Ratios And Drivability

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Summertime is here and the living should be easy. Racing season is in full swing and this time of the year we get numerous calls from shops inquiring about gear ratios. The one thing that becomes apparent during these conversations is that very few technicians are comfortable or familiar with figuring out ratios.

A transmission, stick or automatic, transmits power from the engine to the driveshaft or drive axles (rear-wheel or front-wheel drive). That sounds simple enough, but the transmission must make that power usable, which is called drivability. An engine produces a certain amount of horsepower at a given rpm. The turning force produced by the engine is known as torque and is measured in foot pounds. The transmission and final-drive gear must be carefully matched to give the engine maximum mechanical advantage within the power band (torque curve) of the engine. In passenger cars fuel economy and emissions are major factors that the manufacturers must address in each model they produce in order to have as little pollution as possible, along with good gas mileage and smooth acceleration and drivability. Gearboxes are designed with ratios to provide good acceleration for hill climbing and freeway on-ramps, smooth low-speed operation around town, and fuel-efficient highway cruising. In other words, proper gearing of the transmission determines how usable the power of the engine will be. Inevitably compromises are made by the manufacturer because of design and cost problems. In the past this has created a few vehicles that were really horrendous to drive because of the large "steps" created by poor ratio selection in the gearbox. The typical engine power band in gasoline-powered passenger cars is 2,000-5,000 rpm.

Diesel-powered vehicles, particularly heavy-duty trucks, present other problems for the engineers. A typical diesel truck engine produces power in a very narrow rpm range, usually 1,500-2,800. This small range of usable power makes 10- to 16-speed transmissions necessary and, in many cases, two-speed rear ends. Ten or more speeds keep the engine making fuel-efficient power at all times, and the driver is shifting constantly to get up to road speed.

Racing puts an even tougher burden on transmission design as most race engines turn at very high rpm and have a fairly narrow power band on the top end of the rpm range. This means that transmissions must be designed to handle high horsepower and very high rpm and have numerous ratios available to match the transmission to various tracks raced in that series. For example, Indy cars will turn the motors to 14,000 rpm and will compete on superspeedway and road courses. The transmission ratio used at the Indianapolis Motor Speedway will not be competitive at a road course like Long Beach.

Now it may be that you as a trans rebuilder don't do any race work and fail to see how the ratio in a transmission can affect your daily life. With the huge variety of transmissions in today's cars and trucks, the price pressure put on shops by customers and the scarcity of skilled standard-gear technicians have a lot of shops swapping junkyard gearboxes and rear ends to satisfy their customers. What happens when a unit is swapped into a car with the wrong ratios for the vehicle? The engine either runs out of revs or lugs the car, and drivability is out the window. The trans looked the same externally and it fit, but the customer will haunt you. Swapping a gas-engine trans into a diesel vehicle will cause the same kind of problems. A simple

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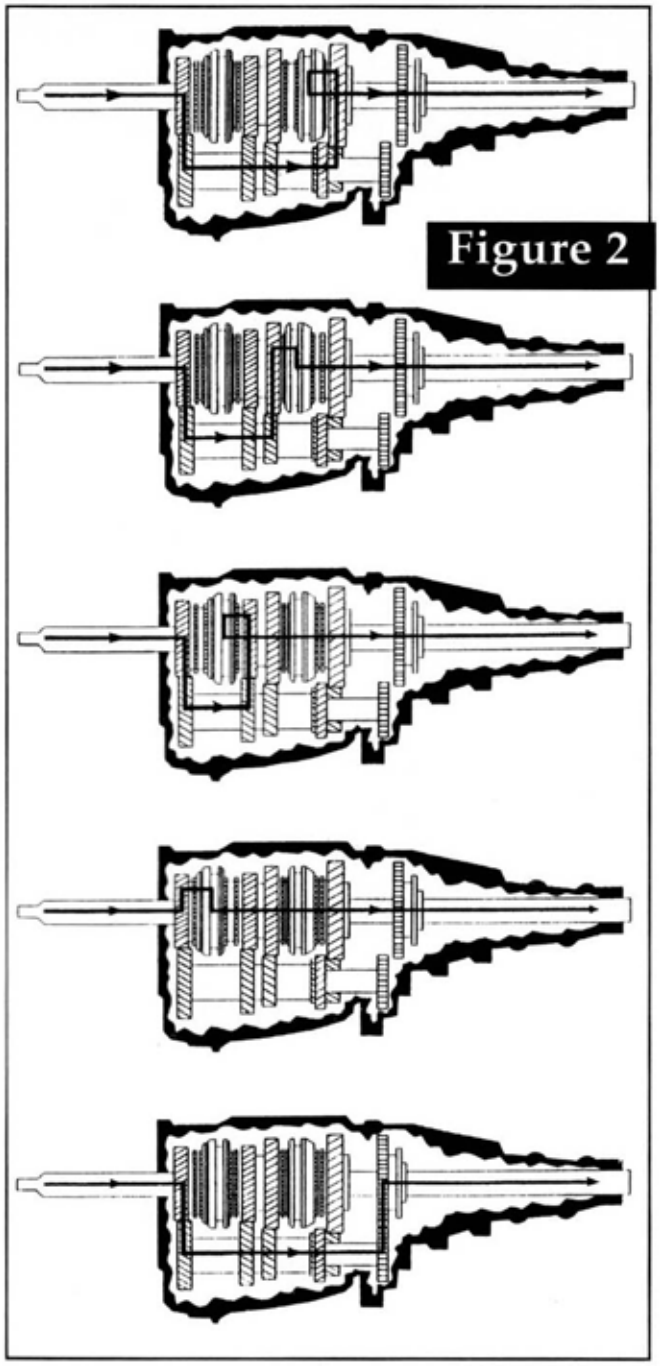

Figure 2

Up To Standards

Four-, five- and six-speed transmissions are figured the same way.

If you divide a drive gear into a driven gear where the drive gear has a greater number of teeth than the driven gear you will get an answer that is less than 1. When this happens, the gear is said to be overdriven. A typical 5th gear in today's transmissions will have a ratio of .75 to one. This gives us ¾ of a turn at the crankshaft for each turn of the output shaft, which keeps the engine rpm low at highway speeds and dramatically improves fuel economy.

Front-wheel-drive transmissions are no more difficult. There is just one more ratio to be figured. The transfer-gear and ring-gear ratios must be added to your calculations as the differential is inside the transaxle.

When you call your gear supplier to order parts the salesperson usually will ask you for tooth counts. Now it is easy to see why those questions are asked. In order to get the right parts it is absolutely necessary to know the tooth counts and therefore the gear ratio, as the same model transmission may be produced with different ratios to accommodate different engine and rear-end ratios in various car models. Next time you take apart a stick trans, grab your pocket calculator and figure out the ratios. Do it a few times and it will be as easy as making change with money. TD

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