So Polaris introduced a new sport UTV in 2008, a vehicle concept that for all intents and purposes had never been mass produced. It was directed at the type of consumer who wanted to reach the backcountry on the trail, ride the sand dunes or drive down the dirt road to the nearest fishing hole. This new UTV was basically a do all type of rig.

Polaris called it the RZR and the concept took off like a storm … not only because the RZR is so versatile, but because the RZR owner could enjoy it while sitting next to his or her companion. This means the passenger doesn’t have to be a skilled motorcycle rider or experienced on an ATV. The passenger can just relax, enjoy the scenery or even have a conversation with the driver. With a small amount of cargo space to carry a cooler, some supplies and the ability to license them on most county roads, the RZR became so popular that it is a common vehicle for many people.

Just like most toys we have in the modern age, the RZR can be modified to better suit our riding style or conditions. Of course, it’s always nice when the modification helps the machine perform better and for many of us, this is a priority. The CVT (continuously variable transmission) drive system on the RZR is one area where you can see big performance gains with a few mods. By changing and maintaining the components inside the clutches, improved performance and drivability are pretty easy things to achieve. In fact, once you have experienced the difference from just a few changes, you will wish you had made them long ago. Why didn’t the manufacturers just build their UTVs with the better setup to begin with? The answer is they could, but they need the vehicle to work in many conditions from mud to sand to sea level to 12,000 feet in altitude. The manufacturer has to use a general setup in order to make the vehicle work wherever it is sold. Polaris does recommend that the customer change some of the parts to make the vehicle work at its “optimum” for the customer’s preferred conditions. The company usually gives the customer a specification sheet of what parts to use, but it really only takes into consideration riding elevation.

What makes up a CVT clutch?

If you’re new to the CVT transmission you might be thinking, “Well this is all fine and dandy but I don’t have a clue how this thing works, what parts to change or how to change them.”

The purpose of this article is to answer those questions and help take you to the next level. If you have been around CVT clutches before, this could be a good refresher.

CVT Clutching 101

A CVT consists of two variable clutches connected together with a high strength belt. Each clutch has two tapered sides or sheaves that keep the belt centered. One sheave is fixed to the shaft and does not move while the other one moves in and out, forcing the belt to a higher or lower position in the clutch. This allows the CVT to have a low gear ratio and a high gear ratio with an infinite number of ratios in between, which gives it the ability to keep the engine rpm in its optimum power output range for all operating conditions. But what makes the clutches move or “shift?” The answer is the centrifugal force.

PRIMARY CLUTCH

The primary clutch is mounted to the PTO shaft or output shaft of the motor. It responds to two different forces: centrifugal force from the engine spinning the clutch as well as resistance that the belt transfers from the secondary clutch (more on that later). Here is how it works. (see figure A) Inside the engine clutch (the clutch mounted to the engine is sometimes called the drive clutch) are some weights (15) that pivot on a pin (16) mounted to the movable sheave. The weight is shaped like a half rounded ramp and pushes against a roller mounted to the center section of the clutch called the spider.

The spider cannot move as it is threaded onto the center shaft that connects the two sheaves together. So when the clutch starts spinning, the weights try to swing away from the center of the clutch towards the outer side of the clutch, but they hit the rollers (13) which are mounted to the spider. So in order for the weight to move, something has to give. The force from the weights pushing against the roller forces the movable sheave to move toward the fixed sheave, pushing the belt higher in
The secondary clutch, or as some call it, the driven clutch, is mounted to the splined input shaft of the transmission and is connected to the primary clutch with a belt that wraps around both clutches. It responds to two different forces: the force that the belt puts on it from the primary clutch and the force that the shaft puts on it from the transmission.

The secondary clutch is a much larger diameter than the primary clutch and the belt wraps around the outside of the two sheaves, again one being fixed and one being movable. When the primary clutch begins to shift it forces the belt higher in the primary clutch. This causes the belt to get tighter and tries to pull the belt down in the secondary, forcing the two sheaves apart or as some would say, forcing the clutch to shift. Because the belt has such a large diameter to pull around, it starts in a really low gear with a lot of leverage to turn the clutch, which in turn rotates the shaft and makes the machine move.

The clutch also has a spring and a clutch cap. The cap is bolted to the movable sheave and has a hole in the middle in order to allow it to slide down the shaft with the movable sheave. Installed in the middle of the clutch between the spider and the cap is a spring that resists the movement of the movable sheave. As the movable sheave starts to shift, the cap compresses the spring resisting the shift. This is necessary in order to prevent the centrifugal force from causing the clutch to start shifting at an idle as well as to control the rate at which the weights shift out.

In other words, if it weren’t for the spring, when the engine started, the centrifugal force would just slam the clutch all the way open. The spring also helps the moveable sheave return to the lower ratio as throttle is reduced.
The fixed sheave is connected to the shaft that the movable sheave slides on. The roller assembly (8, 9, 13, 14) slides onto the splined shaft and is held in place with a snap ring (12). A spring (15) is installed between the movable sheave and the roller assembly. Without it, down pressure from the belt would try to open the clutch too fast. The helix (10), or cam as some call it, is bolted to the movable sheave and rides against the rollers mounted to the roller assembly. As the movable sheave begins to shift, the pressure generated from the helix riding on the roller provides resistance against the shift. Because the part of the helix that rides against the roller is cut at an angle, the angle can be changed to allow more or less resistance to the shift.

Polaris changed to a different style clutch for 2010 and 2011. (see figure C) It still basically functions the same as the 2008-2009 style but uses fewer parts. The helix and movable sheave are cast as one unit meaning the helix is not removable. They also moved the roller assembly to the inside of the stationary sheave and the spring and snap ring to the outside of the movable sheave. The downside to this is that you can’t tune the clutch by switching to a different angle helix because the helix is not removable. For this, you will need to purchase an aftermarket clutch that uses a removable helix like the one SLP uses and sells.

PARTS

Now that you understand the names and locations of the individual parts, it is critical to know which ones are important to maximizing the performance of your clutches. There are four main tuning parts that allow the user to calibrate to his or her performance criteria: the primary spring, the primary weights, the secondary spring and the secondary helix. For each basic part there are many different versions or options of that basic part to choose from.

At first all these parts can be confusing and overwhelming mainly because the user just doesn’t understand the small differences between them and how that difference will affect the calibration of the clutches and performance of the machine. Let’s clarify these differences.

Here is an example of what the primary weight looks like mounted to the pin. The clutch cap has been removed so we can show the weight as it pushes against the roller pin on the spider.

**PRIMARY WEIGHTS**

The weights in a CVT clutch system are the main factor in controlling peak rpm. They also have a significant effect on how fast the clutches shift out. A simple rule to remember is heavier weights equal less rpm and lighter weights equal more rpm.

Let’s say your stock RZR makes its peak power at 6500 rpm. To get the best performance out of it, you want to tune the clutches to hold the peak rpm at 6500 rpm during full throttle operation. But you’re taking a trip to the mountains where the RZR will make less power because of the higher elevation. This means that it won’t want to run at 6500 rpm but instead will only spin 6000 rpm. By installing lighter weights in the primary clutch, the engine won’t have to work as hard to rotate the clutch, making it easier to spin up to 6500 rpm.

Weights also affect how fast the clutch can shift. Using heavier weights will make the clutch try to shift open faster. This is good because the faster the clutches shift open, the faster the RZR will accelerate. Get the weights too heavy and the clutch will shift open too fast and pull the rpm down away from where it makes its most power, resulting in slower acceleration and lower top speed.

**PRIMAR Y SP RING**

Springs are color coded in order to tell them apart and to identify their rate. (see chart A) For example, SLP sells a spring that is solid red, but has a gold and black stripe up the side and is rated at a 55/225. The color in most cases is given a rate which is essentially a measurement in pounds per square inch (PSI). In the case of the red/gold/black, the red doesn’t have a psi rating but the gold and black do, the gold representing the 55 and the black representing the 225. Each psi rating is an actual measurement of how many pounds you would see on a scale if you were to compress the spring down to a specific height. The first number, called the preload number or, as some call it, the initial rate, is measured on the scale with the spring compressed down until it measures 2.25 inches. At this point the scale should read around 55 lbs. The second number or final rate would be measured at 1.25 inches tall with the scale showing 225 lbs. of pressure.

Now keep in mind that not all manufacturers use the same measuring points so if you want to compare springs from two different spring manufacturers you will need to find out how they measure their spring rates. Most spring manufacturers print the measuring point on the spring chart. An example of this can be seen under the clutching section of the SLP website (www.startinglineproducts.com).

A simple rule of thumb is the higher
The clutch holding tool is used both to hold the clutch while removing the retaining bolt as well as while using the clutch puller to remove the clutch from the shaft. You can also use the holding tool to hold the clutch when you reinstall and torque the clutch retaining bolt. See the RZR manual for torque specifications.

The spring rate, the higher the rpm will be. Each number on the spring rate affects a different part of the shift curve. See Chart A. The first number mainly affects engagement which is low rpm when the unit begins to move from a dead stop. The stiffer the spring’s initial rate, the higher rpm the unit will rev before the clutch grabs the belt and the machine begins to move. The second number has more to do with the upper mid-range and peak rpm. The stiffer the final rate, the faster the machine will get to high rpm and the better it will maintain peak rpm through varying conditions.

SECONDARY SPRING
The secondary spring is identified just like the primary spring. It is color coded and measured in psi but performs a little bit different function when compared to the primary spring. Because the secondary does not have weights, something has to put side pressure on the clutch sheaves so they will grip the belt as well as prevent the clutch from opening too fast. The clutch holding tool is used both to hold the clutch while removing the retaining bolt as well as while using the clutch puller to remove the clutch from the shaft. You can also use the holding tool to hold the clutch when you reinstall and torque the clutch retaining bolt. See the RZR manual for torque specifications.
stiffer the spring, the slower the clutch can open and the more pressure will be applied from the sheave to the belt. If the secondary spring is too soft, or the helix angle is too steep for how much spring rate you have, it may result in belt slippage, causing an increase in heat and wear on the belt and clutches. Excessive heat is bad and needs to be addressed.

HEX

The helix helps apply pressure to the belt by providing resistance to the shift. It uses fingers that ride on the roller and are cut to a specific angle. The angle is measured in degrees and most are cut with multiple angles strategically spaced out to create different loads at different parts of the shift curve.

For example, a typical helix would have numbers like 70-53.33 with the first two numbers representing the two angles that have been cut into the helix and last number representing the duration or physical cut length of the first angle in inches. The helix starts its shift curve cut to a 70-degree angle and as the RZR begins to speed up the helix cut will stay at 70 degrees for .33 inches or 1/3 of an inch. At this point the angle will change to the 53-degree and the cut will stay at that angle for the final duration of the cut. There are also some helixes that only have one angle so the cut is the same from start to finish.

The load and pressure on the belt can be adjusted by using helixes with more aggressive or less aggressive angles. The steeper the angle, the faster and more aggressive the clutch will try to shift as long as the motor has the power to support it. If you get overly aggressive with angle and don’t use a stiff enough spring, the spring will not be able to hold enough pressure on the belt and the belt will try to slip.

TOOLS

Most of the tools used to work on the clutches are basic hand tools most people would have in the garage like wrenches, sockets, ratchets, pliers and screwdrivers, but there are a few specialty tools needed in order to remove the clutches, change out parts or perform maintenance.

A clutch puller is used to remove the primary clutch from the engine. It looks like an oversized bolt and threads into the clutch until it bottoms out on the crankshaft, at which time it will force the clutch backwards and pop it off the crankshaft. This takes some elbow grease and it will make a loud “pop” when it comes loose from the shaft. It is possible to change both the primary weights and spring while the clutch is still attached to the motor so the clutch puller is only needed if you want to remove the clutch for cleaning or other services.

The clutch press tool is a tool used to remove the secondary spring from the clutch and consists of a small frame that the secondary clutch will fit into with a handle that sits over the center of the clutch. The handle can be pushed down to put pressure on the roller assembly or spring in order to remove the snap ring that holds them in place. Because of the high spring pressure on the secondary clutch, the leverage from the handle is necessary to keep the spring from popping out and hitting the user in the face.

MAINTENANCE PREVENTS POOR PERFORMANCE

Cleaning and inspecting the clutches is the key to maintaining the CVT system. Periodically remove both clutches from the unit so that they can be disassembled and cleaned. Do not use solvents or oil-based products on the clutches, as these chemicals will absorb into the pores of the aluminum sheaves and then come back out later causing the belt to slip.

Use hot soapy water and a soft brush to clean all surfaces and parts of each clutch. Once clean, rinse well and inspect each part for wear, rub marks or cracks. If cracks are found, the part is not usable and should be replaced. A cracked clutch will eventually fly apart no matter how small the crack is.

Replace the parts that are worn or damaged and re-assemble the clutches. Any worn parts that are not replaced will cause the clutch to shift poorly, resulting in decreased performance, acceleration and speed. Worn parts can make the clutch shift abruptly, making the unit harder to drive. Make 100 percent sure that both clutches and the belt are clean before re-installing them back on the unit. That means
even new belts should be washed in hot soapy water to remove any mold release or residue that could cause the belt to slip. If the belt slips, it will cost you performance.

**THE BENEFITS**

So in the end why is all this important? Well, it depends what you want out of your RZR. For the person who wants reliability, understanding each of the parts and how to take care of them will help you properly maintain the machine and prevent big problems that could leave you stranded or in a bad situation. Having a clear understanding of the CVT system can help you save a few bucks doing your own maintenance or can help you understand the services your dealer can provide to eliminate costly repairs that could have been prevented with proper maintenance.

If you’re like me, you like to make your toys perform at their best and educating yourself on with information about the CVT system is well worth the time and investment. Companies such as SLP take the time and have the resources to put these machines to the test, find what works best and assemble the parts into kits that are easy to understand and install. By changing a couple of clutch parts, you can really bring out the performance of the RZR. Faster acceleration, better top speed, cooler clutch temperatures and better drivability are big performance gains that are easily achievable. 

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