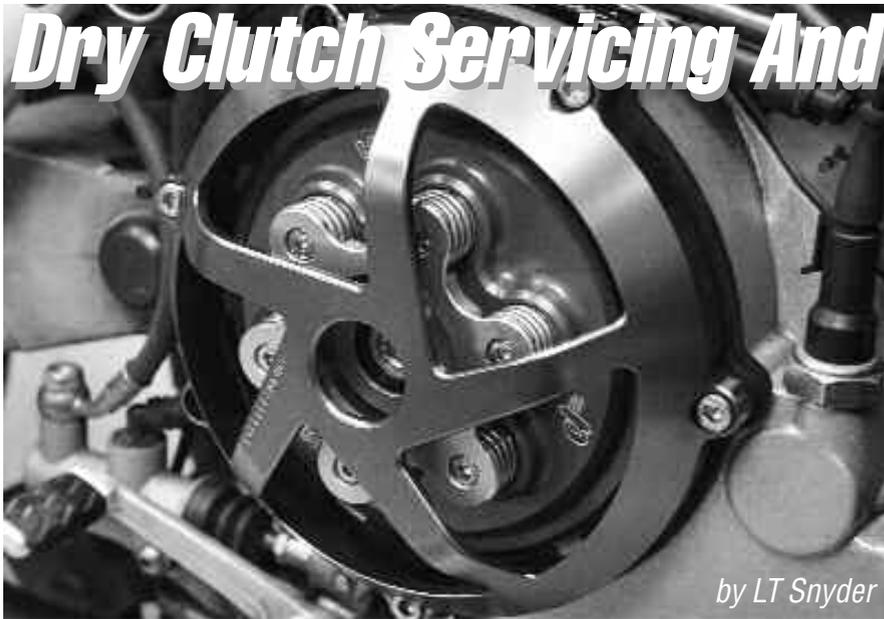


# Dry Clutch Servicing And Modification



by LT Snyder

the engine). Also, because a wet clutch setup is inside the engine cover, its removal once an engine is warm is problematic. If you haven't played hot potato with the wet clutch from a race bike, you aren't missing anything. Finally, because a wet clutch uses engine oil for lubrication, the oil is contaminated with debris from the clutch pack (namely, worn material from the driven and friction plates—see photo 1).

The most identifiable characteristic of a dry clutch is the sound it makes. Most dry clutches rattle a distinctive tune. While this rattle is commonplace, it isn't absolutely necessary. In fact, a rattling dry clutch is a sign of an improper setup. The rattle from a dry clutch comes from two things: the drive/friction plate fingers banging into the clutch basket tangs and the plates banging into each other. Both types of banging are a result of less than optimal clearances.

I HAVE LONG BEEN a fan of the dry clutch. There are several reasons: the ease with which a dry clutch can be worked on, the peek-a-boo looks of an exposed dry clutch and its functionality. Unfortunately, dry clutches have a bad reputation. Complaints include the tell-tale rattle, the fact that they tend to be grabby, require more frequent maintenance and yield a stiffer clutch pull. In an effort to minimize these criticisms, this article will explain how a dry clutch works, how to service it, and modifications that will enhance its operation. While Ducati, BMW and Moto Guzzi all use a dry clutch setup, BMW and Moto Guzzi typically use a single-plate diaphragm spring unit, much like a car's. Ducati's is a multiplate setup, similar to most conventional wet motorcycle clutches and also has the most aftermarket support. Hence, I will use their clutches in my examples.

## Shake, Rattle and Roll

Dry clutches have long been used as original equipment by some manufacturers on purpose-built race bikes. The primary reason for the use of a dry clutch on a high-performance bike is ease of maintenance. A dry clutch can be quickly serviced by either first removing an access cover (in the case of closed cover clutches), or by directly removing the outer pressure plate. On wet clutch bikes, the engine oil must be drained and the right side engine cover must be removed and its gasket replaced (on some bikes they can simply be leaned further to the left to pool the oil away from the right side of

When the gap between the drive/friction plate fingers and the clutch basket tangs is minimized, most of the rattle goes away. When this gap optimization is combined with a mechanism to reduce the degree to which the plates bang into each other, the result is a quiet clutch.

Unfortunately, most dry clutch owners don't know how a properly set-up dry clutch should sound, and, as a result, do little to maintain their clutches. When a dry clutch begins to make more noise than the exhaust, it is signaling that it should be serviced. Dry clutch manufacturers tend to issue specifications for the minimum allowable thickness of the drive/friction plates (minimum thickness for a stock non-race spec Ducati is 2.8mm) but not specifications for the maximum lash between friction plate fingers and basket tangs (Photo 1). This is unfortunate, because I have found that the fingers on the drive/friction plates wear out long before the plates reach their minimum allowable thickness. In fact, the drive/friction plate thickness specification is lax enough so that clutch packs and baskets require less maintenance than valves. However, the larger the gap between the friction plate fingers and basket tangs, the more the clutch will rattle. And the more the clutch rattles, the more the friction plates will bang into the clutch basket. Eventually, the leading edge of the friction plate fingers get hammered into an "L" shape (see photo 2), while the clutch basket tang walls begin to get notched. Sometimes this occurs long before the material on the friction plate wears past service limits.



Photo 1

Photo 1, left: Most of a dry clutch's rattle comes from the fingers of the friction plates banging into the clutch basket.

Photo 2, Right: The classic "L"-shaped wear pattern of a friction plate's finger.

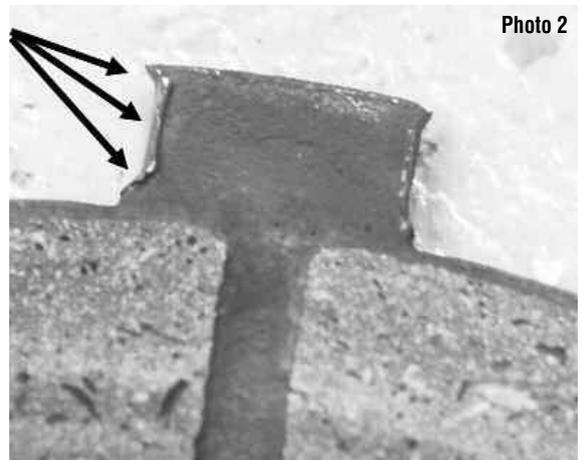
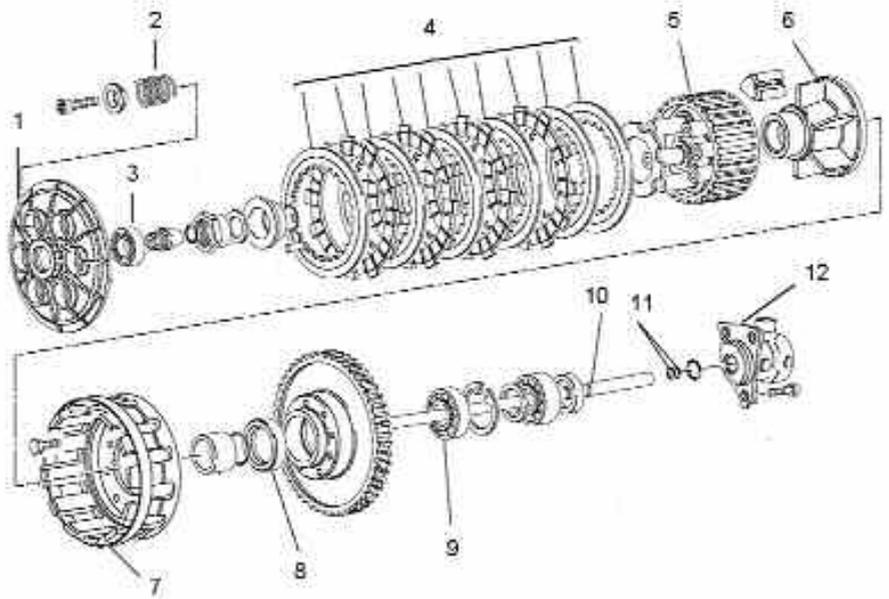


Photo 2

## HOW A DRY CLUTCH FUNCTIONS

When you pull in the clutch lever (hydraulic or mechanical), you apply pressure to the outer pressure plate (1) holding the friction/drive and driven plates together in the clutch pack (4). The disengagement is typically actuated by a rod (10) that goes through the motor and out the end of the transmission shaft. The pushrod applies pressure to the pressure plate (1). The pressure plate applies force against the clutch pack via a set of springs (2). When the pressure plate is pushed out, the engine is being allowed to free-wheel. In order to smooth the engagement of the clutch, a series of plates with friction material on both sides is allowed to slide against steel plates driven by the rotating center portion of the clutch (5 - the clutch drum which is mated to the output shaft). When the clutch is released, the friction/drive plates (the fingers of which are mated to the clutch basket - 7) slide against the driven plates until the clutch spins up. When the clutch is pulled, the friction plates separate from the driven plates, thus breaking the link between the transmission and the rear wheel. To smooth the engagement/disengagement process, the clutch pack also houses a curved driven plate. This curved plate takes the place of one of the standard driven plates and forces separation of the pack.



### LEGEND

1. Pressure plate, 2. Clutch springs, 3. Pressure plate bearing,
4. Clutch pack consisting of steel driven plates and alloy or steel drive (friction) plates, 5. Clutch drum, 6. Cush drive, 7. Clutch basket,
8. Transmission seal, 9. Transmission needle bearing,
10. Clutch pushrod, 11. Pushrod O-rings, 12. Clutch slave cylinder.

How do you keep a dry clutch from rattling? The best way to accomplish this is to accurately match the clutch plates to the basket (see photo 3). Most clutch manufacturers make only a half-hearted effort at this. Instead, aftermarket clutch makers put their efforts into manufacturing lightweight clutch baskets (in an effort to reduce rotating mass) that wear like the original equipment steel baskets. Others, such as Sureflex and STM make friction plates that are oversize for their baskets. Owners must then grind the fingers of the drive/friction plates themselves.

Today's better dry clutch baskets offer hard aluminum alloys, Teflon coating and/or steel or titanium inserts to provide extra durability (see photo 4). Unfortunately, when metals bang into each other, wear still occurs. The original equipment clutch packs for older dry clutches consist of steel friction and driven plates, but most aftermarket clutches have aluminum drive/friction plates and steel driven plates. Therefore, the greatest wear on the clutch plates and the basket is between the fingers and tangs, and which of the two wears most is determined by which alloy is softer.

A common question about dry clutches is how long a clutch will last. Answering that question depends on a lot of factors, including the bike's gearing, the type of riding (stop and go versus highway), how the rider uses the clutch (the amount of slip used and/or abuse like drag launches), how much weight is on the bike (one-up versus two-up) and the type of clutch installed. I've seen dry clutches in need of replacement in as few as 3000 miles. On the other hand, I've also seen them last as long as 50,000 miles.

### Setting Up A Dry Clutch

Another consideration for a clutch is the pack thickness. If the pack is too thick the plates can't achieve sufficient separation when the pressure plate is pushed outward, thus making it difficult to shift

gears and find neutral (see photo 5). If the pack is too narrow, the pressure plate won't apply enough force on the clutch pack and slippage will result. Clutch pack thickness can be changed by using thinner or additional driven plates. Pack thickness must be within a millimeter of specification due to the movement of the pressure plate, as the pressure plate only moves a few millimeters when the clutch lever is squeezed. For Ducati clutches, the sweet spot of clutch pack thickness is  $\pm 0.5$ mm the specified pack thickness. Total pack thickness varies from vendor to vendor and application to application. Race type slipper clutches tend to have thicker packs. The OEM pack spec for non-race variant Ducatis is 38.5mm.

Even with a clutch pack within spec for thickness, the plates will rattle a little against each other. An aftermarket part to minimize this rattle is a "quiet clutch kit." Available from Dr. Desmo, the kit consists of a thicker dished plate, a spacer plate and a friction plate with only one side surfaced with friction material. The quiet clutch in essence reduces the slop of in-and-out movement of the clutch plates, thus reducing the noise. Clutch pack thickness variance is crucial when using a quiet clutch due to the thicker dished plate. Still, I've found them to be effective in both providing good clutch feel and reducing noise (see photos 7 and 8).

### Servicing A Dry Clutch

Clutch life can be extended if the pack is periodically taken apart and cleaned (see photo 9). Prior to disassembly, measure the gap between the plate fingers and the basket tangs. If the leading edge of the plates have started to bend into an "L" shape, replace the entire friction plate set. If the plates are within specification, remove the pressure plate and clean the friction and plates with contact cleaner. (Make sure to wear gloves.) The driven plates should then be lightly sanded with a Scotchbrite pad to remove any additional

Photo 3



Some vendors, such as Pro-Cutting, hand-grind the friction plate fingers to perfectly fit the tangs of their basket. The resulting gap is very small, yielding a quiet long-lasting clutch.

Photo 4



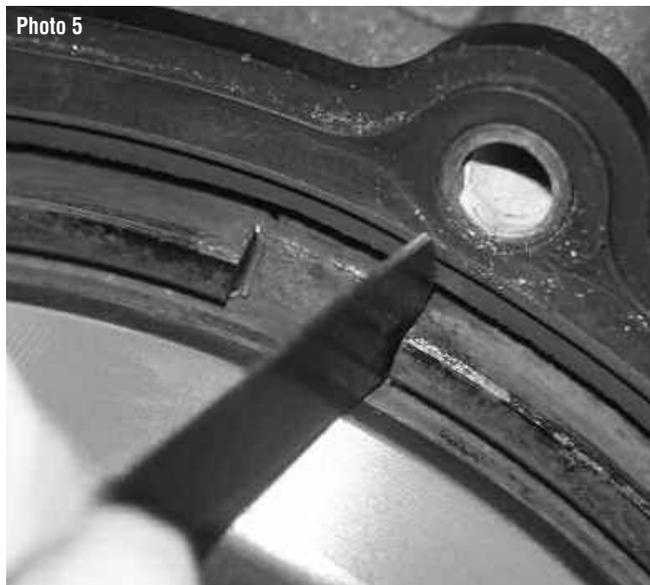
This Barnett clutch basket has steel inserts between the basket tangs to minimize wear. Unfortunately, the gap between the basket tangs and the Barnett clutch pack drive/friction plates isn't optimal, causing premature wear on both the friction plates and the fingers on the basket insert.

Photo 6



Left: Owners should also check for notching of the basket tangs every 6000 miles. Tangs that are notched more than .75mm should be replaced (my specification). Notches in the basket can cause clutch packs to wear prematurely. New friction plates cannot compensate for the gap caused by worn basket tangs. Worn fingers can only be discerned by removing the pressure plate, several of the friction plates and inspecting the basket.

Photo 5



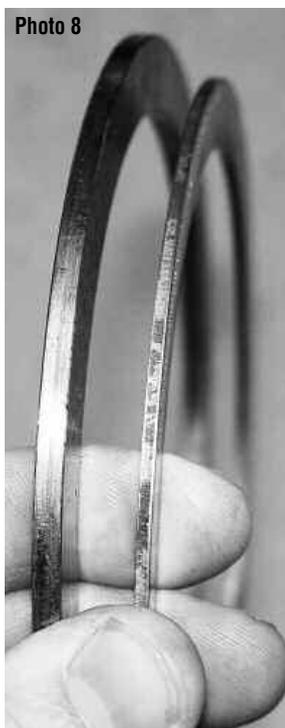
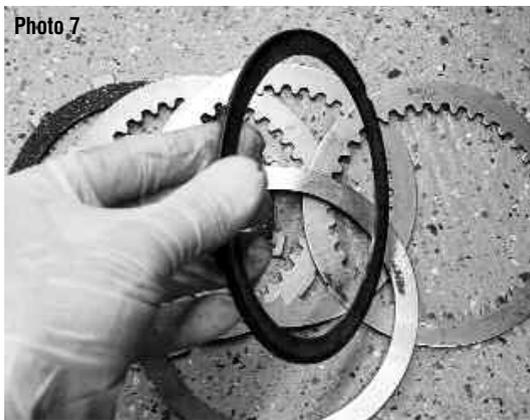
By keeping an eye on the gap between the friction plate fingers and the clutch basket, owners can keep track of the wear on their clutch. The specification I use for determining whether to replace the clutch plates is a gap of no more than 2.5mm. Optimal gap is no more than .5mm (this is my own specification). Some baskets, such as the brand Procutting and STM (available from Motowheels), require that the drive/friction plate fingers be filed to fit the basket. However, a tighter fit isn't always better. If the fit is too tight, the drive/friction plates get stuck in place in the basket, thus locking up the clutch and the transmission. It only takes a few thousandths of an inch for the friction plates to slide freely in the basket. By fitting the clutch plates to the clutch basket, wear is minimized. A side benefit is that the clutch is quiet. In fact, a properly set-up aftermarket dry clutch will be quieter with an open clutch cover than the stock closed cover clutch because the gap between the fingers and the clutch basket are optimized, better than what comes from the factory (factory clearance is approximately .75mm).

film. If any of the driven plates has blued or warped, it should be replaced. To inspect for warping, lay each driven plate on a smooth flat surface and try to slide a feeler gauge under any part of the plate. Blued plates tend to stick and bind, causing noise during clutch engagement. One way to avoid bluing is to vent the clutch cover to dissipate heat. Heat and friction are the enemies of clutch longevity. While I encourage venting, I do not encourage open clutches. Body parts and spinning clutches don't mix.

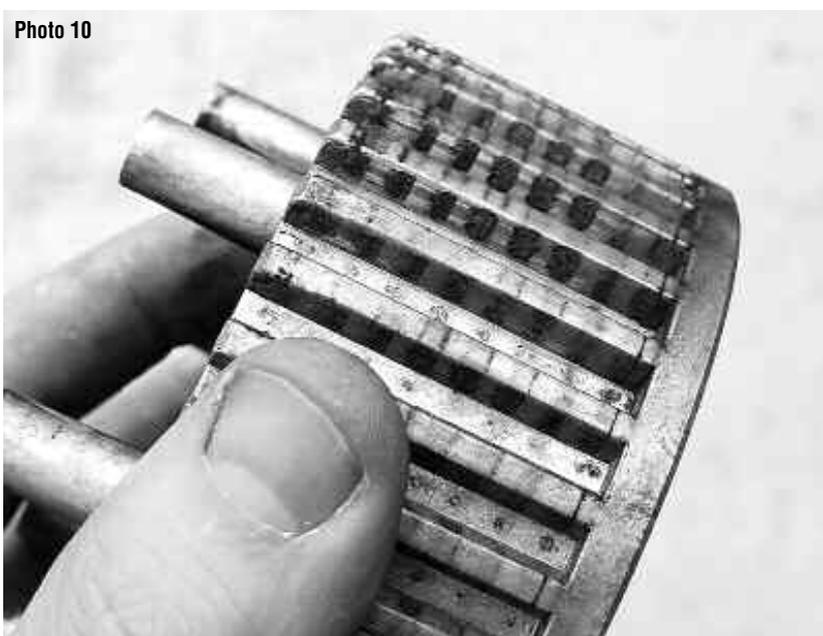
With the clutch pack out, owners should also inspect the clutch drum for notching (see photo 10). The inner tangs of the driven plates mate with the fingers of the drum and cause wear similar to that on the clutch basket. By removing the clutch drum, the cush drive behind it can also be inspected. The cush drive on the hub, like the cush drive on the rear wheel, reduces both vibration and wear to the transmission and drivetrain. The rubber blocks in the cush drive dry out over time, but are a robust design.

In addition to cleaning the clutch pack itself, the inner walls of the clutch basket, the clutch cover, and both sides of the pressure plate should also be cleaned (see photos 11, 12 and 13). Rusty clutch springs should also be inspected. Aftermarket springs coated with zinc chromate or aluminum springs are attractive options if running a vented cover, but they provide no additional functionality.

There are additional parts of the clutch system that should also be serviced when inspecting the clutch. Clutches will be either cable or hydraulically actuated. If hydraulic, both the clutch master and slave cylinders should be inspected yearly and the fluid replaced (see



**Top:** This picture shows a quiet clutch. The concept is to use a spacer plate and thicker curved plate to reduce the axial movement of the clutch when the clutch lever is released. Dr. Desmo sells this quiet clutch as a combo with the rest of the clutch pack. By providing a ready-made pack, owners are saved the hassle of measuring pack thickness. Cost is \$325. **Top right:** The quiet clutch's dished plate is noticeably more curved than the stock curved plate in the clutch pack. By providing a thicker curved plate, more slop can be taken up. **Above:** Longevity of the clutch pack can be extended by periodically removing and cleaning both the friction plates and the steel driven plates with contact cleaner. Always use rubber gloves when servicing dry clutches. Worn clutches are grimy and contact cleaner can be absorbed through the skin. Use Scotchbrite pads to scrub the drive plates.



**Above:** Clutch drums notch just like clutch baskets. However, it is rare to have to replace the drum. Aftermarket clutch drums are much lighter than the OEM drum. However, alloy drums typically don't contain a cush drive or have hard anodizing. Nevertheless, I have found them to be effective in enhancing engine performance. Remember, less rotating mass means a more responsive motor.

## RESOURCES

Barnett Engineering: [www.barnettclutches.com](http://www.barnettclutches.com)  
 Desmotimes: [www.desmotimes.com](http://www.desmotimes.com)  
 Dr. Desmo: [www.drdesmo.com](http://www.drdesmo.com)  
 Motowheels: [www.motowheels.com](http://www.motowheels.com)

photo 14). Inspecting the seals of the slave cylinder will also prevent surprises. Additionally, the pushrod that actuates the clutch should also be inspected. On Ducatis, the pushrod is sealed on the left side of the motor by two O-rings and on the right side of the transmission shaft by a single O-ring. These seals should be replaced every few years (see photo 13). Two other areas to inspect are the transmission shaft needle bearings and the pressure plate bearing. Should either bearing fail, the pushrod will begin to wear. When properly set up, the pushrod in a dry clutch does not spin. Instead, it rides in the spinning transmission shaft and pressure plate. Should it begin to spin, it can superheat the clutch slave cylinder and boil the clutch fluid. I've experienced this undesirable failure in the middle of a long trip. When clutch fluid boils, the clutch lever can be buried to no effect. In essence, you will have no clutch.

### Clutch Modifications

There are a host of clutch modifications that can be made to enhance the feel of the clutch and the performance of the bike. Lightening the clutch will yield effects similar to lightening the engine's flywheel. Less rotating weight allows the engine to spin up faster. The seat-of-the-pants feel is that the bike has more horsepower. Lightweight clutch baskets, plates, and hubs can shed several pounds of rotating mass, but shedding weight isn't cheap. An aftermarket lightweight clutch basket and plate setup can cost between \$400 and \$650.

Another upgrade can be performed by switching to baskets and plates that have more fingers/tangs. Aftermarket Ducati clutches come in a 48-tooth basket variant (compared to the stock 12-tooth setup). The advantage of this setup is more contact area between the plates and the basket. More contact area means better feel and reduced wear. Such configurations cost more than traditional clutch baskets and plates, but I consider this upgrade a modest investment compared to the next modification I'll discuss. Expect to pay between \$600 and \$800 for a 48-tooth basket and plate setup. Motowheels has the best selections of these type of clutches.

For those with a higher budget, slipper clutches may be your ticket. While I prefer to use slipper clutches on the track, the advantages of a slipper clutch—even on a streetbike—cannot be ignored. Slipper clutches have a mechanism that reduces back torque during downshifting. By using a series of ramps, slipper clutches momentarily disengage the clutch during downshifts until back torque lessens. Unfortunately, because they are more complex, slipper clutches require more frequent servicing and are more prone to misbehave due to dust and debris. In addition, they are almost twice the cost of a traditional lightweight clutch upgrade. Owners should be

Photo 11



These stainless springs offer two benefits: they don't rust and they look great. Barnett also sells aftermarket steel springs in various tensile strengths to suit the needs of owners. Unfortunately, their springs aren't coated and tend to rust.

Photo 12



Owners can check for springs that are compressed by laying a straight edge along all six springs. If any of the springs are shorter, replace all six. You can't purchase individual springs.

Photo 13



Most owners replace the outer pressure plate for aesthetic reasons. The stock pressure plate, left, doesn't look very good, but will probably last the life of the bike. The only consumable item is the center bearing. Owners should check for wear by placing a finger in the center and spin the bearing to check for stiction.

Photo 14



Also check for wear on the clutch pushrod. Failed transmission or pressure plate bearings can cause the pushrod to notch. When this occurs, the pushrod should be replaced. Pushrods will typically have O-rings at one end. On this Ducati pushrod, dual O-rings are used to prevent oil from getting past the left side of the pushrod.

wary of the slipper clutch they choose. Not all are created equal, and some require more frequent servicing than others. I recommend against the ball-bearing type slippers for anything other than track bikes. The Sureflex brand slipper is one that I recommend (available from Motowheels). Clutch-happy owners can expect to pay between \$700 and \$1200 for a slipper clutch.

## Bottom Line

A properly set-up dry clutch will offer superior engagement feel, greater durability, and last, but perhaps not least, quiet operation. If this appeals to you, this article should provide insight into future modifications. At the very least, you should now be able to offer advice to owners who think their loud clutches sound cool. 🗣️

A common failure on Ducati dry clutches is leakage of the slave cylinder located on the left side of the motor. The slave cylinder pushes against the pushrod when the clutch lever is squeezed. This design is a third generation slave cylinder, and failure is less likely. Aftermarket slave cylinders have larger pistons, which yields a softer clutch pull. Unfortunately, the softer clutch pull comes at the expense of pressure plate movement. When using an aftermarket slave cylinder, I recommend increasing lever travel to compensate. Lever travel can be increased by switching to adjustable levers.



Photo 15



This slipper clutch from Sureflex (available from Motowheels) has the ramps in a two-piece hub—a telltale sign of a slipper clutch. Other slippers will also have a spider-shaped outer pressure ring in lieu of springs and/or ramps with bearings. The ramps are designed to cause the clutch pack to open up during back-torque conditions, thus allowing the clutch to slip. A properly setup slipper clutch slips during back-torque but not during acceleration.