A Desmotromic Discussion

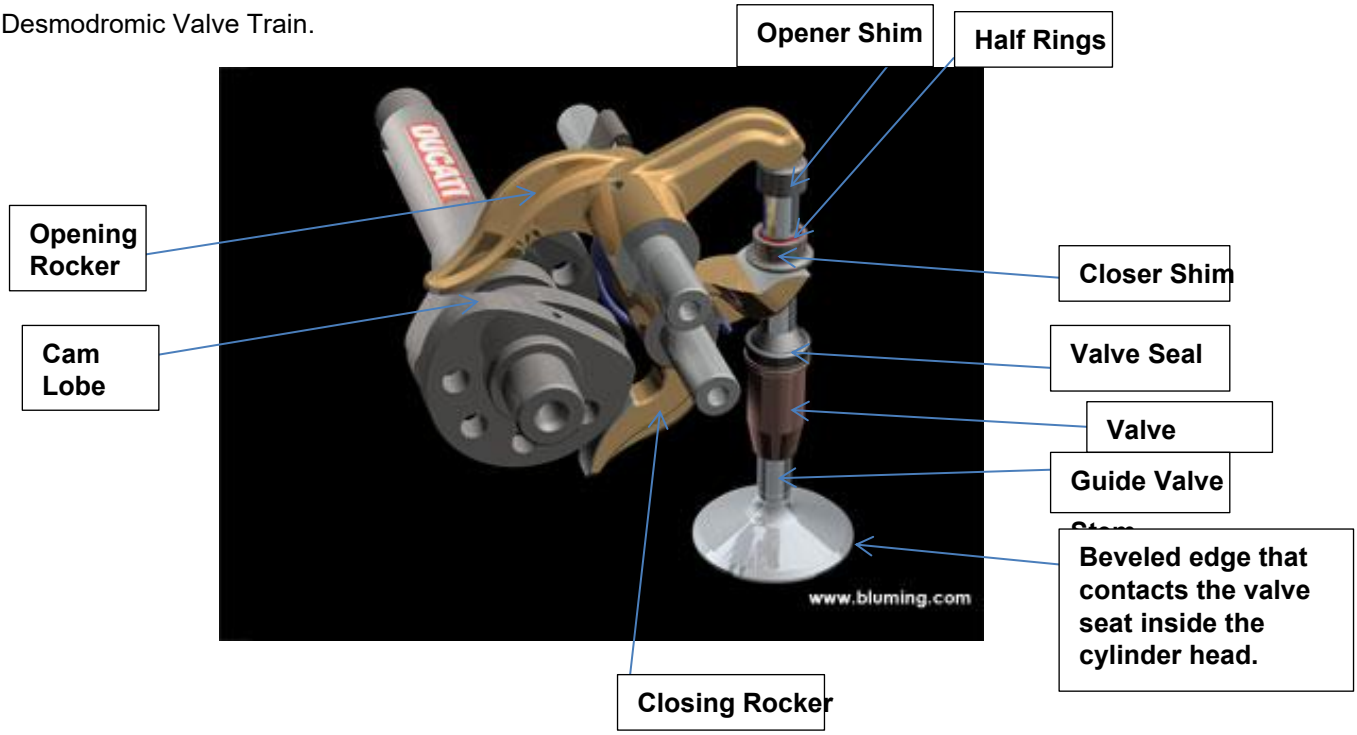
Ducati motorcycles are unique in many ways. First and foremost, Italian designers always consider form and function. You can see it in the way they design shoes, clothes, and cars. They have a talent to form a shape that is appealing to the eye and the heart. Inside the motor Ducati has chosen a method of valve actuation that is sleek, attractive, and functional.

What makes Ducati's method of valve actuation different from that of all other motorcycles on the road today is a unique system that accurately guides rocker arms that then give precise movement to the valves. Why was this Desmodromic method chosen?

Desmodromic comes from two Greek words Desmo, which means a bond or knot, and Dromos, which means a track or a way, denoting how the cams are continuously bound to the rocker arms.

In the mid 1950's Fabio Taglioni, an Italian engineer was employed by Ducati to build a race bike that could win the 125 cc class to capitalize on the "win on Sunday, buy on Monday" concept. The state of metallurgy at that time limited the rpm of the motors using valve springs. Spring breakage occurred as did valve float where the spring doesn't "keep up" with the fast rotation of the cam. Overcoming heavy spring forces zapped precious power. Taglioni, the Dr. , as they called him, saw the Desmodromic valve concept as the answer to the valve spring problems of the day. In 1956 the 125 "Desmo" Ducati won its first Grand Prix Race. Over the following years he perfected the concept and made "Desmo", short for Desmodromic, the heart and soul of the Ducati motors. It has been used for decades in all Ducati motorcycles including their Moto GP bike, which won the championship in 2007.

Other motorcycles on the market today use a cam and rocker arm to open the valve and a beefy coil spring to shut the valve. The Desmodromic valve train in a Ducati uses a cam and rocker arm to open the valve by pushing down on the opener shim on top of the valve stem. Similarly, a cam and rocker arm shut the valve by pushing upwards on a closer shim. The closer shim is locked onto the shaft of the valve stem via two small half rings (the red pieces down inside the top of the closer shim) that fit in a groove of the valve stem. The picture below shows a CAD Model of a 2V Desmodromic Valve Train.



The left side of the pic shows the cam faces. The rockers follow these as the camshaft rotates. As the rockers track on the cam lobes they rotate up and down thus creating movement of the valve stem. Both the opening rocker arm and the closing rocker arm work in unison to open and close the valve.

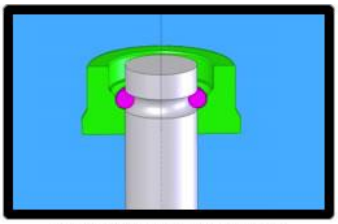
Ducati was not the first company to use the Desmodromic Concept. Springless valve actuation was first patented in 1896 by Gustav Mees. Various car manufactures in the early 1900's used the design. Mercedes Benz built a formula one car in the 1950's. Norton also built a Manx 500 during the same time frame t using it also. Both companies chose not to develop the concept further.

The advantages of the Desmodromic system are in power and consistency of function. However, the system in all Ducati's is more complex compared to motors with valve springs. There are more moving parts. Moving parts create wear and wear leads to maintenance. Early Ducati motors required valve clearances to be adjusted every 4500 miles. The process of adjustment was costly, time consuming and intimidating to the motorcycle enthusiast wanting to do ones own maintenance. Luckily, as more robust metals were developed and tolerances tightened up on the moving parts, the valve adjustment intervals have increased to 15,000+ miles on some current models.

What valve clearances are we talking about? The Ducati engineers designed the valve train so that when the valve is completely shut, there is a slight clearance between the opening and closing rocker arms between the opening and closing cam lobes. This clearance is necessary so the cams and rockers are not fighting against one another. Remember, the opening rocker and closing rocker are working in tandem with each other. The opening rocker opens the valve then the closing rocker takes over and shuts the valve. The optimal closing rocker clearance is typically around .002 in. and the opening clearance is around .005 in. With these clearances in place the valves open and close at the precise time in the combustion cycle to give optimal performance. When the valve and valve seat wear, the valve will move further up into the cylinder head. The timing of the valve will also change slightly in the combustion cycle. To remedy this, thicker or thinner shims are replaced to bring the clearances back to optimal. The valve adjustment process involves measuring the clearances and replacing the shims.

In addition to valve seat wear, clearances can change as a result of deformation of the little half rings that retain the closer shim onto the valve stem. The half rings are made of small diameter wire formed on a machine and then mechanically cut off. The wire is spring steel and is fairly soft compared the closer shims and valve stems. Over a short period of time (a few thousand miles) the half rings flatten out due to the millions of valve cycles. As the half rings flatten out, the closer clearances increase. During this process the half rings also "work harden" so that the deformation slows down. The half rings work adequately in street bikes, but require attention due to deformation over time. On a race track or if the motor is running up in the higher rpm's consistently, the half rings flatten out rather quickly and can even break.

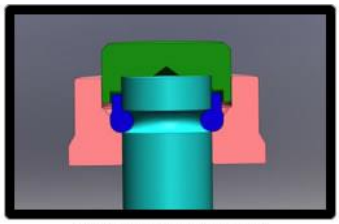
In the late 90's, Guy Martin from MBP, developed a replacement for the half rings. It was first used in a 748 race bike at Daytona. The sustained high RPM's with the steep lift of the racing cams simply pulverized the half rings causing the pistons to collide with the valves. They replaced the half rings with MBP retainers and the bike finished on the podium. The Figure below shows a comparison between the stock half ring (in pink) and the MBP Retainer (in blue), showing the advantages. Longer valve adjustment intervals can be obtained with their use.



STOCK HALF RING

Features /Characteristics

- Wire Formed/Mechanically Cut
- Made from Spring Steel
- Deforms during use
- Can break during use if clearances get too large
- Low resistance to bending



MBP RETAINER

Features /Characteristics

- Precision Machined
- Made from Tool Steel
- Does not deform
- Will not break
- High resistance to bending

Ducati continues to use the Desmodromic system in MOST of their motorcycles. It contributes to the mystic of this beautiful Italian creation. Additionally, it provides a challenging and rewarding maintenance opportunity for ambitious Ducati owners with a love of tinkering. The arrival of the MTS1200 V4 in 2021 is the first instance of a non-Desmodromic engine entering production at Ducati since the 80s. Ducati did this to compete with other European and Japanese manufacturers of sport/adventure tourers in an effort to remove the stigma that Ducati has for being maintenance-intensive. The MTS V4 touts valve adjustment intervals every 60,000Km (37,000 miles).