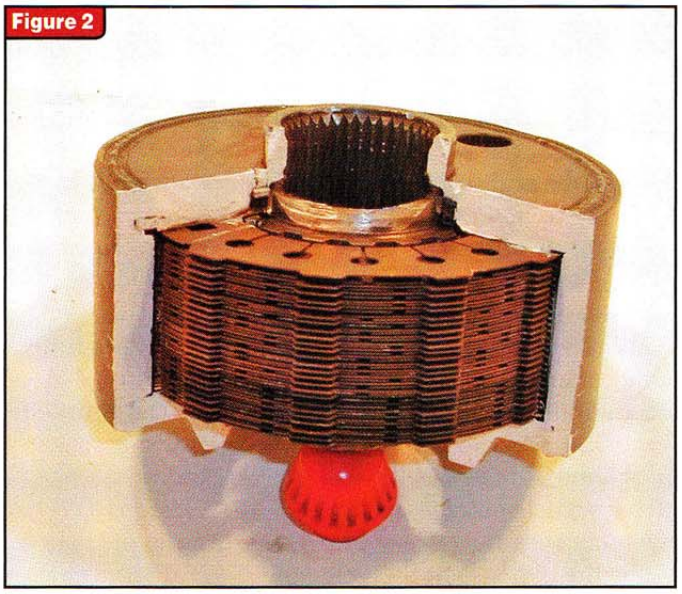
Figure 1

Figure 2



that has some interesting qualities. The viscosity of this fluid increases almost instantly with heat, causing it to expand and fill the entire case. The discs now are forced to run through this fluid and become coupled by the force necessary to "shear" through this sticky fluid. This transfers power to the front axle, splitting torque between the rear and the front and making both axles transmit power to the wheels. When the slippage at the rear axle is eliminated by equalization of shaft speeds, the fluid cools and recedes, allowing power to flow to only the rear axle until the next slippage occurs.

The viscous-coupling design for transfer cases was an advance, but the coupling was a reactive device that had to wait for a slip to occur before becoming active. Viscous couplings are not new and are found in many components. Mechanical fan clutches on automotive cooling systems have viscous couplings, as do some torque converters and differentials, and some vehicles have a center viscous coupling in the driveline.

There is nothing you can do as a shop to repair a viscous coupling. When they are bad they must be replaced. How do they go bad when no driver control is present? The main cause is tires. If a vehicle's tires are not all within $\frac{1}{4}$ inch in circumference, the viscous coupling interprets the difference in the rolling ratio as a slip and begins to send power to the front axle. After a short time of working constantly, the viscous coupling overheats and fails. If you replace a viscous coupling without measuring tire circumference, it may fail within several weeks. The end result is that you pay for a new coupling that also will fail if the tire-size issue is not cured.

Looking at the size on the tire sidewalls is not enough, as that size means nothing when the tire is inflated. You must measure each tire with a stagger gauge or a tape measure or else pay the price. You will be surprised at how many problems you will no longer have to deal with once you make a habit of measuring all four tires on every vehicle you work on. Remember that mismatched tire sizes also will kill differentials in front-wheel-drive automatic transmissions.

We get many questions as to whether changing the transfer-case fluid will help a viscous coupling perform better. The answer is no, because the viscous coupling is a sealed unit and the fluid in the transfer case serves only as a lubricant. Units that use a viscous coupling are the NV 119, 129, 149, 229 and 249 and the BorgWarner 4404, 4410, 4472 and 4473.

The next advance in transfer-case technology came with "automatic" or "active" transfer cases. These are clutch-driven transfer cases in which a clutch pack in the transfer case is engaged to send torque to the front axle. With the exception of the New Venture 247 transfer case, these are all computer-controlled units that have the ability to "sense" or detect a slip before it happens. Understanding how this works should make it crystal clear how sensitive these units are to mismatched tire sizes.

Ford says in its repair manuals that a difference of 0.006 inch in tire size can set a code. On the GM side, a 15-rpm difference in prop-shaft speeds can set a code. A 15-rpm difference in prop-shaft speeds correlates to a difference of $\frac{1}{16}$ inch in tread wear. Measure the tires before you do anything else on these transfer cases. A safe bet is usually to have all four tires within $\frac{1}{4}$ inch.

Now, back to the NV 247, which is used in Jeeps. Instead of a viscous coupling this unit, shown in Figure 3, has a "progressive pump coupling" that is a sealed, non-rebuildable component. In the 247 there are two pumps. The first is a gerotor type of pump that is driven

off the output shaft and provides pressurized lube oil throughout the transfer case and provides oil to the pump coupler. The pump coupler contains a second pump, with sophisticated valving, to apply a clutch pack that is also inside the coupling. This unit works just like a viscous coupling in that a difference in shaft speeds causes the pump to pressurize the clutches, sending power to the front axle until shaft speeds equalize and the pump loses pressure. These units are extremely sensitive to fluid quality. They also are reactive units, in that nothing happens until there is a slip.

The other automatic or active transfer cases that feature complete computer controls are the NV 126, 136, 226, 236, 245 and 246, and the BorgWarner 4405, 4406 and 4411. All these units are capable of electronically anticipating a slip and sending power through the clutch pack to the front axle. This is done through a comparison of vehicle road speed with prop-shaft speeds, and the computer changes the duty cycle on the clutch apply to eliminate any differences in speed.

Tied into these systems is throttle position, so that in the automatic position under hard acceleration the unit goes from 2WD to 4WD within milliseconds. The computer will monitor the ABS, traction control, transmission manual-lever position, brake switches and stability control. This means that you need to scan all applicable systems to diagnose a problem. You must check for codes in the powertrain, drivetrain, ABS, body and chassis systems.

Ford has further complications with its multiplex wiring systems. Because of the combination of signal paths running through the same circuits, problems such as a bad rear-glass heater grid, a shorted door-ajar signal or a shorted windshield wiper can cause a transfer case to malfunction.

If you examine the manuals involved in repairing active transfer cases you immediately realize how things have changed. There are 40-50 pages on the actual unit repair and 200 pages of diagnostic codes, circuits and troubleshooting trees. The stability-control systems on late-model vehicles are capable of comparing steering angle, yaw rate, road speed and throttle opening with specifications in the computer database. Using these inputs, it can anticipate a driver entering a turn at too high a speed and activate the transfer case to prevent the vehicle from understeering or oversteering. Certain automatic transmissions have the same capability to prevent unnecessary upshifts when the vehicle is cornering.

It is a brave new world out there. You can look at it as a negative complicating your life, or you can view it as a plus making the knowledgeable technician a valuable commodity. The more you know and understand, the lower your stress level will be and the more satisfaction you will have with your work. TD

Figure 3