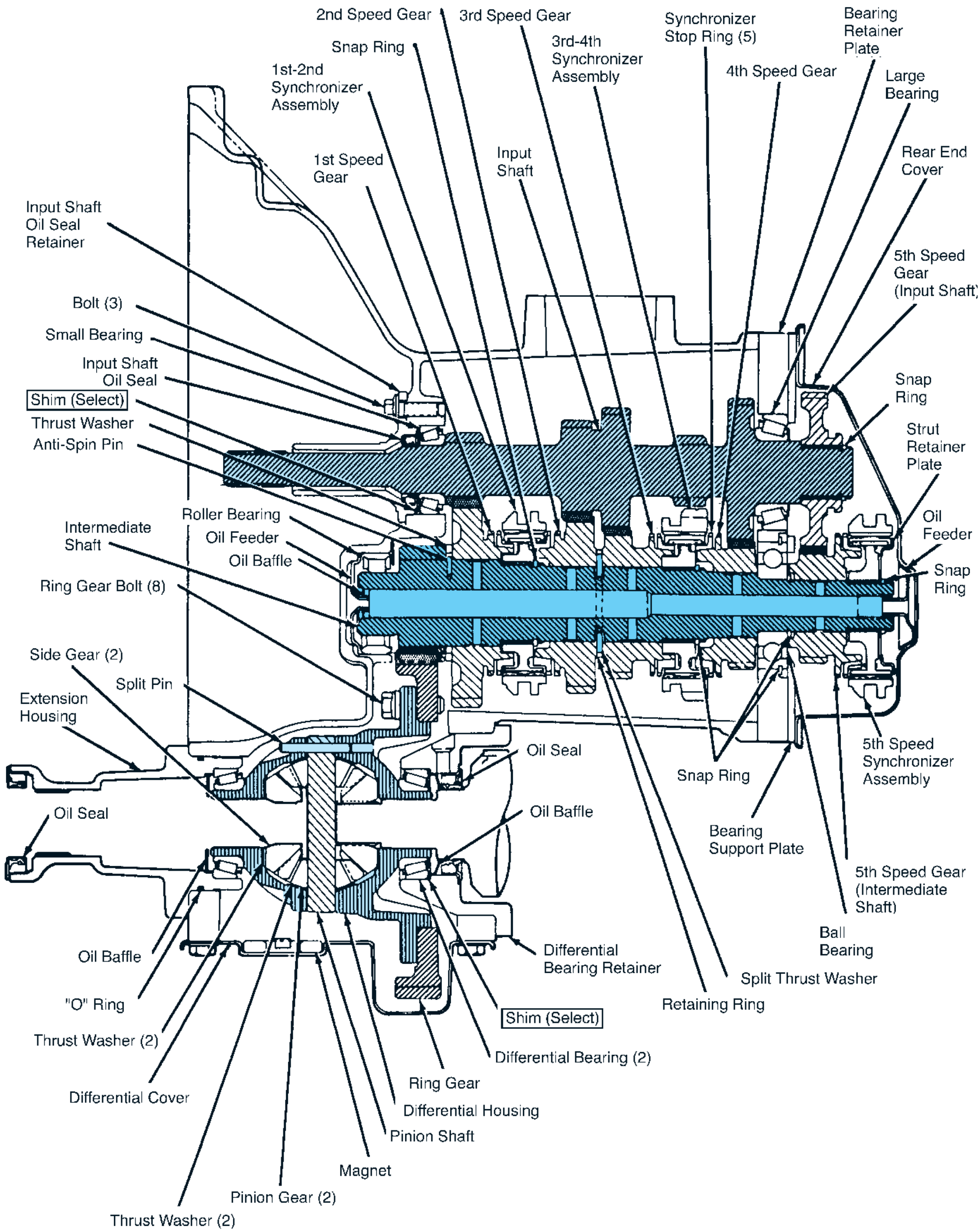


FIGURE 7-3 Five-speed transaxle. Note that all of the gears are fixed as a cluster to the input shaft and that the speed gears and synchronizer assemblies are on the intermediate (main) shaft of this transaxle. *(Courtesy of DaimlerChrysler Corporation)*

on the input shaft and mainshaft represents the power paths for a particular gear ratio. If you look closely at each gear pair, you can see that one gear is secured solidly to the shaft and the other floats on the shaft, right next to a synchronizer assembly (Figure 7-3). Some transaxles secure all the gears on the input shaft to form a cluster gear. These can be either a single cluster gear or a group of gears pressed onto a splined shaft. Other designs float all or some of the driving gears on the input shaft and secure the driven gears onto the mainshaft.

Most engines rotate in a clockwise direction (viewing the drive rotation from the right, or passenger, side of the vehicle). As you view the transaxle, the input shaft rotates clockwise, the mainshaft rotates counterclockwise in forward gears, and the differential rotates clockwise to drive the wheels in a clockwise direction (Figure 7-4).

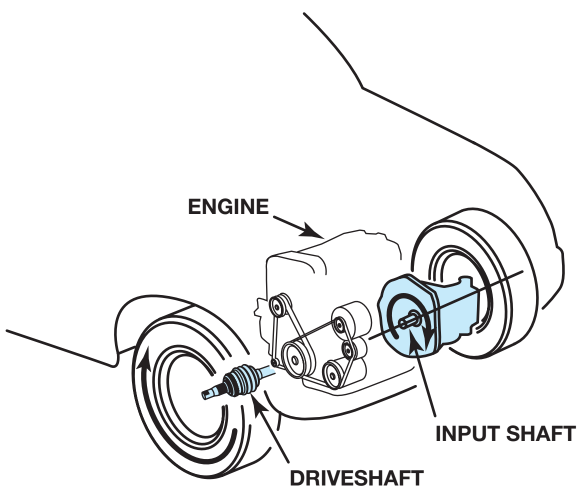


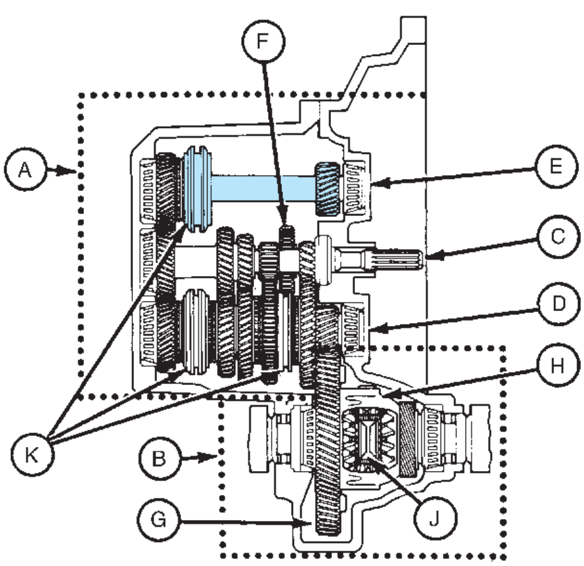
FIGURE 7-4 The engine and the transaxle input shaft rotate in a clockwise direction in most FWD vehicles (viewed from the right side). The intermediate shaft will rotate counterclockwise and drive the ring gear, differential, and driveshafts in a clockwise direction.

In some transaxle designs, two mainshafts are used (Figure 7-5). If there is a space conflict in the vehicle because of the length of the engine and transaxle, the transaxle can be shortened by placing some of the gears and an additional final drive pinion gear, on a separate shaft. This shaft becomes an alternate to the mainshaft for the power flow through these gears.

POWER FLOW

The power flow through the transmission section of a transaxle is essentially the same in all the forward gears (Figure 7-6). The power passes from the driving gear on the input shaft to the driven gear on the mainshaft and then through the synchronizer assembly to the mainshaft itself. Because the power passes through only one set of gears, the ratio for that gear speed is determined by that pair of gears. The smallest gear on the input shaft drives the largest gear on the mainshaft for first gear, and the largest gear on the input shaft drives the smallest gear on the mainshaft for fourth gear. The synchronizers are the same as those used in a transmission; their parts and operation are identical (Figure 7-7).

The power flow for reverse gear is also similar to that of an RWD transmission. In most cases, the reverse idler is shifted into mesh with the reverse gear on the input shaft and the sleeve of the 1–2 synchronizer assembly, which has the spur gear teeth for reverse on the outer diameter. The idler gear will rotate in a counterclockwise direction viewed from the right side, the 1–2 synchronizer assembly will rotate clockwise, and the differential and drive wheels will rotate counterclockwise to drive the vehicle backward.



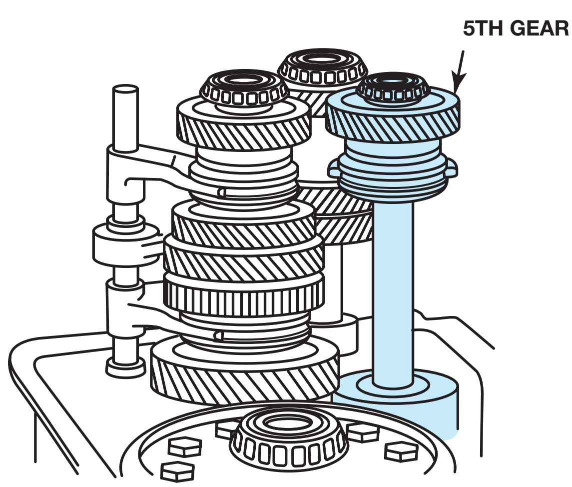


FIGURE 7-5 This transaxle mounts the fifth gear and fifth gear synchronizer assembly on a separate shaft (E) along with a final drive pinion gear. *(Courtesy of Ford Motor Company)*

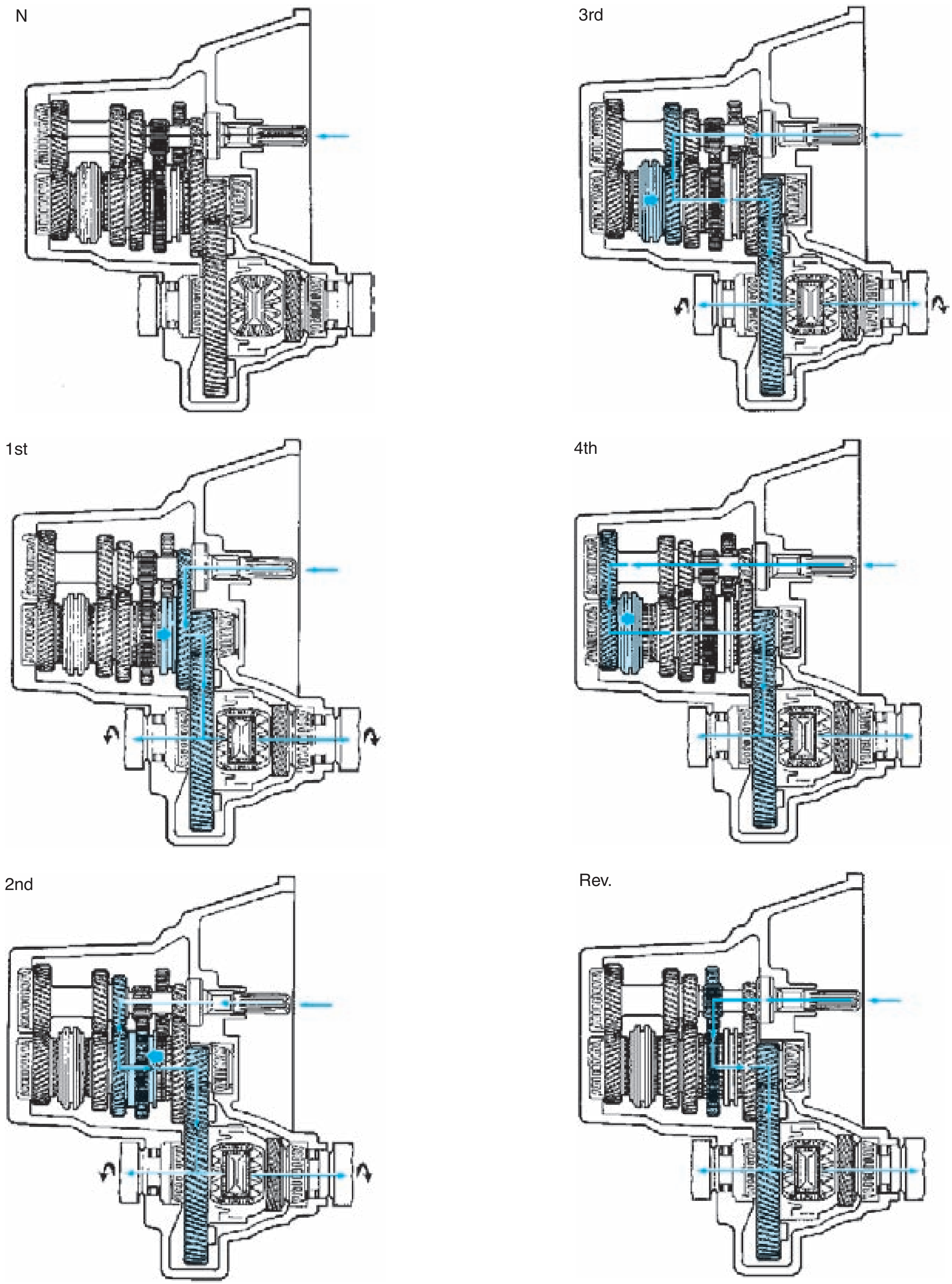
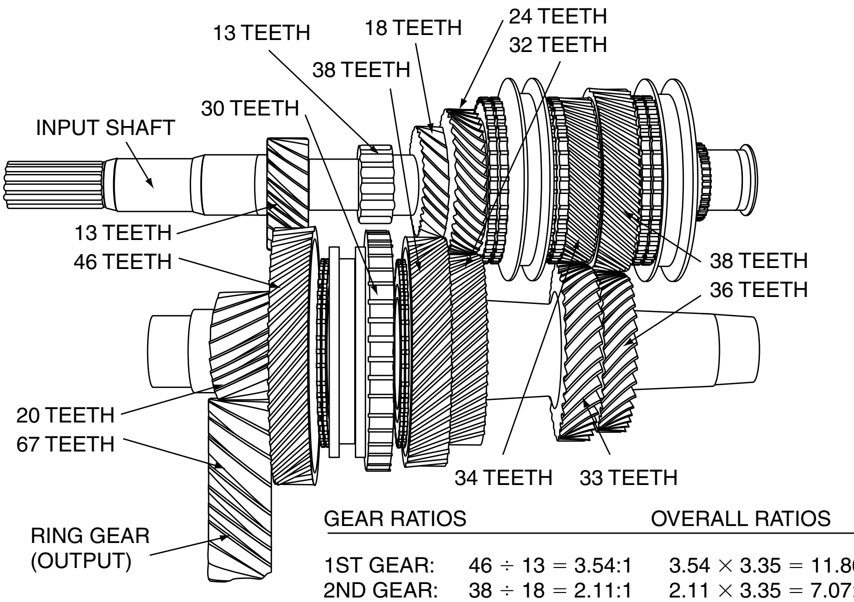


FIGURE 7-6 The power flows through the gear set of a four-speed transaxle are shown here. Note how they are similar except for the gear sizes and that, in reverse, an idler is used. *(Courtesy of Ford Motor Company)*



GEAR RATIOS		OVERALL RATIOS
1ST GEAR:	46 ÷ 13 = 3.54:1	3.54 × 3.35 = 11.86:1
2ND GEAR:	38 ÷ 18 = 2.11:1	2.11 × 3.35 = 7.07:1
3RD GEAR:	32 ÷ 24 = 1.33:1	1.33 × 3.35 = 4.45:1
4TH GEAR:	34 ÷ 33 = 1.03:1	1.03 × 3.35 = 3.45:1
5TH GEAR:	36 ÷ 38 = 0.83:1	0.83 × 3.35 = 2.78:1
REVERSE:	30 ÷ 13 = 2.31:1	3.31 × 3.35 = 7.74:1

FINAL DRIVE: 67 ÷ 20 = 3.35:1

FIGURE 7-7 The gear ratios of a transaxle are determined by dividing the tooth count of the driven gear by that of the driving gear. Multiplying the transaxle gear ratio by the final drive ratio gives us the overall ratio.

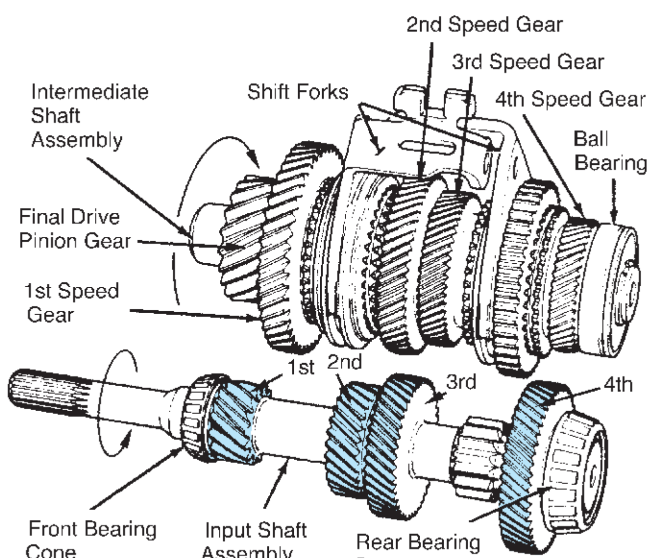


FIGURE 7-8 Gear set of a four-speed transaxle; note how first gear uses the smallest driving gear and the largest driven gear and how the gear sets change in size. *(Courtesy of DaimlerChrysler Corporation)*

All of the transaxle gears, with the exception of the reverse idler and differential, will rotate whenever the input shaft rotates. The speed gears on the mainshaft will rotate at a speed determined by their gear ratio (Figure 7-8). A 1:1 ratio requires a pair of gears of equal size, so transaxles do not necessarily use this ratio. The engineers are free to select the ratio that best fits the use of the vehicle.

FINAL DRIVE AND DIFFERENTIAL

As mentioned earlier, power leaves the mainshaft through the drive pinion that drives the final drive ring gear on the differential case (Figure 7-9). The drive pinion and ring gear are a pair of helical gears with a ratio, similar to an RWD rear axle, which determines engine rpm at cruise speeds. This gear set operates rather quietly and does not require critical adjustments like those necessary for the hypoid gear set used in an RWD rear axle.

The differential case has a differential pinion shaft running through it on which the two differential pinion gears float. These gears are not secured to the shaft. They are located between the differential case and the two side gears; side gears are also called *axle gears* (Figure 7-10). The axle gears also float in the case, but they have internal splines so they can drive the CV joints and driveshafts. All four of these gears are spur bevel gears. You can usually hear them operate by lifting both drive wheels and rotating one wheel by hand. At this time, note that the other wheel is rotating in the opposite direction; the pinion gears are acting like idlers between the two side gears.

The load of the side gears determines what the differential pinion gears do. If both side gears are loaded the same and offer the same resistance, the differential pinion gears remain motionless on their shaft and the entire differential assembly rotates as one mass with no internal gear movement. When a vehicle goes around a corner, the side gears are equally loaded,

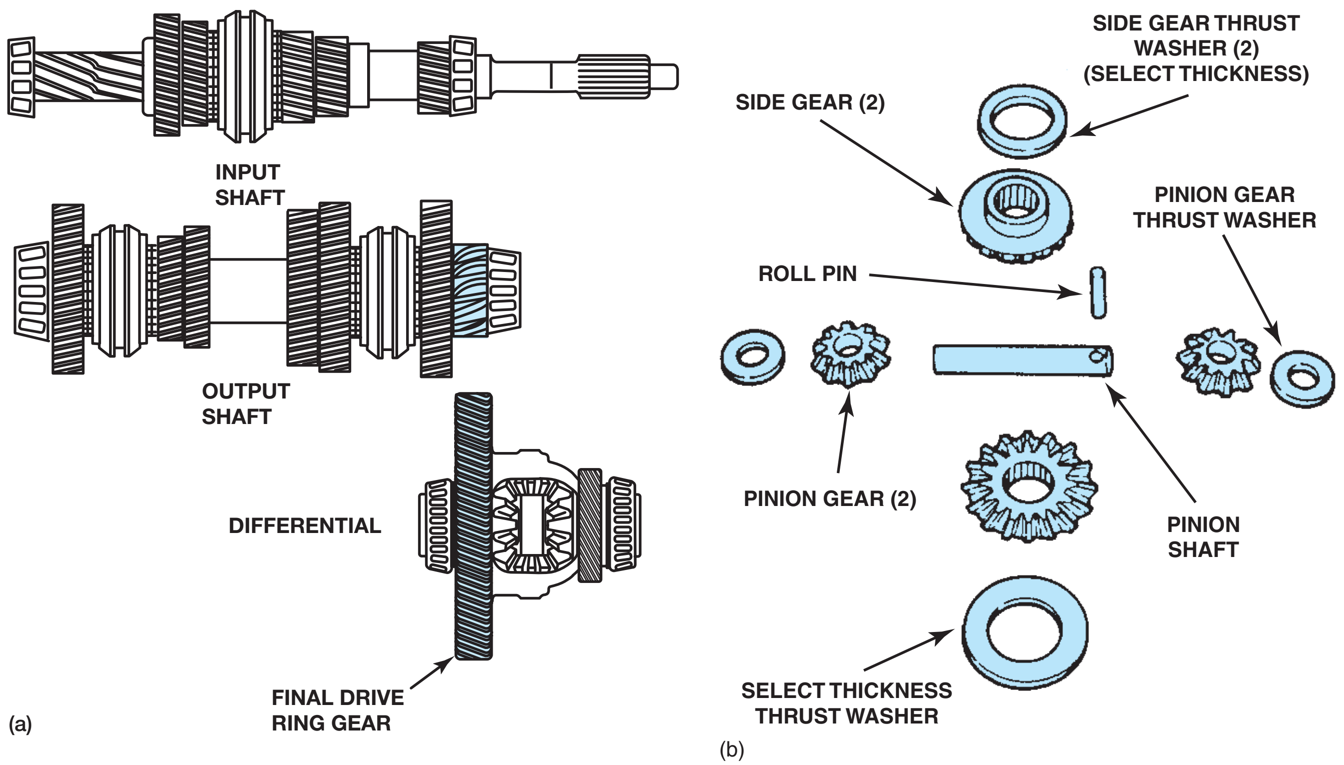


FIGURE 7-9 The final drive pinion gear drives the ring gear mounted on the differential case (a). This is an exploded view of the differential and its parts (b). *(b is Courtesy of DaimlerChryster Corporation)*

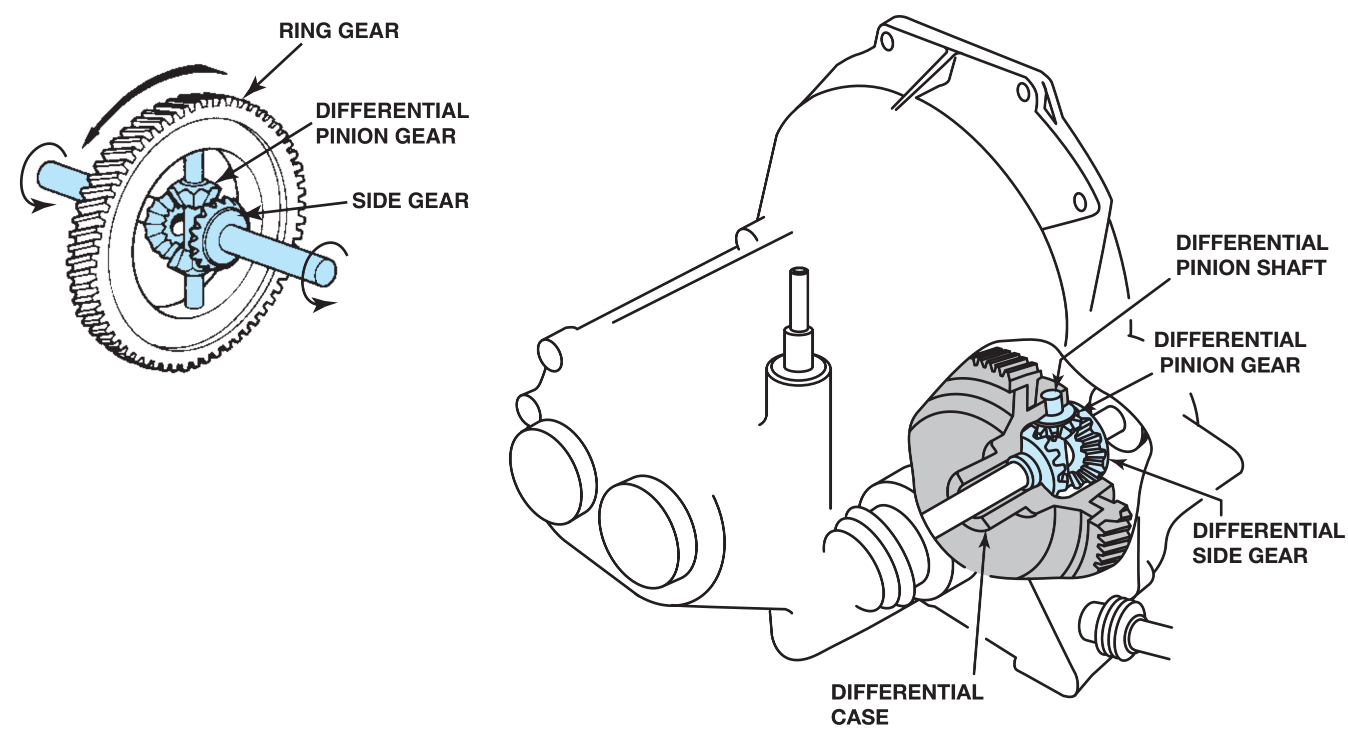


FIGURE 7-10 Simplified view (top) and cutaway view of a transaxle differential. The power flows from the ring gear to the differential case, through the differential shaft to the differential pinion and side gears, and on to the driveshafts.

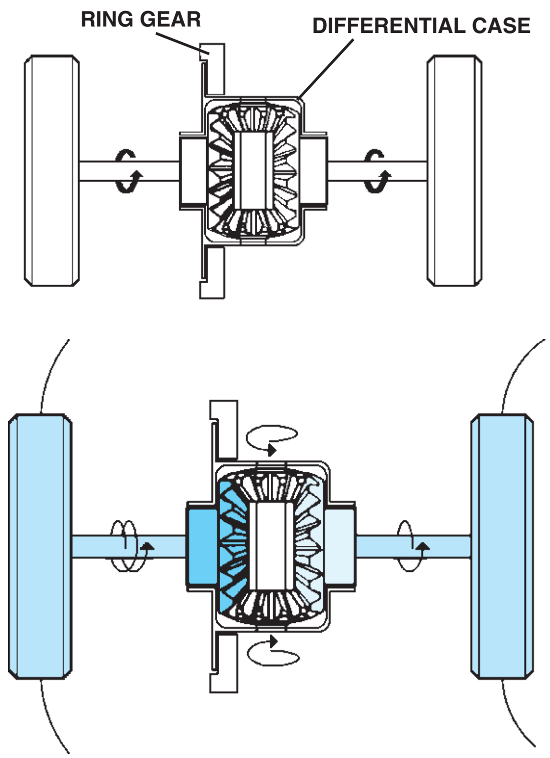


FIGURE 7-11 An equal load from each side gear will keep the differential pinion gears from rotating on their shaft, and both side gears will be driven at the same speed. If one wheel slows, the differential pinions will rotate on their shaft and drive the other side gear and wheel at an increased speed.

but the one connected to the outer wheel will rotate faster (Figure 7-11). At this time, the differential pinion gears will rotate on their shafts to compensate for this change in speed. The outer wheel will speed up relative to the vehicle and differential, and the inner wheel will slow down the same amount. For example, if the outer wheel speeds up 20 percent from 100 rpm to 120 rpm, the inner wheel will slow down 20 percent to 80 rpm. Some people think of the differential as kind of a balance scale; it pivots when a change in load occurs.

The major drawback of a differential occurs when one wheel does not have traction. To demonstrate this, set the parking brake, raise one drive wheel off the ground, start the engine, release the parking brake, and carefully let out the clutch with the transmission in first gear. You should see the vehicle stand still with one wheel spinning. Be careful doing this because a vehicle with a limited slip differential or with excessive drag in the differential can drive both wheels enough to move the vehicle. Remember that the differential splits torque equally. Assume that it takes 10 ft-lb of torque to spin the raised wheel. When torque arrives at the differential, it will exert a force equal to 10 ft-lb at each side axle gear (Figure 7-12). When the side gear with the least resistance begins to spin, the

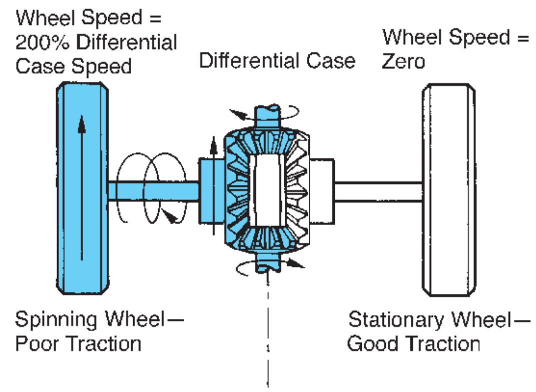


FIGURE 7-12 If one wheel has poor traction, it will rotate easily, so the differential pinion gears will rotate on their shaft and "walk" around the other side gear, which offers more resistance. The result is wheel spin on the side with poor traction.

pinion gears will simply rotate on their shaft and "walk" around the stationary side gear with good traction. The 10 ft-lb of torque is not enough to rotate the stationary side gear with the tire with good traction. At this time, the raised wheel will increase speed 100 percent, or double; if the differential case is turning 100 rpm, the wheel will be turning 200 rpm. Don't run the raised wheel too fast; above 35 mph (40 kph) on the speedometer (actual tire speed is 70 mph) the tire could explode from the centrifugal force.

Lack of one-wheel traction as just described is not a great problem in FWD vehicles because engine weight is close to the drive wheels. Rear-wheel traction is a larger problem with RWD vehicles, and one-wheel tire spin is more common. Limited slip differentials were developed to solve this problem, and they are described in Chapter 11. Occasionally, with RWD vehicles that encounter one-wheel spinning problems, the driver can partially apply the parking brake and drive out of the problem. Parking brake application will increase the drag and torque loading of the spinning tire and force the differential to send more torque to the other tire.

The differential case is usually mounted on a pair of tapered roller bearings. A drive gear for the speedometer is usually mounted on the differential case.

FIVE-SPEED TRANSAXLES

Adding an additional gear to the input shaft and an additional floating gear and synchronizer to the mainshaft is one way of making a five-speed version from a four-speed transaxle. On some units, the synchronizer and floating gear are placed on the input shaft, and the fixed gear is on the mainshaft (Figure 7-13). Because of space limitations in the case, fifth-gear is often positioned under the cover at the left end of the case or on a second mainshaft, as described earlier.

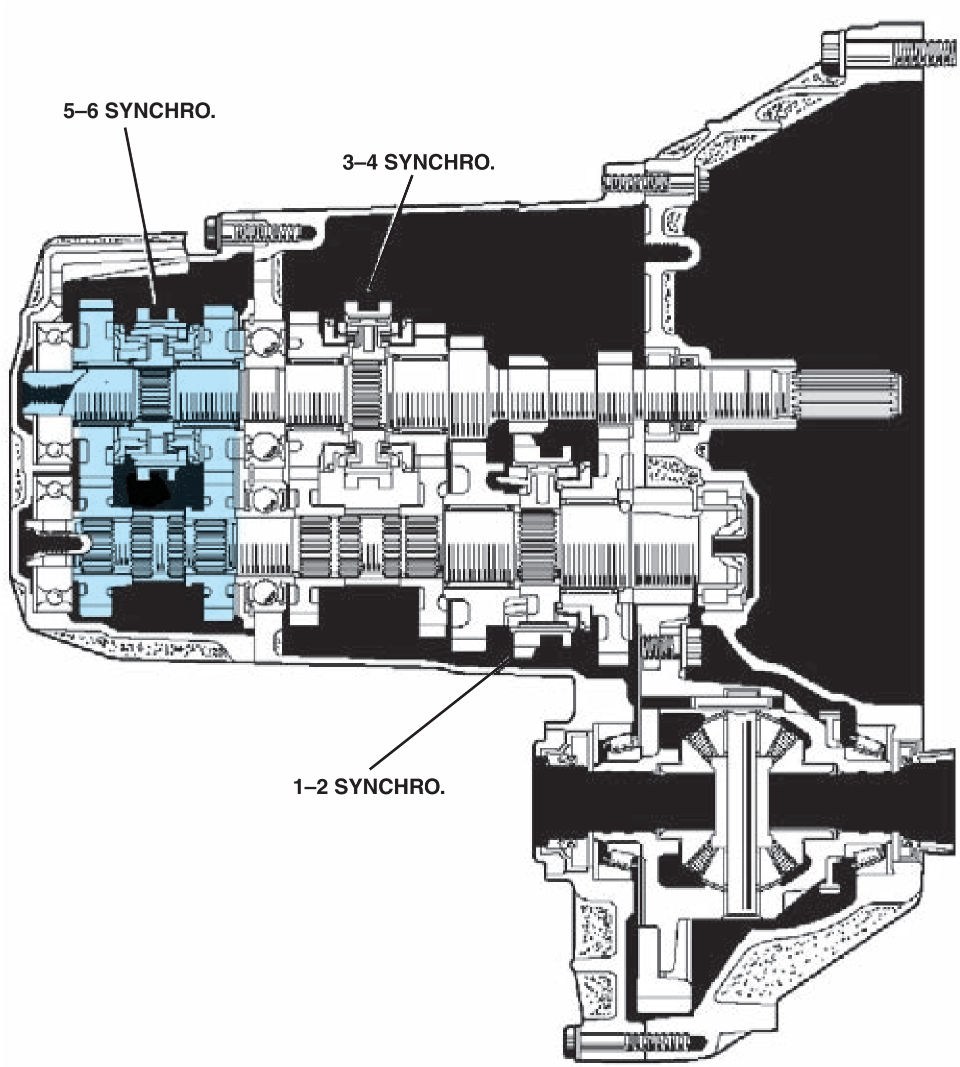


FIGURE 7-13 Six-speed transaxle with the fifth and sixth gears and synchronizer assembly in a side case. This unit is longer than the one shown in Figure 7-5. *(Courtesy of Toyota Motor Sales USA, Inc.)*

Five-Speed, Four-Shaft Transaxle

The transaxle in some vehicles uses four shafts, with a synchronizer assembly and two driving gears on the input shaft (Figure 7-14). The driven gears are two of the driving gears fixed onto the intermediate shaft. The output shaft (mainshaft) has the floating speed gears and the 1–2 and 3–4 synchronizer assemblies. The lowest-ratio gear set between the input to intermediate shafts is used for first, the next lowest for second, and so on for third and fourth gears. Then the input shaft synchronizer is shifted for fifth gear. The higher-ratio gear on the input to intermediate shafts times fourth gear becomes the ratio for fifth gear.

LENGTHWISE TRANSAXLES

A few FWD vehicle manufacturers place the engine longitudinally (lengthwise) instead of in a transverse position. This requires a major change in the transaxle. In these units the power must turn 90° to align with the front driveshafts (Figure 7-15). The transaxle portion of these units is basically the same as that just described except that the power leaves the mainshaft through a *spiral bevel pinion gear*, which is meshed with a mating *spiral bevel ring gear* mounted on the differential case. Some units use a hypoid gear set that mounts the drive pinion above or below the center of the ring gear (Figure 7-16). This gear set turns the power flow as it produces the necessary final

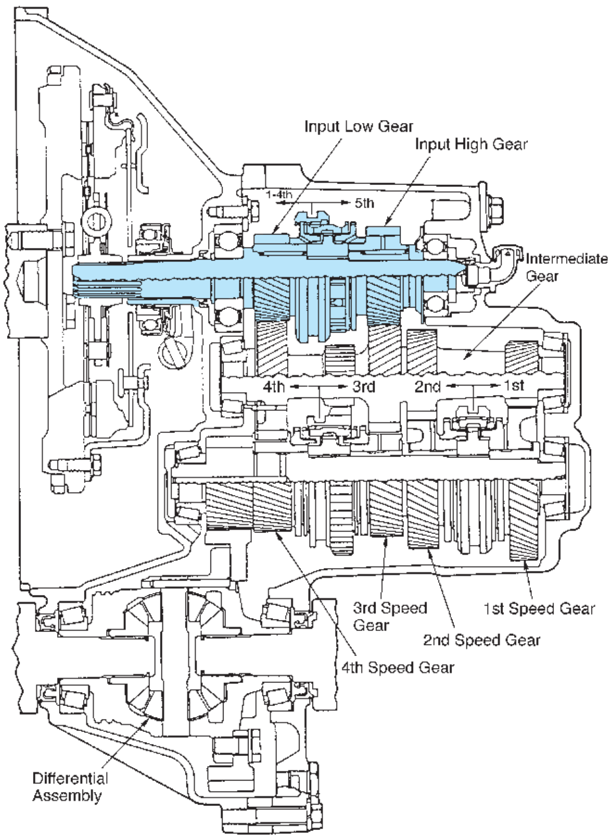


FIGURE 7-14 This transaxle uses four major shafts; note how the uppermost synchronizer assembly can drive the intermediate gear set through either third or fourth gear. *(Courtesy of Hyundai Motor America)*

drive reduction. The power flow from the ring gear through the differential to the CV joints is the same as described previously.

A spiral bevel gear set requires adjustments for proper ring and pinion gear positioning during assembly procedures. These adjustments are essentially the same as those for the hypoid gear set described in Chapter 11.

This transaxle lends itself to AWD or 4WD because of the lengthwise position of the mainshaft. It is a fairly simple matter for the manufacturer to install a dog clutch at the rear end of the mainshaft and extend an output shaft to connect to a driveshaft for the rear wheels. Transverse-mounted transaxles require a 90° gear set in order to drive a shaft for the rear wheels.

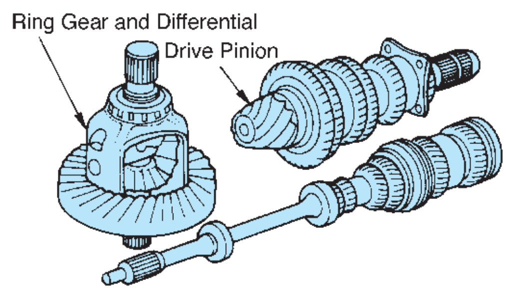


FIGURE 7-16 The gear sets from the transaxle illustrated in Figure 7-15 are shown here; the transmission section gear set and differential are very similar to those of other transaxles. *(Courtesy of Subaru of America, Inc.)*

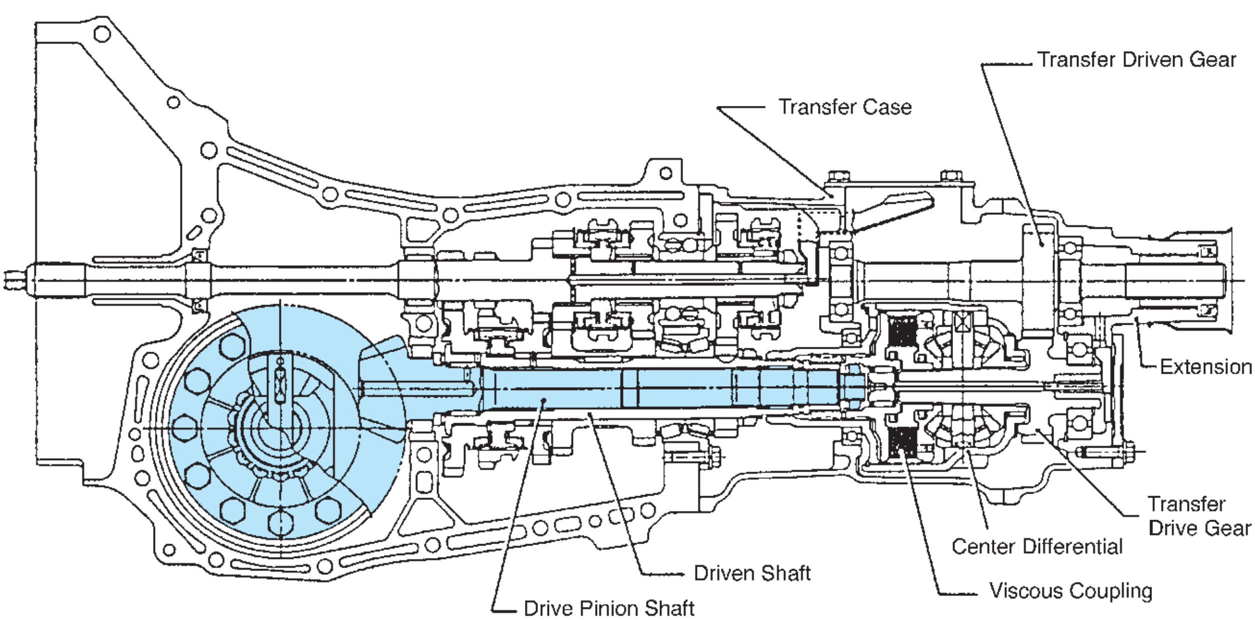


FIGURE 7-15 This FWD transaxle is used with an engine that is mounted lengthwise in the vehicle. Note how the final drive is through a hypoid ring and pinion gear set. Also note the center differential and extension to drive the rear wheels of an all-wheel-drive vehicle. *(Courtesy of Subaru of America, Inc.)*

DUAL-CLUTCH TRANSAXLE

A dual-clutch transaxle is essentially two transmissions built into one case. Each portion is driven by one of the clutches, and these clutches are applied, one at a time, to transfer power. A dual-clutch transmission is essentially an automatic transmission that uses manual transmission style gears with two countershafts. The shifts can occur vary rapidly, being controlled by how fast each clutch can be applied. This transaxle is presently available in some models of the Audi TT and Volkswagen Golf and is called a *direct shift gearbox (DSG).*

The gear arrangement shown in Figure 7-17 illustrates how the 1–3 and 5 synchronizer assemblies are driven by clutch #1. The 2–4 and 6-reverse synchronizers are driven by

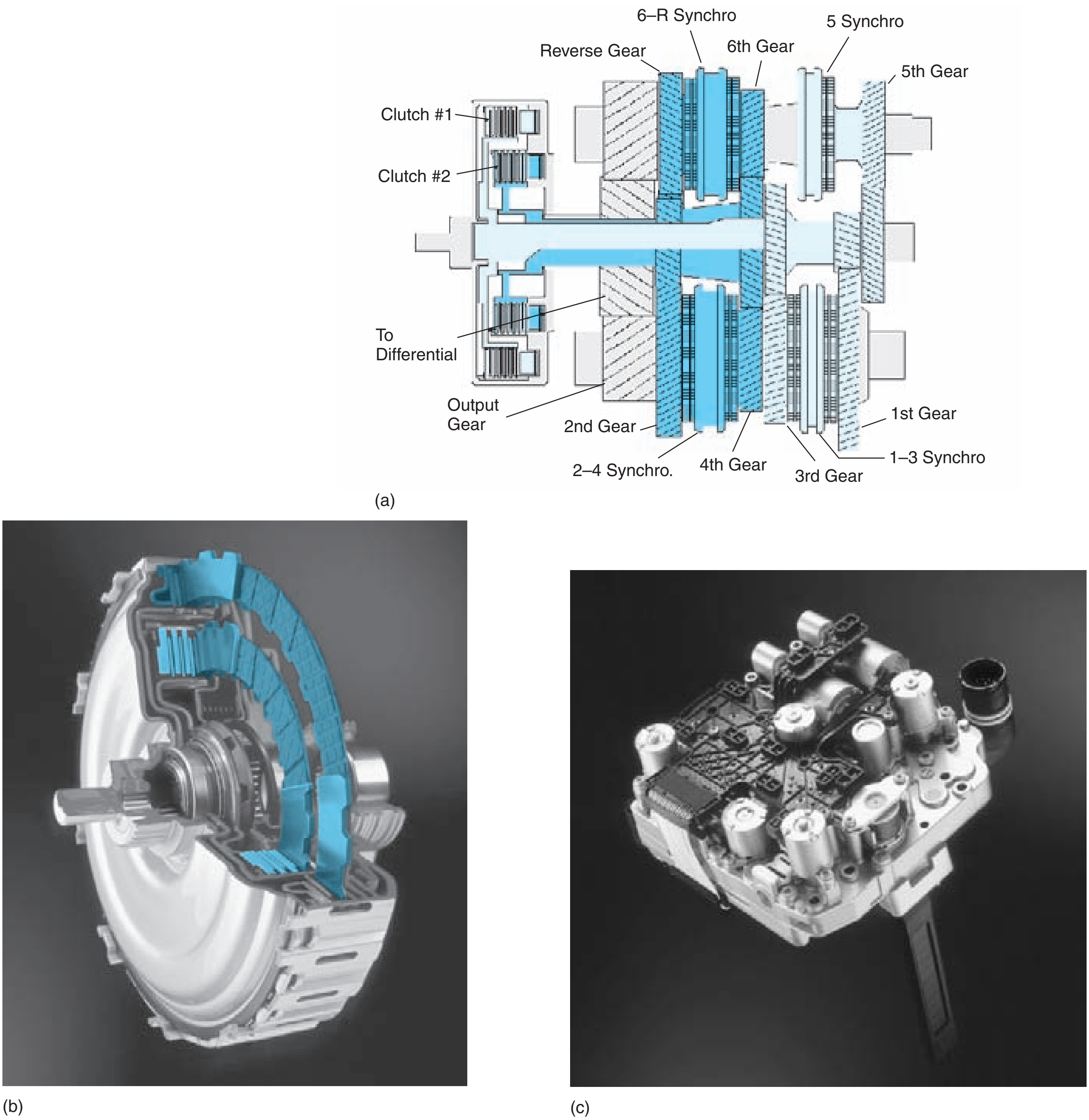


FIGURE 7-17 A dual clutch transaxle uses two clutches to send torque to the gear sets (a). The cutaway view of a DualTronic™ clutch shows the two clutches (b). A DualTronic™ control module (c), a hydraulic valve body with a microprocessor, 11 solenoids, and external electrical connectors. *(b and c Courtesy of BorgWarner Inc.)*

clutch #2. Both clutches are built into one *DualTronic™ clutch* assembly. Vehicle movement begins with the 1–3 synchronizer shifted to first gear and clutch #1 applied. The 2–4 synchronizer is then shifted into second gear by a hydraulic servo, and the 1–2 upshift will occur when clutch #1 is released and clutch #2 is applied. The remaining upshifts occur in the same manner, with the synchronizer shifted early and the actual shift occurring when the clutches are cycled.

The driver can control transmission using a floor-mounted shift lever or one of a pair of paddles mounted in front of the steering wheel. Clutch #1 and #2 are applied by hydraulic pressure, similar to automatic transmission clutches. As mentioned, the synchronizer sleeves are also shifted by hydraulic servos. The hydraulic flow to the clutches and servos is controlled electronically by a *DualTronic TM control module*. This module contains the hydraulic valve body, 11 solenoids, a microprocessor, and the external electrical connectors. Twelve sensors monitor operations like shift lever position, upshift and downshift paddles, engine rpm, and fluid temperatures, and the electronic control module uses information from these sensors to determine the proper clutch and shift servo operation.

SHIFT MECHANISM

The lengthwise transaxle can connect the shift linkage at the rear of the case and use internal linkage much like an RWD transmission. Transverse transaxles require external linkage to connect the shift lever to the transaxle, and this linkage is complicated by engine movement.

A transverse engine tries to rotate in a counterclockwise direction (viewed from the right) in reaction to its torque output. The engine mounts are made from rubber or are hydraulic to isolate engine vibrations. Heavy throttle acceleration will cause the top of the engine to move forward, while closed-throttle deceleration causes a light rearward motion. If the gearshift lever were secured to the vehicle body and connected to the transaxle by a solid rod, these engine motions could produce unwanted shifting in the transaxle.

Most transaxles mount the shift mechanism to the vehicle body through flexible mounts and connect to the transaxle by an **extension rod** or **stabilizer bar**. This bar maintains a constant distance between the shifter and the transaxle (Figure 7-18). A single shift rod is used to connect the shift lever to the transaxle shift shaft, and both it and the extension rod connect to the transaxle through rubber isolaters to block vibrations.

Movement of the shift lever sideways, across the vehicle, will cause the shift rod and the shift shaft inside the transaxle to rotate. This motion will select the proper shift fork or rail (Figure 7-19). Lengthwise movement of the shift lever moves a shift rod and shift fork that in turn moves a synchronizer sleeve or reverse idler gear in or out of mesh.

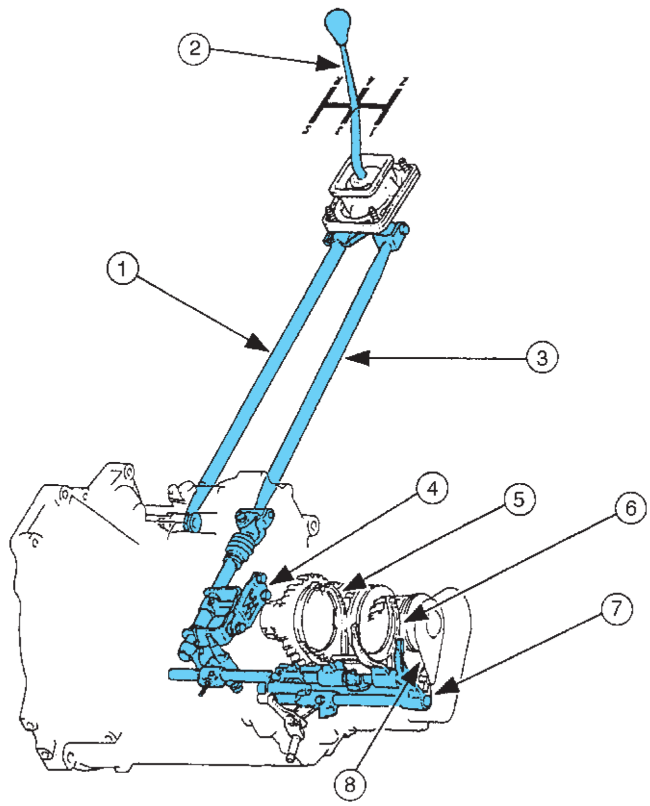


FIGURE 7-18 This shift linkage uses a stabilizer (1) to eliminate ill effects from engine motions. The shift rod (3) rotates for selection or moves fore or aft to complete shifting. *(Courtesy of Ford Motor Company)*

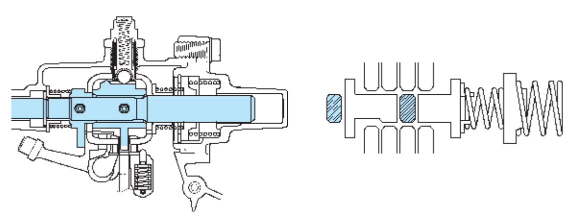


FIGURE 7-19 In this transaxle, selection and shifting motions enter the shift shaft (blue) and are transferred to the shift forks. *(Courtesy of Toyota Motor Sales USA, Inc.)*

Some transaxles use a pair of cables to transfer the shift motion. By their nature, the cables' flexibility makes for easy alignment as well as absorption of engine vibrations and rocking motions (Figure 7-20). One of these cables, the crossover cable, transfers the selecting motion to the shift shafts, whereas the other transfers the shifting motions to the synchronizer.

The internal shift mechanism varies with manufacturers and can appear rather complex (Figure 7-21). It includes shift forks to move the synchronizer sleeves or reverse idler gear, detents to position the shift forks properly, and interlocks to prevent movement of more than one fork at a time.

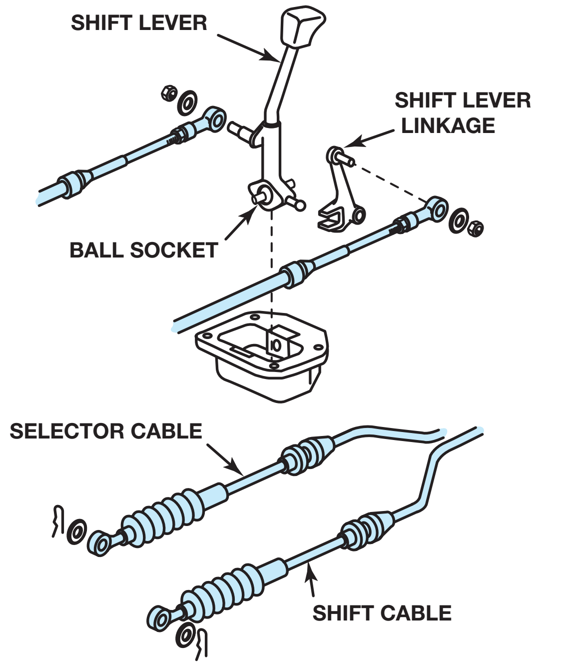


FIGURE 7-20 This transaxle uses one shift cable to shift the gear and another to select the gear to be shifted.

Remote Shifting

Shift linkage can be difficult when the engine is mounted at the rear or middle of the vehicle. Electronic shift controls are often used to produce more precise shifts and/or sequential shifting. Sequential shifts use an up or down pattern with the shifts being performed in sequence: 1–2, 2–3, 3–4; moving the shift lever forward gives an upshift while moving it backward causes a downshift. Remote shifting integrates electronic controls with input from the engine control module and switches mounted at the gear shift lever and/or steering wheel (Figure 7-22). The electronic controls reduce driver ef-

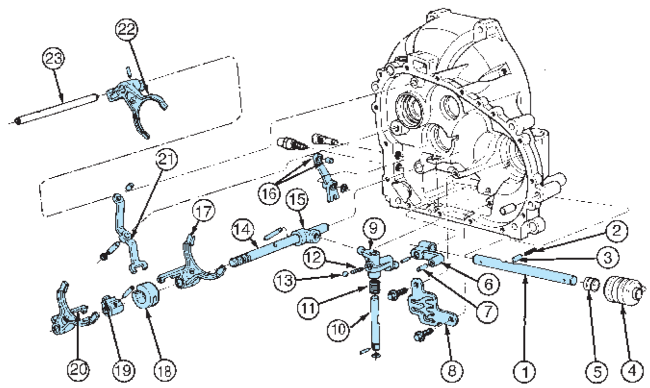


FIGURE 7-21 Exploded view of the internal shift linkage from a transaxle using a shift rod. *(Courtesy of Ford Motor Company)*

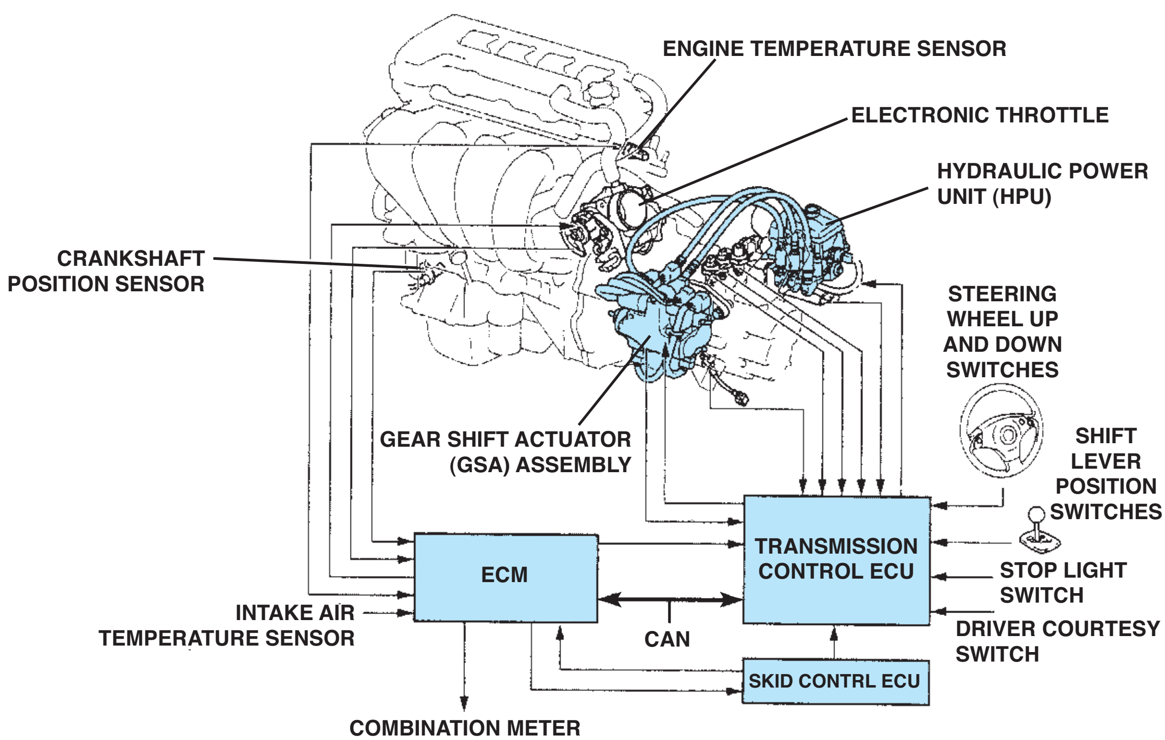


FIGURE 7-22 This mid-engine vehicle uses electronically controlled, hydraulic servos to shift the six-speed transmission. *(Courtesy of Toyota Motor Sales USA, Inc.)*

fort to make the shifts as well as insuring that the shifts occur at the proper time relative to engine speed, vehicle speed, and vehicle load.

Some remote shift system actuators use electric motors to operate the clutch and move the transmission shift levers. Others, as shown, use hydraulic actuators that have electronic controls.

LUBRICATION

Like transmissions, transaxles use a supply of oil in the sump at the bottom of the case that is circulated by gear rotation. The oil is directed to critical areas by troughs and oiling funnels. The fluid level is normally checked at a fill-level plug or with a dipstick (Figure 7-23). Many transaxles use MTF or ATF for the lubricant.

Most transaxles have a common case so the transmission and final drive share the same lubricant. Some units separate the two. With these, a different oil may be used for each gear set, and there will be two fluid-level plugs.

DESIGN FEATURES

As with transmissions, there are certain features that should improve your understanding of transaxle operation and service.

Case

Transaxle cases are made from cast aluminum. Most transverse units use a tunnel case design (Figure 7-24a). Some longitudinal transaxles use a split case (Figure 7-24b). Many cases use a two-part assembly with a right-hand case or cover that also forms the clutch housing and a left-hand or main case that contains the gears. Some units have a separate side case or side cover that encloses the fifth gear set and synchronizer or just the left side bearings. Some units have a bottom or differential cover that provides access to the differential assembly.

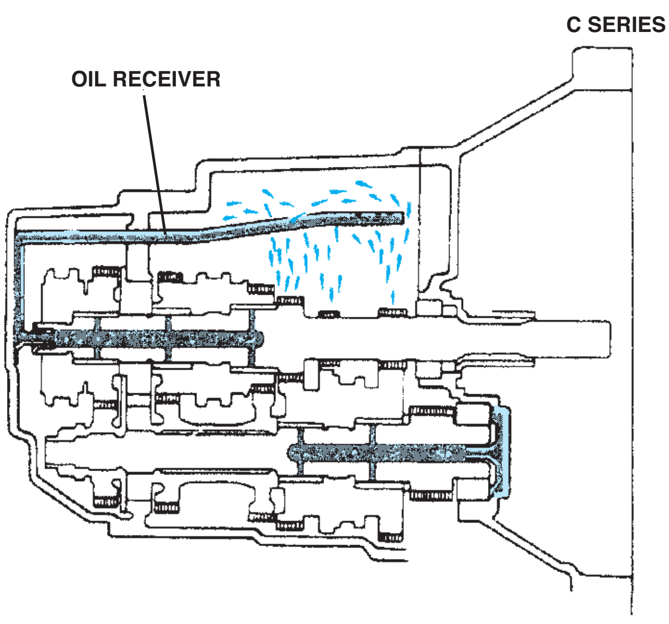
Case Sealants

Most modern units use formed-in-place gaskets. These are usually **room-temperature vulcanizing (RTV)** or **anaerobic sealants** (Figure 7-25). RTV is sometimes called *silicone rubber.* It is thick and very viscous as it comes out of the tube. Depending on temperature and humidity, it will set up to a rubber-like material in about 15 minutes. Anaerobic sealants are quite fluid and set up after the parts are assembled. Anaerobic sealants cure in the absence of air. RTV sealants are commonly used on covers that are less than perfectly flat, or on slightly flexible materials that do not necessarily make perfect joints. To make a good seal, an anaerobic sealant requires a wider, flatter, more perfect surface because it cures to a much thinner thickness than that of RTV. To make a good seal, both types of sealants require surfaces that are clean and oil-free when they are applied.

The proper gasket or formed-in-place gasket should always be used because in many cases the thickness of the gasket can affect transmission operation. These gasket materials have different assembled thicknesses that can determine the spacing between the parts.

Gears

Like transmissions, transaxles use helical gears for all the forward speeds and spur gears for reverse. To allow for engine length in the cramped width of the engine compartment, the speed gears, synchronizer assemblies, and bearings are kept as



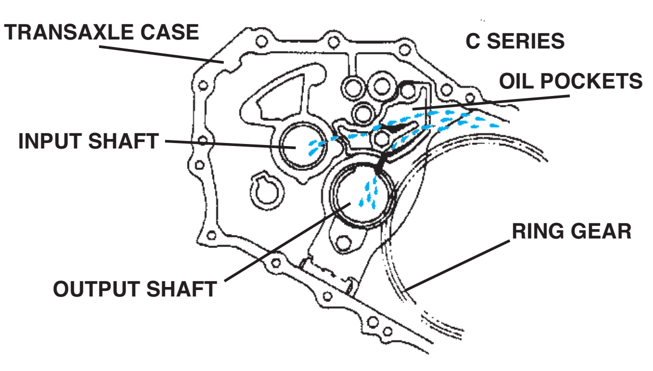


FIGURE 7-23 Oil thrown off of the rotating gears is caught in oil troughs and then carried to the bushings and shafts. *(Courtesy of Toyota Motor Sales USA, Inc.)*

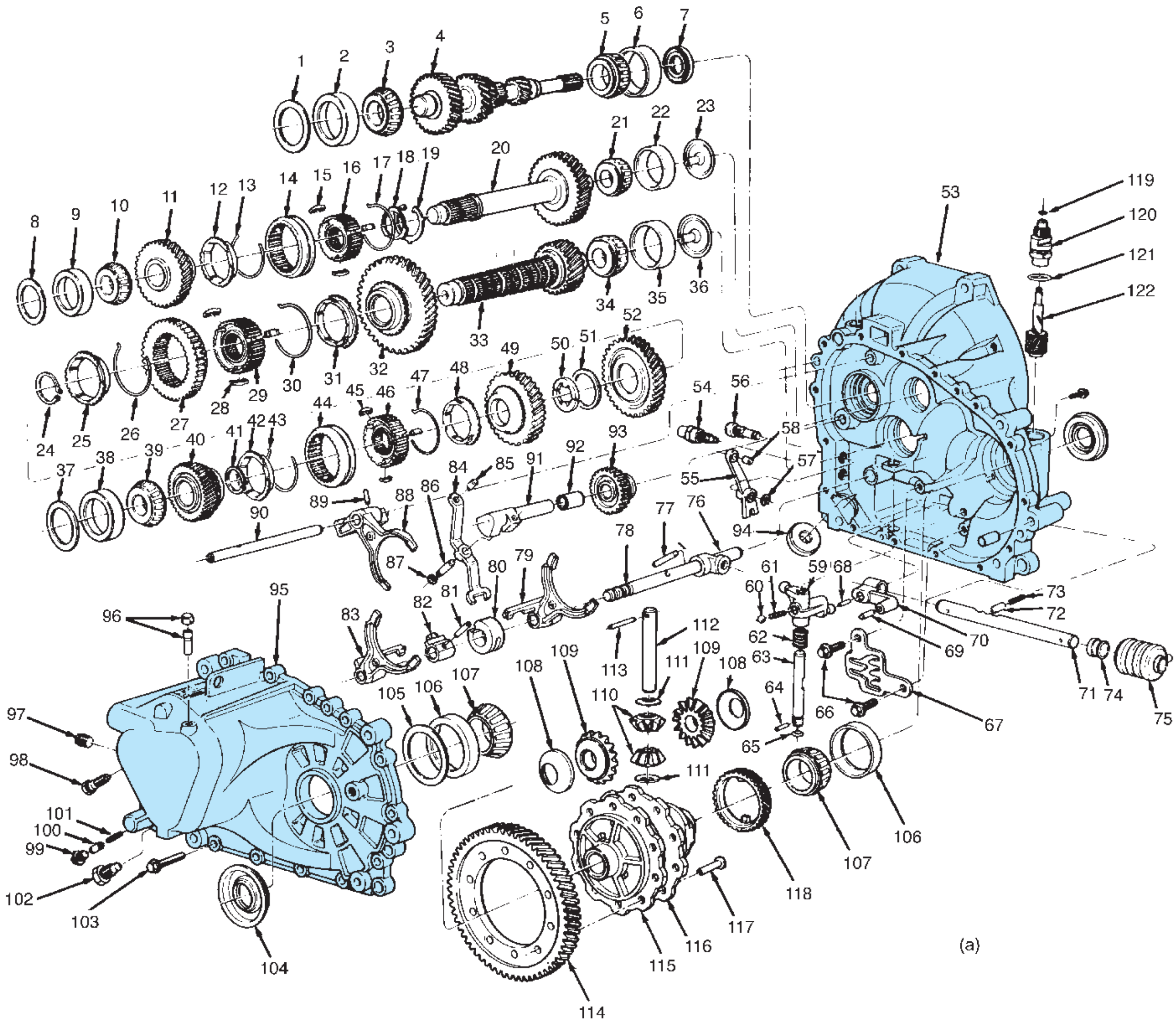


FIGURE 7-24 (a) Most transaxles locate the gear assemblies in the case (95) and the case/clutch housing (53). *(a is courtesy of Ford Motor Company)*

narrow and compact as practical. This design factor is much more critical with transaxles than with transmissions.

The journal area surfaces on many transaxles are made with lubrication slots to compensate for the reduced gear width; on other units, the speed gears are mounted on roller bearings. These features also improve the efficiency of the transaxle and fuel mileage.

Bearings

Some transaxles use a roller bearing at the engine end of the input shaft and mainshaft and a ball bearing at the other end of the shaft (Figure 7-26). The ball bearing supports one end and also positions the shaft to the case as the roller bearing supports the end with the greater side loading from the final drive. This feature makes for easy servicing, as the roller bearing can slide through the openings when the cover is removed or installed.

On transaxles that use tapered roller bearings, bearing clearance or preload is adjusted by selecting the correct size of shim to place at the bearing or bearing cup (Figure 7-27). This selective shim is usually positioned under the bearing cup in the case. Bearings are usually adjusted to a very slight clearance to ensure free rotation. In loaded areas where shaft movement can create a problem, such as the differential assembly, the bearings are adjusted to a slight preload.

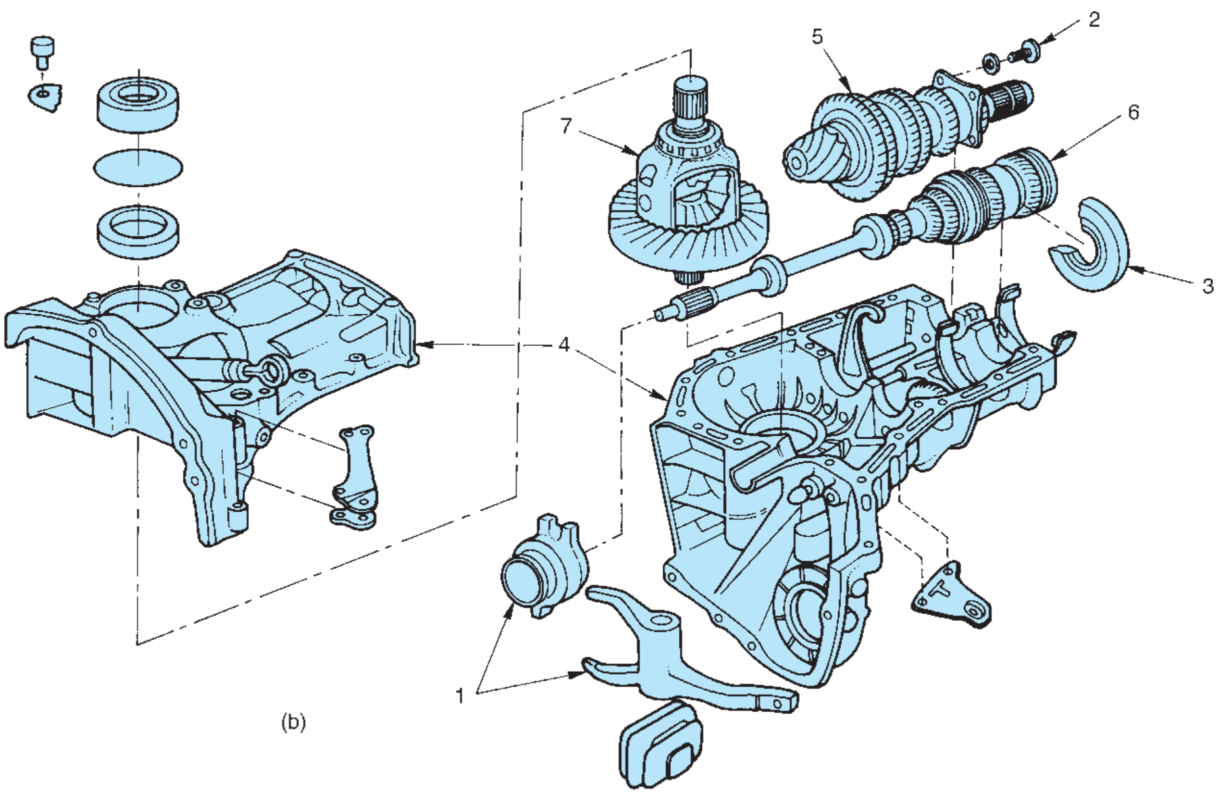


FIGURE 7-24 *(Continued)* (b) A few designs use a split case. *(b is courtesy of Subaru of America, Inc.)*

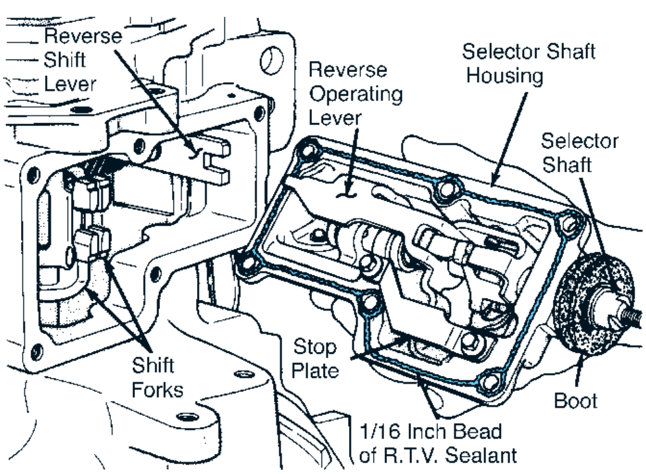


FIGURE 7-25 Most transaxles use formed-in-place gaskets between the case parts and covers, like the RTV sealant used here. *(Courtesy of DaimlerChrysler Corporation)*

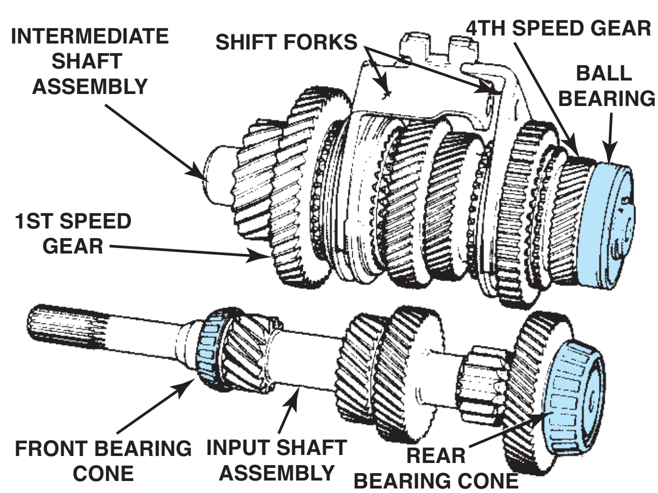


FIGURE 7-26 This transaxle uses a roller bearing at one end of the intermediate shaft and a ball bearing at the other end. A pair of tapered roller bearings support and locate the input shaft. *(Courtesy of DaimlerChrysler Corporation)*

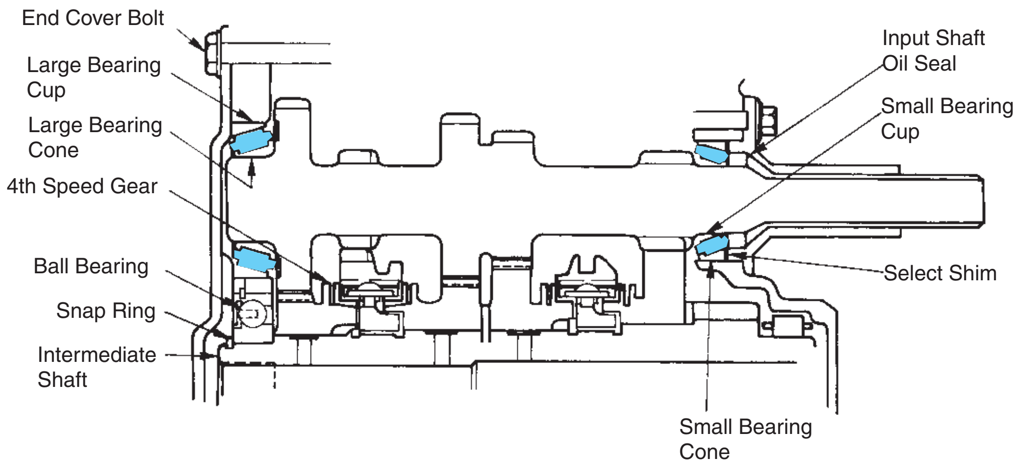


FIGURE 7-27 This transaxle uses tapered roller bearings at the input shaft. To adjust these bearings, the selective shim is located at each bearing set. *(Courtesy of DaimlerChrysler Corporation)*

SUMMARY

1. Transaxles combine a transmission with the final drive gearset and differential.
2. Differentials allow a vehicle to drive two wheels at different speeds.
3. Transaxles normally have two shafts, input and intermediate, and the differential.
4. Some transaxles are mounted in a longitudinal position and use either a hypoid or spiral bevel final drive gearset.
5. Transaxle shifts use external or internal linkage that includes detents, interlocks, and shift forks.
6. Transaxles are lubricated with gear oil or manual transmission fluid (MTF).
7. Special transaxle design features include gear tooth pitch and helix angle, cluster gear variations, case construction, and bearing type.

REVIEW QUESTIONS

1. A transaxle differs from a transmission in that it has ____________ major shafts and it contains the ____________.
2. The power flows from the mainshaft ____________ gear to the final drive ____________ gear.
3. The final drive gears of a typical transaxle are ____________ gears.
4. Which gear range uses the largest driven gear and the smallest driving gear? ____________
5. True or false: A 1:1 ratio is always used in transaxles. ____________
6. The power flow for second gear in a four-speed transaxle from the input to the differential case would be from the second input shaft gear to the (a) ____________ gear and then from the drive pinion gear to the (b) ____________ gear.
7. If the input shaft is turning clockwise, what direction is the output shaft turning? ____________
8. If the input shaft is turning clockwise, what direction is the differential case turning? ____________
9. What determines engine rpm at cruising speeds? ____________ ____________ ____________

10. A longitudinal transaxle must turn the power flow ____________ ____________.

11. A cable-operated shifter uses one cable to ____________ the gear and the other to ____________ the gear.

12. Transaxle cases are made out of cast ____________.

13. When using a sealant to seal the transmission, the sealing surfaces must be ____________ and ____________ free.

14. ____________ sealers dry in the absence of air.

15. In transaxles that use tapered roller bearings, the bearing clearance or preload is adjusted by selecting the correct size of ____________.

CHAPTER QUIZ

1. Most four-speed transaxles have ____________ gears on the input shaft.
   a. three
   b. four
   c. five
   d. six

2. Two students are discussing four-speed transaxles. Student A says they have three shift forks. Student B says they probably have two synchronizer assemblies. Who is correct?
   a. Student A
   b. Student B
   c. Both A and B
   d. Neither A nor B

3. When shifting into reverse, the reverse idler gear is moved into mesh with the (A) reverse gear on the input shaft; (B) 1–2 synchronizer sleeve gear. Which is correct?
   a. A only
   b. B only
   c. Both A and B
   d. Neither A nor B

4. The correct fluid level for a transaxle is at the (A) bottom of the filler hole in the case; (B) indicated area of the dipstick. Which is correct?
   a. A only
   b. B only
   c. Both A and B
   d. Neither A nor B

5. The ring gear on the differential is driven by a pinion gear on the (A) mainshaft; (B) countershaft. Which is correct?
   a. A only
   b. B only
   c. Both A and B
   d. Neither A nor B

6. The inboard CV joints on the driveshaft are splined to the (A) differential pinion gears; (B) differential case. Which is correct?
   a. A only
   b. B only
   c. Both A and B
   d. Neither A nor B

7. Two students are discussing four-speed transaxles. Student A says the differential pinion gears are turning on the differential pinion shaft when the vehicle is going straight down the road. Student B says the axle gears are rotating at the same speed as the differential case. Who is correct?
   a. Student A
   b. Student B
   c. Both A and B
   d. Neither A nor B

8. A five-speed transaxle has the fifth-gear synchronizer and is mounted on
   a. the input shaft.
   b. the mainshaft.
   c. a separate fifth-gear shaft.
   d. any of these.

9. For lubricant, most transaxles use (A) ATF; (B) gear oil. Which is correct?
   a. A only
   b. B only
   c. Either A or B
   d. Neither A nor B

10. In a transaxle, the synchronizer assemblies are mounted on the (A) input shaft; (B) mainshaft. Which is correct?
    a. A only
    b. B only
    c. Both A and B
    d. Neither A nor B

11. Two students are discussing a four-speed transaxle with a 3.4:1 first-gear ratio. Student A says the mainshaft gear has 3.4 times as many teeth as the input shaft gear. Student B says the input shaft gear is about one-third the size as the mainshaft gear. Who is correct?

- **a.** Student A
- **b.** Student B
- **c.** Both A and B
- **d.** Neither A nor B

12. When a transaxle is shifted into third gear, a(n) (A) shift fork slides the 3–4 synchronizer sleeve into mesh with third gear; (B) interlock moves to lock the 1–2 shift fork stationary. Which is correct?

- **a.** A only
- **b.** B only
- **c.** Both A and B
- **d.** Neither A nor B

13. The final drive ring and pinion gears in a typical transaxle are

- **a.** hypoid gears.
- **b.** helical gears.
- **c.** spiral bevel gears.
- **d.** Both b and c.

14. When a transaxle shift shaft is (A) rotated—a fork slides a sleeve or gear into mesh; (B) slid in or out—a particular shift fork is selected. Which is correct?

- **a.** A only
- **b.** B only
- **c.** Both A and B
- **d.** Neither A nor B

15. Shift motions are transferred from the shifter assembly to the transaxle by (A) either two or three shift rods; (B) a pair of cables. Which is correct?

- **a.** A only
- **b.** B only
- **c.** Both A and B
- **d.** Neither A nor B

16. First gear on the clutch shaft has 11 teeth, and the first speed gear on the mainshaft has 39 teeth. What is the ratio?

17. Use the gear ratio from question 16. How fast will the mainshaft be turning if the engine is running at 2000 rpm?

18. If the mainshaft final drive pinion has 19 teeth and the ring gear on the differential has 71 teeth, what is the final drive ratio?

19. Use the gear ratio from question 18. How fast will the differential be turning if the mainshaft is running at 1000 rpm?

20. If we combine the gear ratios from questions 16 and 18 in the same transaxle, what is the overall ratio for first gear?

21. Using the gear ratio from question 20, if the engine is running at 2000 rpm, how fast will the wheels be turning?