We will start our overview of the CVT with identification. It is easy to identify when a vehicle is equipped with a CVT. The shape of the case is unique and you are not likely to mistake it for anything else. The standard Chrysler identification label is also located on top of the transaxle with the serial number and other information (Fig. 3).

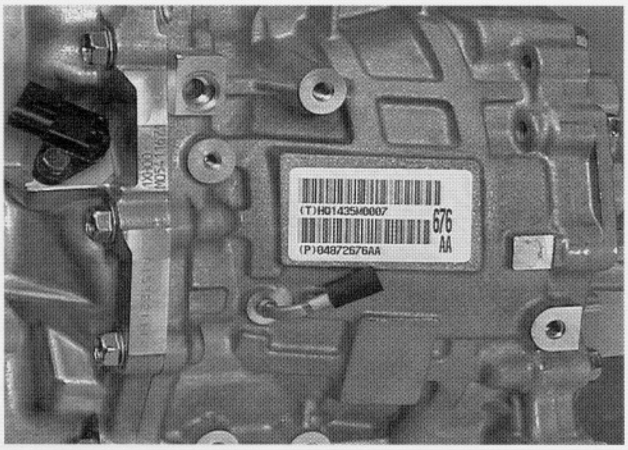

Figure 3: The standard Chrysler identification label is located on top of the transaxle.

The first Chrysler Group vehicle to use the CVT will be the 2007 Dodge Caliber. At the Caliber launch, the CVT will be offered behind 2.0-litre and 2.4-litre engines.

The main advantages of the Continuously Variable Transaxle are efficiency and smooth operation. First of all, the CVT's wide range of ratios contributes to fuel economy. CVT ratios range from about 2.3 to 1 in low, to an overdrive ratio of about a 0.4 to 1 in high.

The CVT is designed so that acceleration demands are met using continuously variable ratios, along with an engine speed that ramps up quickly, instead of discrete gears and a series of increases and decreases in engine speed (Fig. 4). Meeting acceleration demands in this way has several advantages.

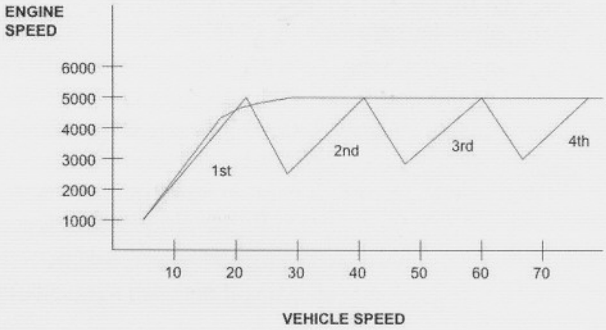

Figure 4: CVT engine and vehicle speed versus a conventional electronically controlled transaxle.

Because the engine operates in an efficient rpm range longer, better fuel economy results. Because of continuously variable ratios, there is a smoother transition from low ratio to high. Both the efficient use of engine rpm and continuous ratios contribute to smoother operation when a vehicle is climbing hills or towing a trailer. An additional advantage is excellent performance.

Because of the way a CVT operates, the torque converter clutch can engage earlier during acceleration and disengage later during braking. This also contributes to fuel economy because early engagement minimizes slippage in the torque converter and later disengagement allows the PCM to prolong decel fuel shutoff.

As you might expect, CVT operation is going to feel a little different to drivers, and customers may have questions based on these differences.

Because the transmission ratio and engine speed change smoothly to respond to power demands, under most circumstances drivers will not notice distinct shifts. For this reason, service advisors, or anyone else who deals directly with customers, should be prepared to explain the typical driving experience.

One exception to the stepless transition occurs if a driver presses the pedal to the wide-open-throttle position. Toward the end of accelerator pedal travel, the linkage engages a spring-loaded plunger to alert the driver of imminent wide-open throttle and a kickdown-type change in transaxle ratio and engine speed (Fig. 5).

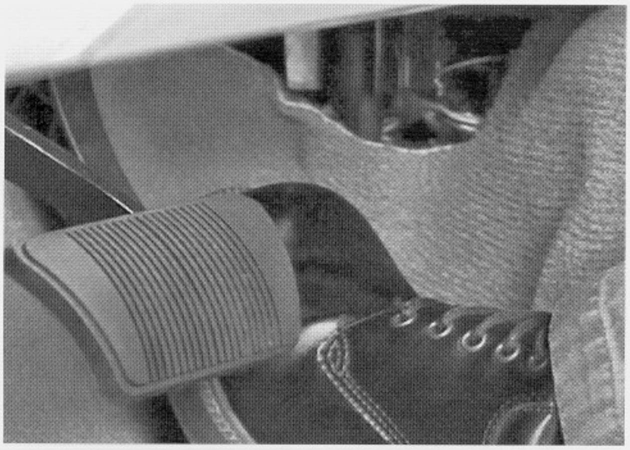

Figure 5: A spring-loaded plunger in the accelerator linkage alerts the driver of imminent wide-open throttle and a kickdown-type change.

Another exception is Auto/Stick™ mode, which provides six distinct ratios. We will discuss Auto/Stick in greater detail later.

2 MASTERTECH

CTV COMPONENTS AND OPERATION

In some cases, CVT components are like those used on other transaxles, and in other cases, they are very different. For instance, the torque converter and converter clutch are similar to those in other automatic transaxles. On the other hand, the pump is off centre and driven by a chain instead of being driven directly by the torque converter hub (Fig. 6). It also maintains higher system pressure than conventional pumps – regulated line pressure can be up to 750 psi.

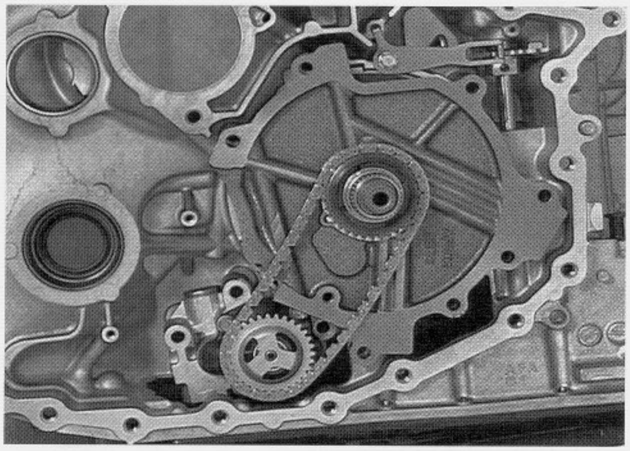

Figure 6: The CVT pump is off centre and driven by a chain.

One critical difference between the CVT and conventional automatics is the fluid. CVT automatic transmission fluid is unlike any other ATF, and its green colour is used to help identify it. CVTF+4 has unique friction characteristics and the use of any other fluid will damage the transaxle (Fig. 7).

Figure 7: CVTF+4 has unique friction characteristics, and the use of any other fluid will damage the transaxle.

Although the green colour is useful in identification, remember that, as with all automatic transmission fluids, CVTF+4 will darken with age.

Two filters are used to help keep the fluid free of contaminants. A screen filter is used in the oil pan on the pump pickup, and there is a non-serviceable paper filter behind the onboard cooler.

As its name suggests, the onboard cooler is located on the transaxle. Engine coolant that circulates around fluid passages helps warm the fluid in cold weather (Fig. 8). A pressure-operated bypass valve prevents fluid from reaching the air-to-oil cooler when the fluid is thicker due to cold ambient temperatures. The air-to-oil cooler is part of the vehicle cooling module.

Figure 8: Engine coolant circulates around fluid passages in the onboard cooler to help warm the fluid in cold temperatures.

The Continuously Variable Transaxle uses clutches to transfer power from the torque converter to the pulleys and belt. Forward and reverse clutches are coupled to a planetary gearset with the planetary annulus acting as the input from the torque converter (Fig. 9).

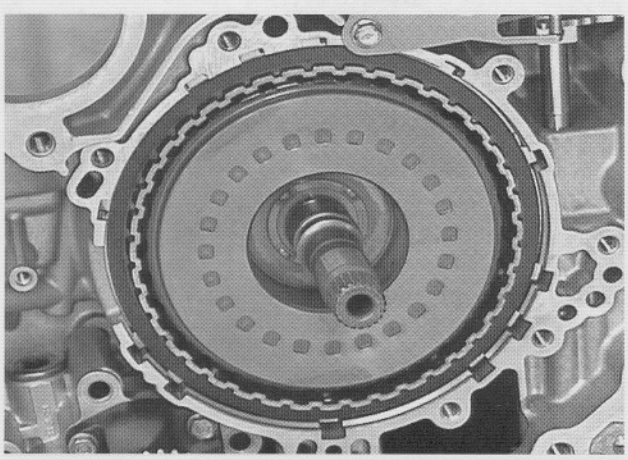

Figure 9: Forward and reverse clutches are coupled to a planetary gearset.

The reverse clutch holds the planetary carrier, which reverses the direction of the sun gear and of the primary pulley. In reverse, the ratio of the planetary gearset is 0.745 to 1.

The forward clutch locks the planetary gearset together for a 1-to-1 input ratio. The transaxle is in Neutral when neither clutch is engaged.

At the heart of the CVT is the pulley and belt system, referred to as the variator (Fig. 10). The primary, or input, pulley has a fixed side and a moving side, which is positioned by hydraulic pressure.

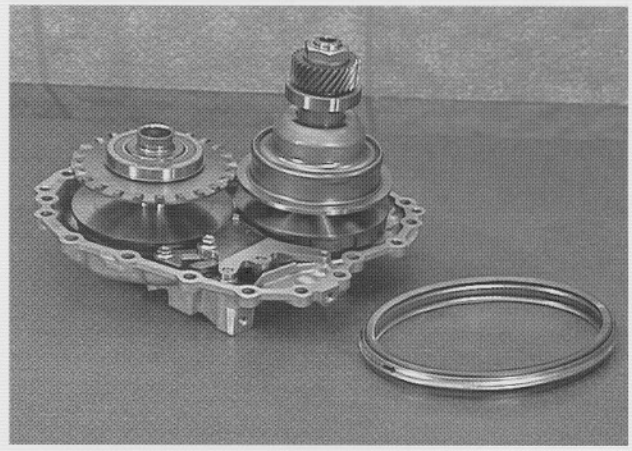

Figure 10: CVT variator – primary and secondary pulleys and belt.

The belt consists of approximately 400 segments held together by two sets of 12 steel bands. The bands fit into grooves in the segments. The segment sides have serrations which, like the tread on a tire, allow them to grip the pulleys.

Like the primary pulley, the secondary pulley has fixed and moving sides; however, the locations are switched.

When the vehicle accelerates from a stop, the primary pulley sides are farther apart, which in effect means that the belt is being driven by a smaller-diameter pulley. The secondary pulley sides are closer together so that the belt is driving a larger-diameter pulley. This provides a low ratio (Fig. 11). As vehicle speed increases, the primary pulley sides move closer together, while the secondary pulley sides move farther apart. This change in effective pulley diameter allows the variator to progress through 1-to-1 and then overdrive ratios (Fig. 12).

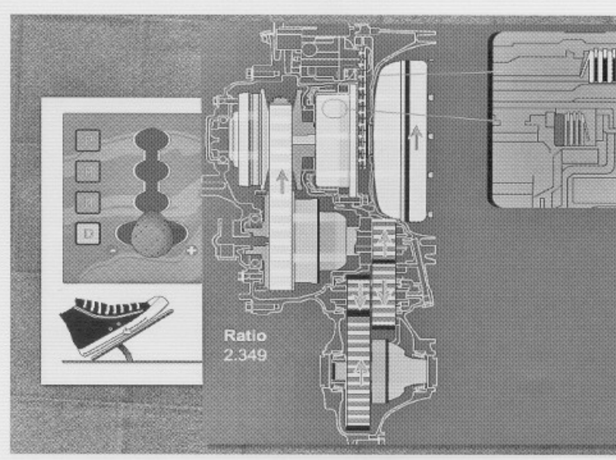

Figure 11: Pulley and belt position as a vehicle accelerates from a stop.

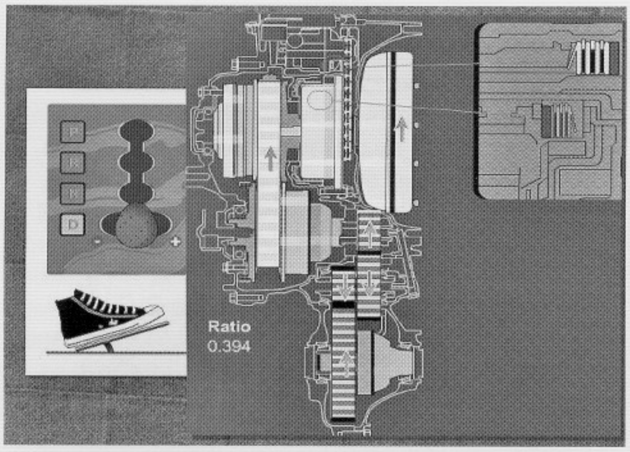

Figure 12: Pulley and belt position in overdrive.

Once past the secondary pulley, power flow is similar to that of a conventional automatic. The shaft that supports the secondary pulley has a final drive output gear and supports the Park gear.

The final drive in the CVT is similar to that found in a conventional automatic. Note that due to an extremely low overdrive ratio, the CVT final drive uses a high numerical ratio – around 6 to 1.

The shift lever and manual valve, along with the Global Powertrain Engine Controller One (GPEC1) and the CVT Control Module, play a part in controlling the flow of power through the CVT. Primary control of the input clutches is through the shift lever and manual valve. However, under certain conditions, the controllers can prevent clutch engagement, such as when a shift into reverse on a vehicle travelling forward would damage the transaxle.

As mentioned earlier, hydraulic pressure positions the moving sides of the pulleys. This clamps the belt against the fixed sides and establishes the working diameters. Hydraulic positioning of the primary pulley determines the ratio, and the higher pressure used on the primary side to position the belt forces a change in the position of the secondary pulley (Fig. 13). The hydraulic clamping of the secondary pulley is proportional to engine torque.

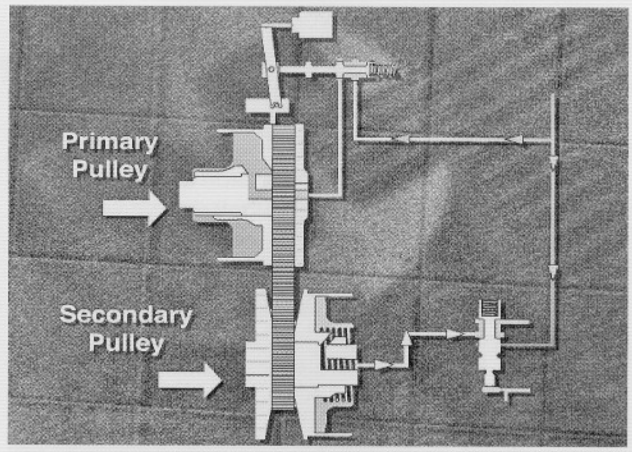

Figure 13: Hydraulic positioning of the primary pulley determines the ratio, and the higher pressure used on the primary side to position the belt forces a change in the position of the secondary pulley.

The CVT Control Module and the GPEC1 work together to control pulley position. The CVT Control Module, located under the instrument panel on the driver's side, provides direct control, regulating and routing fluid pressure by means of four solenoids, two pressure sensors, and a stepper motor located in the valve body (Fig. 14). The fluid control is in response to messages that the CVT Control Module receives over the CAN C bus from the GPEC1.

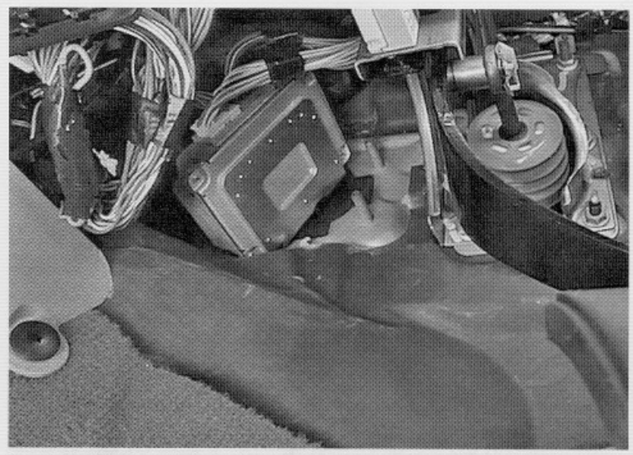

Figure 14: The CVT Control Module, located under the instrument panel on the driver's side, provides direct control of the pulleys.

The GPEC1 bases the progression of the ratios from low to high on models of vehicle operating conditions called variograms. These variograms map out the required change in ratio and engine speed according to torque demand (Fig. 15). With a large torque demand, the ratio progression allows engine speed to climb quickly. With a small demand, ratios result in engine speed climbing more slowly. The variograms map out a number of torque demand scenarios with ratio progressions to match.

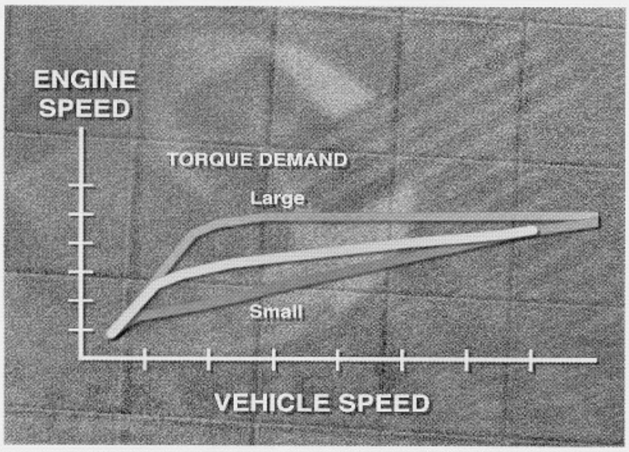

Figure 15: Variograms map out the required change in ratio and engine speed according to torque demand.

Besides torque demand, the ratio progression in the CVT is also affected by the mode of operation selected by the driver. The Drive position is used for most driving, and the ramp-up in ratio and engine speed is designed to provide fuel economy.

On Calibers without Auto/Stick™ there is also a Low Sport position indicated by "Ls." Low Sport uses a more aggressive ratio selection to provide quicker acceleration and more engine braking. Keep in mind that one big difference between CVT Low Sport and Low on conventional automatics is that CVT Low Sport does not limit the transaxle to lower ratios. The complete range of ratios is still available.

On some Calibers the CVT is available with Auto/Stick. In that case, there are plus and minus selections on the sides of the Drive position that correspond to upshifts and downshifts. Once a driver initiates Auto/Stick by pushing the shift lever to the side, it offers manual selection of six distinct ratios. Except in special cases, when the transaxle is in Auto/Stick, the ratio changes only when a driver upshifts or downshifts.

To inform the driver of which ratio the CVT Auto/Stick mode is in, the CVT Control Module sends a message over the CAN C bus to the Totally Integrated Power Module, or TIPM, which is the Gateway Module on Caliber. The TIPM in turn sends the information over the CAN B bus to the Cabin Compartment Node, or CCN (Fig. 16). The cluster, which is part of the CCN, displays the selection.

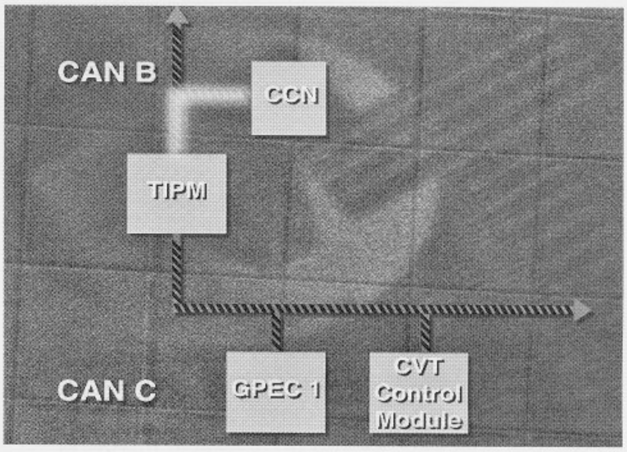

Figure 16: The TIPM sends shift selection information over the CAN B bus to the CCN.