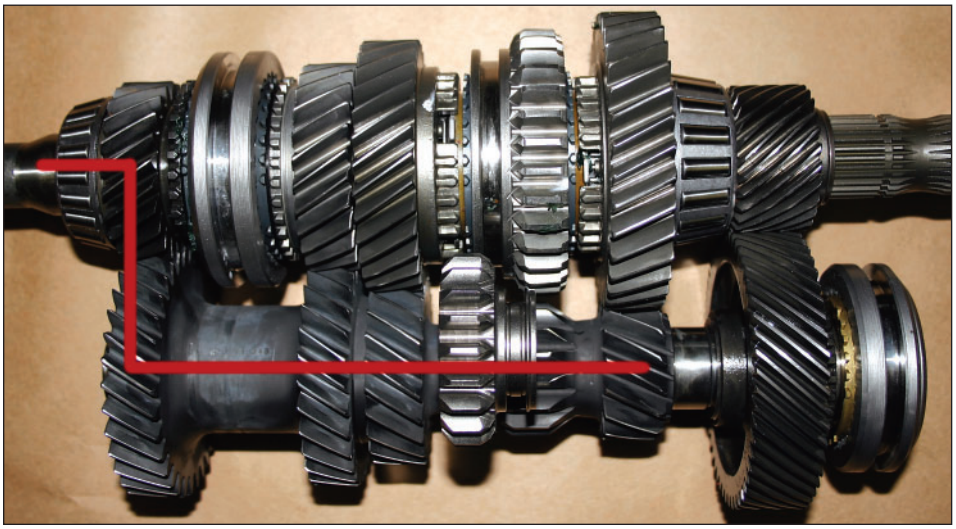
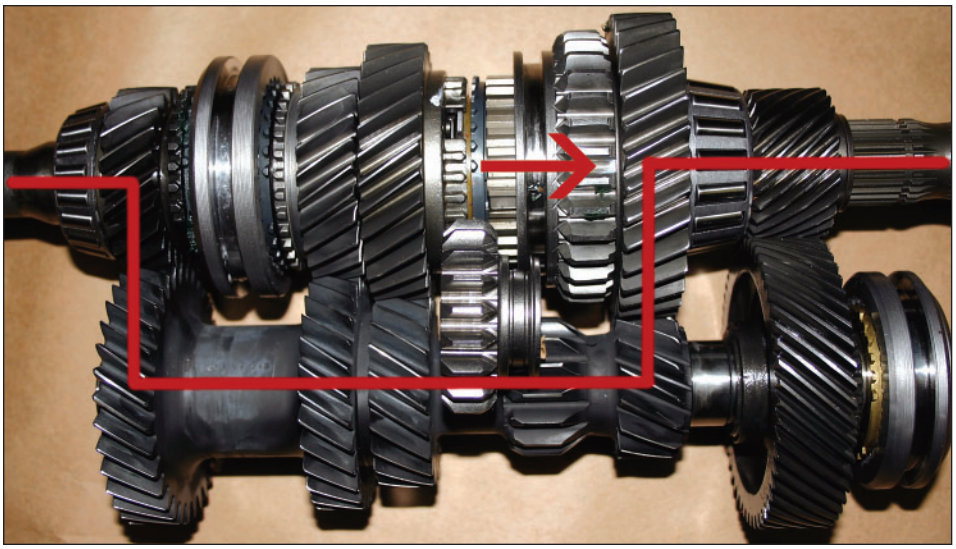
CHAPTER 1

THEORY OF MANUAL TRANSMISSIONS



Power flow in neutral.



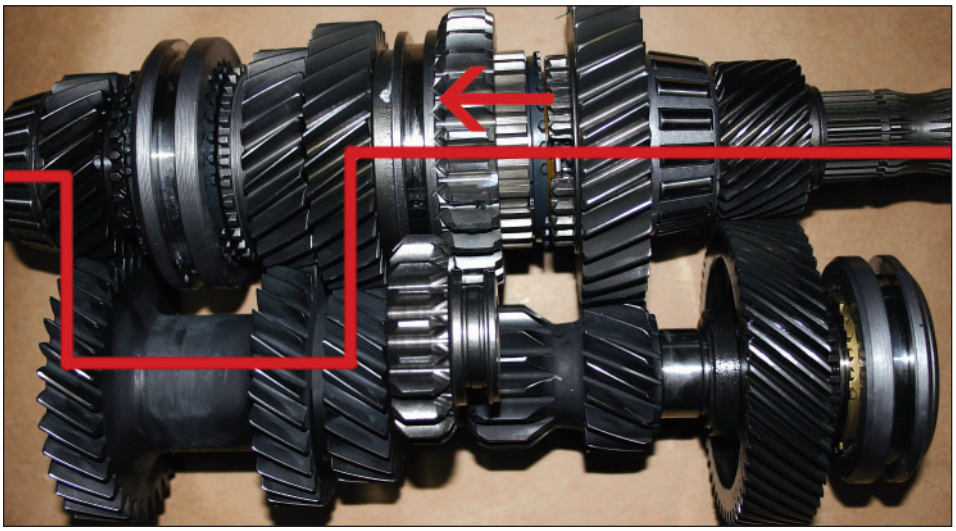
Power flow in first gear.

Whether you are dealing with sprocket teeth on a bike or gear teeth on a transmission gear, the simple formula for calculating a gear ratio is: Ratio = Driven ÷ Drive.

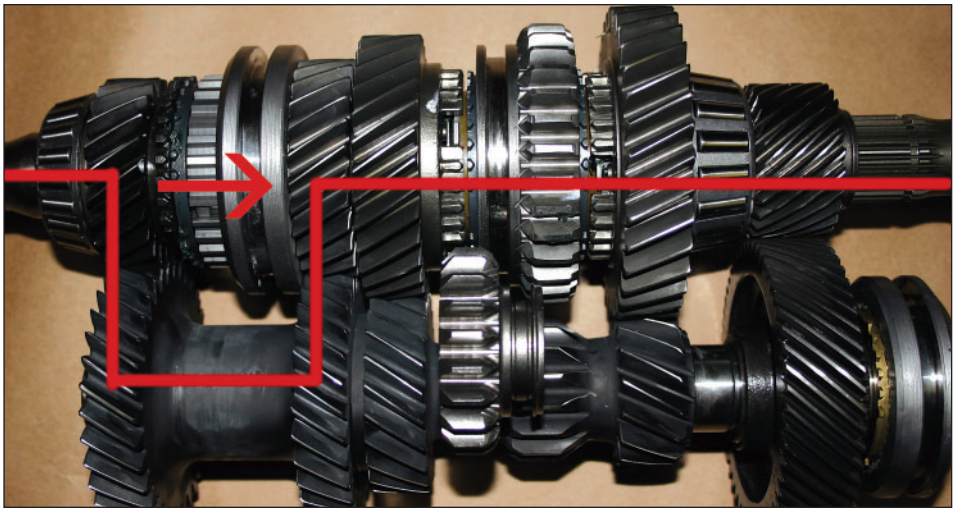
So if the drive gear has 10 teeth and the driven gear 20 teeth, the ratio equals 2. This is expressed as a 2:1 or a 2.00 ratio. The drive gear must make two turns to make the driven gear turn once. Any ratio with a number greater than 1 is an underdrive ratio. A ratio less than 1 becomes an overdrive ratio. If the drive gear has 40 teeth and the driven has 30, the ratio becomes .75. This is expressed as.75:1. Sometimes overdrive ratios are expressed as a percentage. If the ratio is .75, the difference between .75 and 1.0 is .25 or 25 percent. Therefore, a .75 overdrive ratio is often called a 25 percent overdrive.

Because the average manual-shift transmission contains more than one pair of gears, the same formula holds true for each drive and driven set. The ratio of each drive and driven set is multiplied by each other to give the final ratio. The formula is:

Ratio =
(Driven ÷ Drive) x (Driven ÷ Drive)



Power flow in second gear.



Power flow in third gear.

Power flow in fourth or direct gear.

When looking at the nearby power-flow pictures for first-gear mode, you see that the power comes into the input shaft (drive), down to the countergear (driven), then from the countergear (drive) to the first-speed gear (driven). You can now figure your overall gear ratio. Here is an example: Your input shaft has 21 teeth. The mating driven section of the countergear has 25 teeth. The first-gear section of the countergear has 17 teeth, and the first-speed gear has 36 teeth. Using the formula:

$$\text{Ratio} = (25 \div 21) \times (36 \div 17) = 1.19 \times 2.12 = 2.52$$

Your first-gear ratio is 2.52:1.

Gear ratios are a very important aspect of transmission selection and transmission design. Ratios can help determine proper application as well as the torque capacity of a transmission. Two areas often overlooked when selecting a transmission are gear ratio and center-to-center distance.

The center-to-center distance is the distance between the centerlines of the upper and lower geartrains. To help visualize why a center-to-center distance is important, here is an extreme example: You can have two gearsets. Both sets have a 20-tooth driven gear and a 10-tooth drive gear; however, one set has a center-to-center of 1 inch while the other has a center-to-center of 3½ inches. The set with the larger center-to-center obviously has larger teeth and bigger gears. This yields a stronger transmission, but with a heavy geartrain. The transmission with the small center-to-center may shift easier, because of the lighter mass of the geartrain, but it will be weaker.