TESTASTRETTA DVT VALVE ADJUSTMENT/TIMING BELT CHANGE

By Evan T DeWan at *ducatitoolrental.com*

This applies to all Testastretta **DVT** engines. This guide is for the valve clearance measurement and adjustment procedure. Since the camshafts must be removed to change shims, we recommend measuring all the valve clearances (horizontal and vertical cylinder) before removing the timing belts/camshafts. Overview of the procedure:

Disassembly

- Place motorcycle on stand or lift.
- Put transmission in neutral.
- Remove interference (fuel tank, radiator, fairing covers, etc.).
- Remove spark plugs from each cylinder.
- Install engine turning tool.

- **Measure Clearances**
  - Place horizontal cylinder at Top Dead Center (TDC).
  - Measure opening/closing clearances (and record on worksheet) of horizontal cylinder.
  - Rotate engine to place the vertical cylinder at TDC.
  - Measure opening/closing clearances (and record on worksheet) of the vertical cylinder.

If all clearances are within specification, reassemble. If clearances are out of specification (horizontal, vertical, or both) proceed as below:

- **Shim Replacement**
  - Rotate engine to place horizontal cylinder at TDC.
  - Loosen/remove the horizontal timing belt. If belt(s) are to be reused, mark location and direction of rotation before removal.
  - Remove camshafts to gain access to the valves/shims.
  - Replace shims as required.
  - Rotate engine (270 degrees CCW) and place the vertical cylinder at TDC. This will prevent the valve from falling into the cylinder during shim replacement.
  - Loosen/remove the vertical timing belt.
  - Remove camshafts to gain access to the valves/shims.
  - Replace shims as required.
- **Reassemble Cams**
  - Turn the engine counter clockwise and position the horizontal cylinder at TDC.
  - Use the TDC control gauge and verify, on the intermediate shaft, the engine is at horizontal cylinder TDC.
  - Remove the engine turning tool and install the crank locking tool to hold the crankshaft in position.
  - Remove the TDC control gauge.
- **Belt Installation**
  - Install vertical cylinder camshafts and align using the reaction tool.
  - Install belt on vertical cylinder.
  - Remove the reaction tool.
  - Install the horizontal cylinder camshafts and align using the reaction tool.
  - Install timing belt for the horizontal cylinder.
  - Remove the reaction tool.
  - Install the engine turning tool.
  - Rotate the engine several times to insure freedom of movement and to take any slack out of the timing belts. Set horizontal cylinder at TDC.
  - Tension both timing belts.
  - Rotate the engine several times and Verify belt tension.
- **Reassemble**

DISASSEMBLY

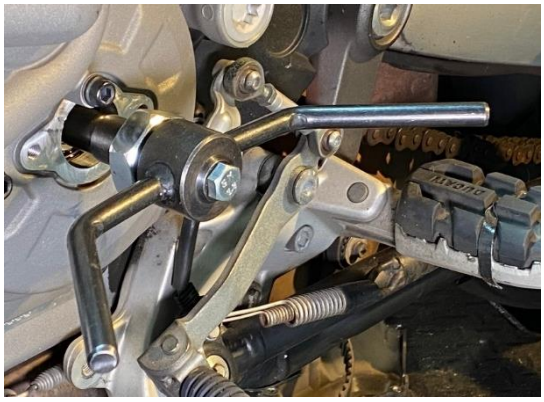
General notes:

- Having a low fuel quantity before starting the procedure prevents spillage and lightens the tank for ease of removal and storage.
- Secure the bike to a stand or on a lift (if available).
- Place the transmission in neutral.
- Take pictures; especially the electrical connections and routing of leads, hoses, etc. to aid in reassembly.
- Segregate assemblies, label items (tape and Sharpie), and store hardware in seperate containers/bags.
- Remove enough interference to gain access to the cylinder heads. This may include the fuel tank/seat cowling assembly, side fairings, the air-box, and radiator.
- If changing the oil during this service, this is a great time to drain the oil. This will reduce continual oil seepage during valve clearance measurement/adjustment.
- Disconnect the battery (the battery negative terminal is the first removed and the last installed).

Remove the timing belt covers:

Undo the bolts securing the top portion of the vertical timing belt cover and remove. Remove the timing belt cover from the horizontal cylinder. Remove the middle portion (downward and forward) of the vertical timing belt cover. Some finesse is required: this is often a tight fit in the frame.

Remove the spark plugs. This is important: Engine rotation is only possible with the removal of the spark plugs and placing the transmission in neutral.



Install engine-turning tool. Remove the cover on the left side of the engine and install the engine-turning tool onto the end of the crankshaft. Note: the tangs on the engine-turning tool fit neatly into indents on the crankshaft. Tighten the bolt to snug and the engine is ready to turn counter clockwise (CCW) into the correct position(s) for valve clearance checking.

From the left-hand side of the engine, rotate the engine slowly counter clockwise until the horizontal cylinder is at Top Dead Center (TDC): top of the compression stroke of the horizontal cylinder. At TDC, the valves and the camshafts are in the rest position. No load is placed on the (horizontal) valves or cams and accurate clearance measurement is achieved. The horizontal cylinder at TDC will be used as a reference condition for several of the following procedures.

There are several ways to find TDC. The easiest way is to stick your thumb in the spark plug hole of the horizontal cylinder and rotate the engine until you find compression coming from the cylinder. Stop at the top of the stroke. Visual verification: a plastic gauge is included with the kit and can be inserted (gently) into the cylinder when approaching TDC. You can note when the gauge has

reached is maximum outward travel to verify the piston is at the top of the stroke**. Remove the gauge.**

MEASURE CLEARANCES

For each cylinder, there are four valves and eight (8) measurements: four (4) opening shim clearance measurements and four (4) closing shim clearance measurements to record. The intake valves on Ducati engines are inboard (the inside portion of the "L" configuration.) The exhaust valves are the ones on the outboard side of the engine (forward and aft).

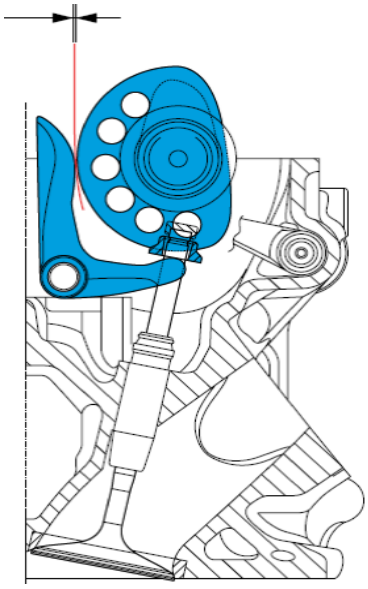
Use the accompanying worksheet to record the measurements. Before beginning, determine what clearance(s) will be acceptable. Ducati gives a factory recommended range for closing clearances (0.0 5mm – 0.10 mm). Some prefer to set the opening/closing clearance to an exact number (i.e. - 0.05mm). Enter the acceptable clearance into column [G] (closing shim clearance) on the worksheet.

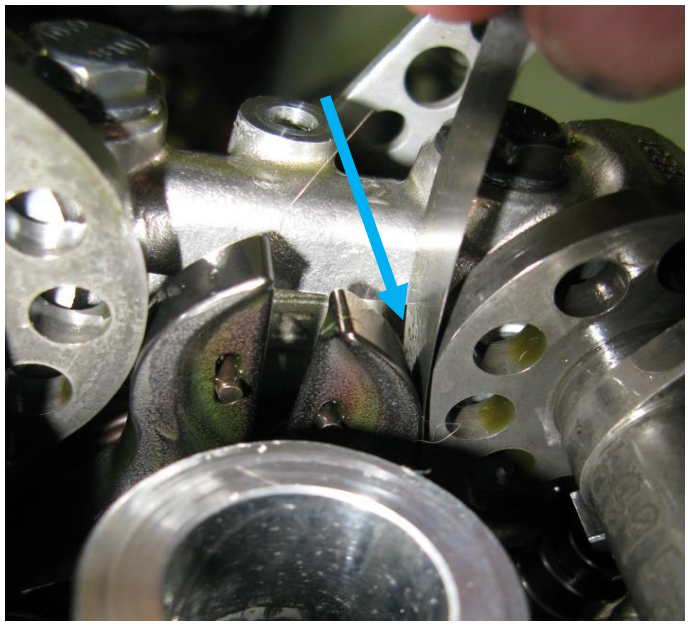
Tip: spread out the feeler gauges in order. This facilitates progressive (larger/smaller) measurement.

HORIZONTAL CYLINDER

Set engine to horizontal cylinder at TDC.

MEASURING THE CLOSING SHIM CLEARANCE





Use the accompanying worksheet (or other preferred method) to record measurements. The worksheet arrangement enables an easy determination about the current valve/shim clearance. It also facilitates determining the new shim size to bring the clearance into specification.

Record the Ducati recommended (or your predetermined) valve clearance in column [G] (closing clearances).

Start with the desired feeler gauge (i.e. - .05mm) and use larger/smaller gauges until the correct clearance can be determined.

Use the feeler gauge to measure the clearance between the closing rocker arm and the camshaft lobe, taking care not to compress the rocker arm return spring. Record this measurement in column [F] (closing shim measured clearance) for the valve under measurement.

Ducati recommended closing clearances

VALVES	CLOSING CLEARANCE (mm)
INTAKE	0.05 ÷ 0.10
EXHAUST	0.05 ÷ 0.10

If measurement [F] is outside the specification (or is not the specification you want), a different sized shim is required to bring the clearance into specification.

Generally, clearances are ***greater*** than specification. A larger sized shim will be required to close up the gap. If this is the case subtract [G] from [F] (smaller from larger) and record this number in column [H] for the clearance just measured. This result, [H], will be ***added*** to the existing shim size, [I], to determine the new shim size [J].

On occasion, the clearance is ***smaller*** than the specification ([G] is larger than [F]). A smaller sized shim is required to bring the clearance into specification. The arithmetic is slightly different. Subtract [F] from [G] and record the result in [H]. In this case, the result [H] will be ***subtracted*** from the measured shim size [I] to determine the new shim size [J]. The new shim size will be smaller than the current shim ([I].

Measure and record the closing shim clearances for the remaining valves.

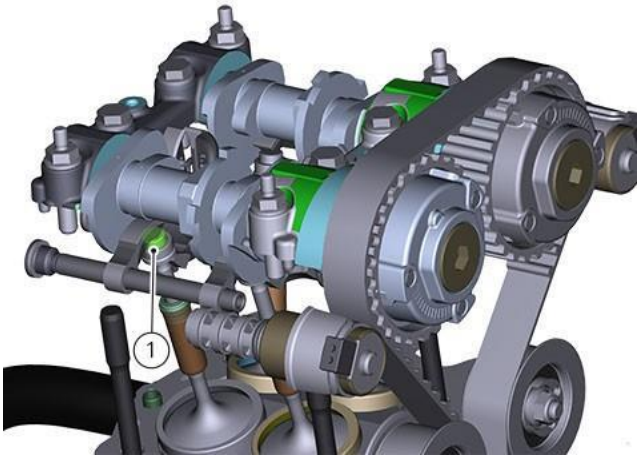
OPENING SHIM CLEARANCE MEASUREMENT

Use a feeler gauge (A), to measure the clearance between the opening rocker arm and the lower edge of the camshaft lobe: Start with the desired feeler gauge (i.e. - .13mm) and use larger/smaller gauges until the correct clearance can be determined. The proper feel is if the resistance on the feeler gauge is similar to inserting the gauge into a large book. Once the clearance is determined, record this as measurement [A] on the worksheet.

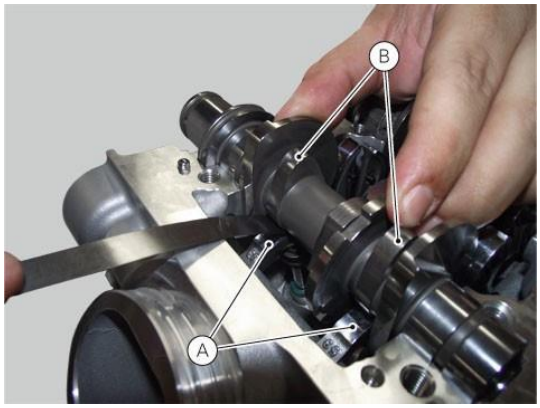
Ducati recommended opening clearances:

VALVES	OPENING CLEARANCE (mm)
INTAKE	0.13 ÷ 0.18
EXHAUST	0.13 ÷ 0.18

If the measurement [A on the worksheet] is outside the specification (or is not the specification you want), a different sized shim is required to bring the clearance into specification.



1: Opening Shim



A: Opening rocker arms

B: Opening cam lobes.

Generally, clearances are greater than specification. A larger sized shim will be required to close up the gap. If this is the case subtract [B] from [A] (smaller from larger) and record this number in column [C] for the opening shim just measured. This result, [C}, will be ***added*** to the existing shim size, [D], to determine the new shim size [E].

On occasion, the clearance is ***smaller*** than the specification ([B] is larger than [A]). A smaller sized shim is required to bring the clearance into specification. The arithmetic is slightly different. Subtract [A] from [B] and record the result in [C]. In this case, the result [C] will be ***subtracted*** from the measured shim size [D] to determine the new shim size [E]. The new shim size will be smaller than the current shim ([D].

Measure and record the opening shim clearances for the remaining valves.

VERTICAL CYLINDER

Rotate the engine 270 degrees counter clockwise and place the vertical cylinder at TDC.

Repeat the steps for the vertical cylinder and record the measurements in the worksheet.

If any clearances are outside the acceptable range, the out of clearance must get corrected by changing the appropriate opening/closing shim(s). Replacing a shims with one of a suitable size will bring the clearance measurement back into the acceptable range.

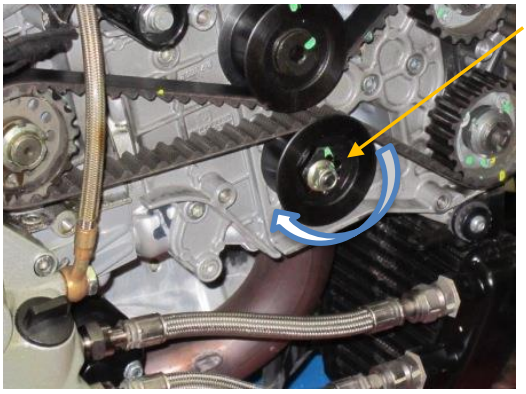
SHIM REPLACEMENT

After the valve clearance measurement for both cylinders, shim replacement (if necessary) is next. Determine which clearances are out of specification and require shim replacement.

The camshafts must be removed in order to access the valves/shims for replacement. The horizontal cam belt is the first to get removed so the procedure starts there.

Rotate the engine CCW and place the horizontal cylinder at TDC.

Important **- If the belts are to be re-used, mark the location (horizontal or vertical cylinder) and direction of rotation with the paint pen.**



Loosen the tensioning pulley by loosening the Fuji nut and rotating the tensioning pulley clockwise (away from the Variators). Loosen the nut and remove the tensioning pulley from its mounting stud on the cylinder head. Removing the tensioning pulley facilitates belt removal/installation. Label the tensioning pulley (horizontal or vertical).

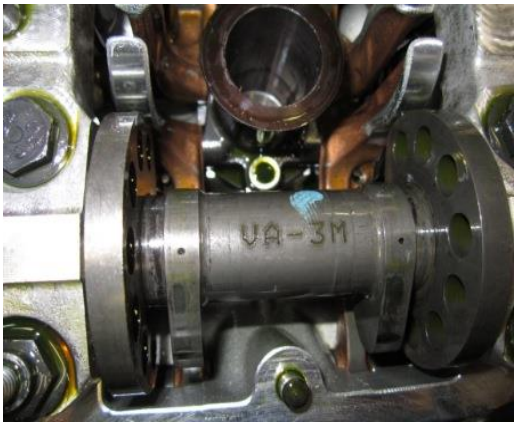
Remove the timing belt.

REMOVE THE CAMS

When removing the cam hold-down clamps loosen the inner retaining bolts and then the outer ones. These nuts are ½ the normal height and it is best to use a 6pt socket.

Note: The vertical cylinder intake cam pulley will rotate due to spring tension when the belt is removed. This is normal and will be addressed upon reassembly.

Each cam is marked to its location. Here it the key to cam markings:



A= intake (Italian word aria)

S= Exhaust (Italian word scarico)

V= Vertical (Italian word verticale)

O= Horizontal (Italian word orizzontale)

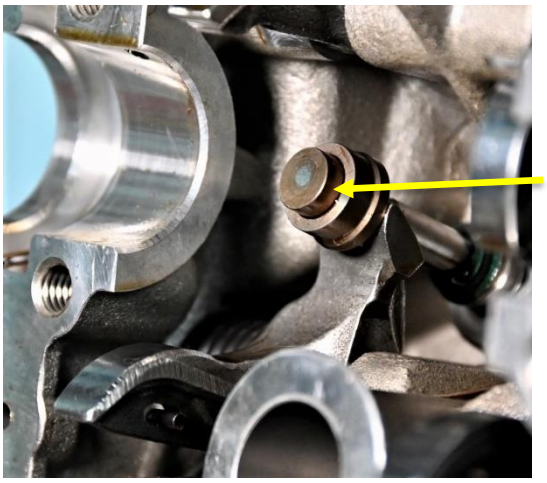
The markings (VA) indicate this is the vertical intake cam.

Use a punch and ***gently*** tap on the Variator to loosen the cam/cam retainers so the camshafts can be removed.

Remove the camshafts and set aside.

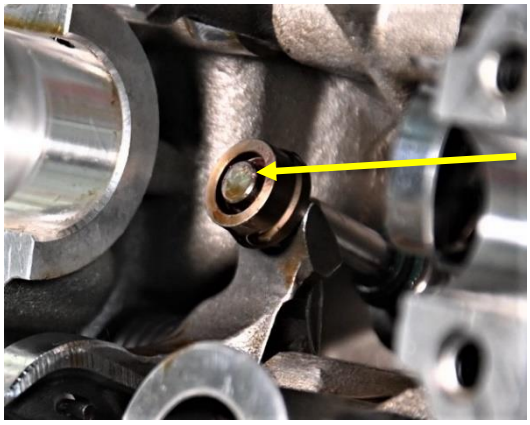
OPENING SHIM REPLACEMENT:

With the cam removed, the opening shim is visible.



Lift/hold the opening rocker out of the way.

The opening shim sets on top of the valve stem.



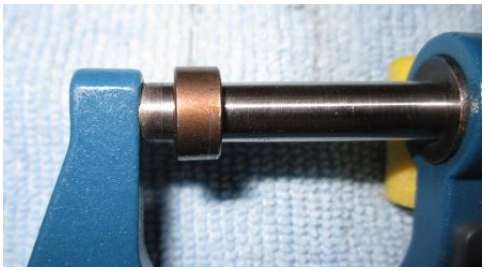
Remove the opening shim by lifting it off of the valve stem.

Opening shim removed.

Note: if replacing the closing shim (vs. the opening shim on a particular valve). Place the removed opening shim in a marked bag/container for ease of reinstallation.

MEASURE THE OPENING SHIM

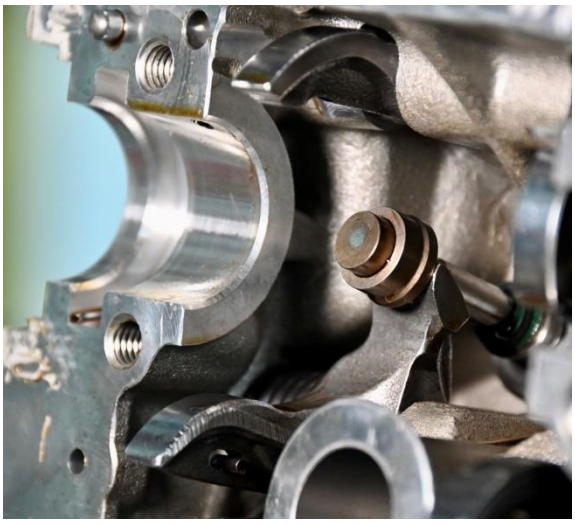
The opening shims are flat on the top and recessed on the bottom so the shim fits securely on top of the valve stem.



Close the micrometer. Do not over tighten. Press the "zero" button to set the reading to 0.00. Open the micrometer and place the shim on the stationary shaft of the micrometer, with the flat side towards the fixed portion of the micrometer. Measure the opening shim and record the measurement in column [D] of the worksheet. Determine the size of the replacement shim by adding/subtracting column [C] to column [D] and record this number in column [E]. The number in column [E] is the ideal shim size to bring the valve clearance into specification. Shims are manufactured in .05mm increments. So a larger/smaller shim should bring the clearance into the desired range. If you are looking for an exact size (vs. in specification range) and the .05mm step (larger/smaller is not going to get you there, here is a solution:

Take the next larger size shim and make it the right size using 400 wet/dry sandpaper. Place the sandpaper on a flat surface (a piece of glass works nicely) and sand the shim into the desired measurement. This method takes some time and effort. Turn the shim every few strokes to provide even sanding. After some time sanding, re-measure the shim to see if it has been sanded into the correct size. If not, continue sanding until it is the correct size, reinstall it onto the valve stem or put it aside if the closing shim on the same valve requires replacement.

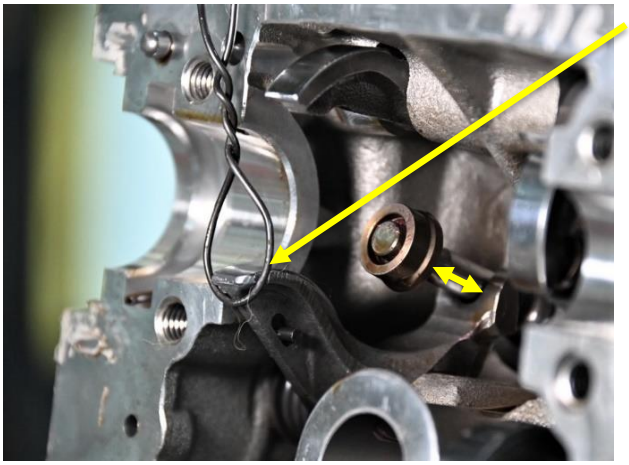
CLOSING SHIM REPLACEMENT



If a closing shim requires replacement, the opening shim will have to be removed from the valve. Remove the opening shim and set it aside, marking the shim's location for reassembly.

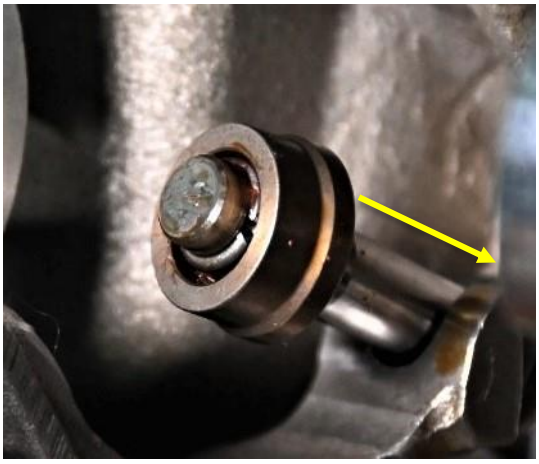
Verify the cylinder is at TDC to prevent the valve from falling fall into the cylinder when the closing shim is removed.

If the cylinder is not at TDC, place the forceps clamp onto the valve stem below the closing rocker arm. This will prevent the valve from falling into the cylinder when the closing shim is removed. The forceps may have to be re-positioned during the valve shim removal process.

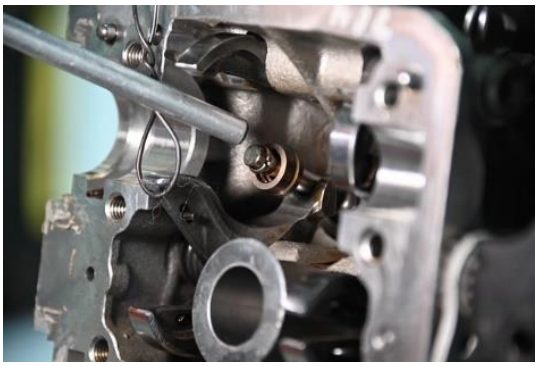


Use safety wire, zip tie, or a screwdriver to lever the closing rocker arm away from the closing shim; relieving pressure on the closing shim. In the photo the closing rocker arm is well away from the closing shim. Remove the opening shim and set it aside.

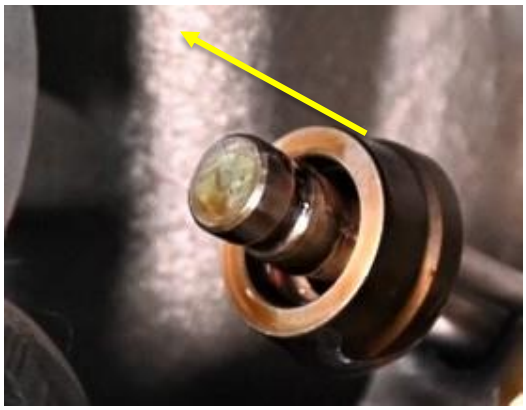
Block the oil return holes to prevent the retaining rings from falling into the cylinder.



Push the closing shim so it slides (down) on the valve stem, revealing the retaining rings (half-rings).



Use the magnet in the kit to remove the half-rings from the valve stem.



Slide the closing shim up and off the valve stem. Set the half-rings aside making note of their location.

MEASURE THE CLOSING SHIM

Place the closing shim-measuring tool inside the closing shim and measure. The closing shim-measuring tool fits inside the closing shim and allows accurate measurement with the enclosed electronic calipers. The closing shim-measuring tool adds 10.00 mm to the shim measurement.

Remember to subtract 10.00 mm from the shim measurement prior to recording the measurement on the worksheet. Record this measurement (minus the 10.00 mm) in column [I] of the worksheet.

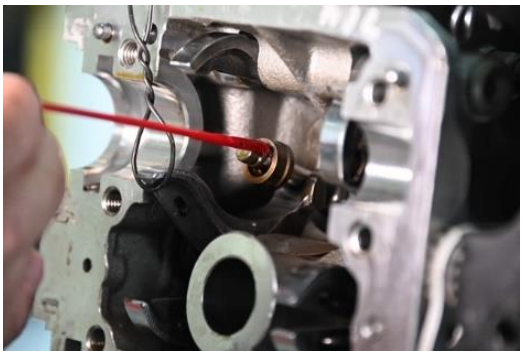
This closing shim measures 3.52mm (13.52mm minus the 10.00mm of the closing shim-measuring tool).

Add/subtract column [H] to column [I] to find: [J] the size of the (new) closing shim to bring the clearance into specification.

- If one of the standard sizes does not bring the clearance close enough to the desired measurement, the closing shims can be sanded into the exact size with 400 wet/dry

sandpaper. Sand the closing shims on the "top" part of the shim: the wider part that contacts the closing rocker arm.

INSTALL THE NEW SHIMS

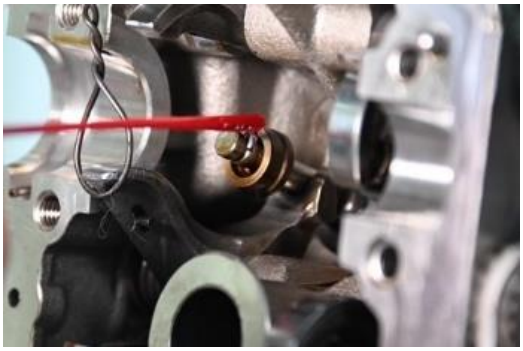


Slide the new shim onto the valve stem.

Install the first half-ring. A little grease/oil in the half-ring recess on the valve stem helps hold the half-ring in position. A little oil or grease on the end of a plastic straw/coffee stirrer helps to position the half-ring.

Installation tip: Adjust the safety wire/zip tie to position the closing rocker where it is only depressed enough so the top of the closing shim is at the bottom of the recess in the valve stem. This will allow the top of the closing shim to act as a flat surface to position the half-ring upon enabling easier half ring installation.

Rotate the half ring to make room for the second half-ring.



Install the second half-ring onto the valve stem.

Slide the closing shim up over the half-rings and insure the half-rings remain seated onto the valve stem.

Release the pressure on the closing rocker slowly until the half-rings seat and the closing shim is secure. The top of the valve and the closer shim should line up nearly flush on top. Reseat the valve several times to seat the half-rings securely.

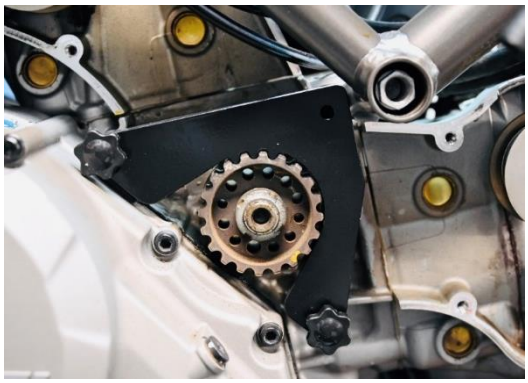
Install/reinstall the opening shim on top of the valve after closing him replacement.

Repeat these steps for all the valves that have clearance(s) outside of specification.

After the shims on the horizontal cylinder have been replaced, rotate the engine (270 degrees CCW) to place the vertical cylinder at TDC. This will prevent the valve(s) from falling into the cylinder when the closing shim(s) is/are removed. Repeat the shim replacement procedure for the vertical cylinder

REASSEMBLE THE CAMS/BELT INSTALLATION

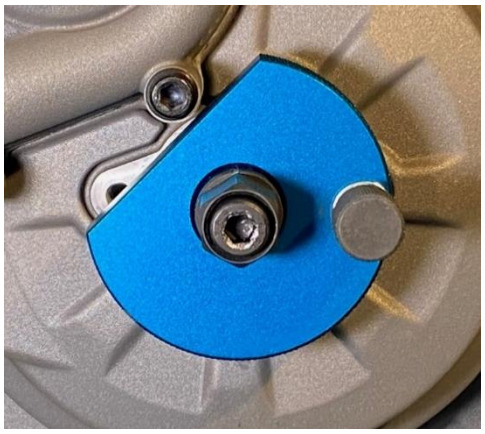
After all shims are replaced/reinstalled, installation of the camshafts is next.



Use the engine turning tool to rotate the crankshaft counter clockwise (by looking at the engine from the left side), to bring the horizontal cylinder piston to the TDC.

For this type of engine, ***there is just one TDC*** that allows performing a correct timing.

Fit the TDC Control Gauge on the Intermediate Shaft pulley. It must perfectly match with the teeth on the Intermediate Shaft pulley and the threaded engine case holes.
If this is not the case, rotate the crankshaft until reaching the top of the piston stroke again and try refitting the tool. For this type of engine, there is just one TDC position that allows performing a correct timing.



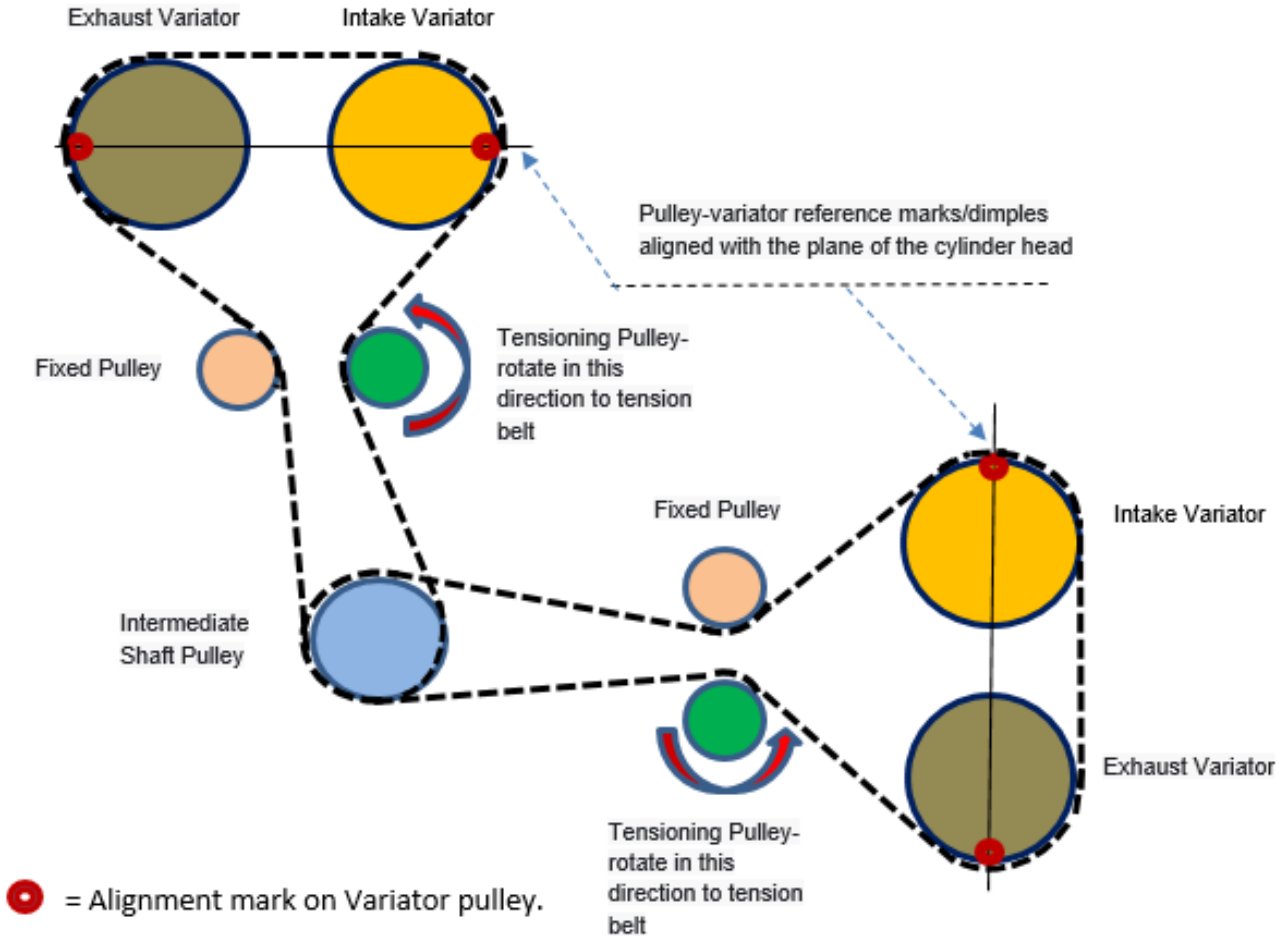
When the timing is correct, remove the engine turning tool from the left hand side of the engine. Install the crankshaft locking tool onto the crankshaft and lock the tool/crankshaft into position.

Install the vertical and horizontal cylinder camshafts

Note: When reinstalling camshafts, insure all opening rocker arms are in the correct position: underneath the camshaft lobes. It is easy to install the camshafts with the opening rockers "up" and out of the way of the opening shim.

Use gasket sealant on the mating corners where the cam retainers meet the flat surface of the cylinder head for sealing. Torque in two stages to 7ft lbs.

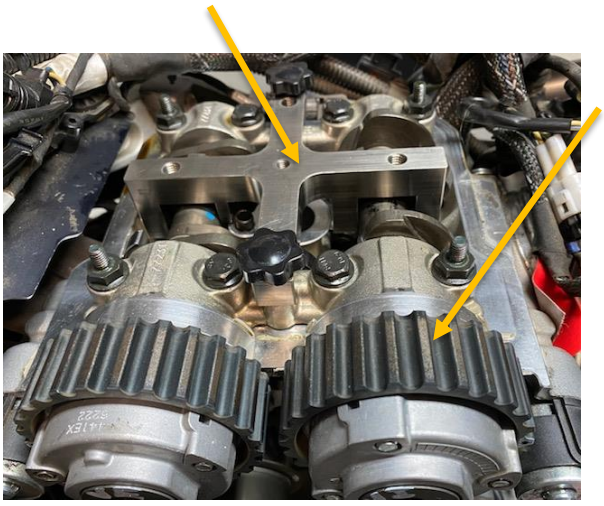
BELT INSTALLATION



The diagram shows the alignment of the camshafts when properly installed. The crankshaft is locked into position with the crank locking tool (disregard the dimple on the Intermediate Shaft Pulley).

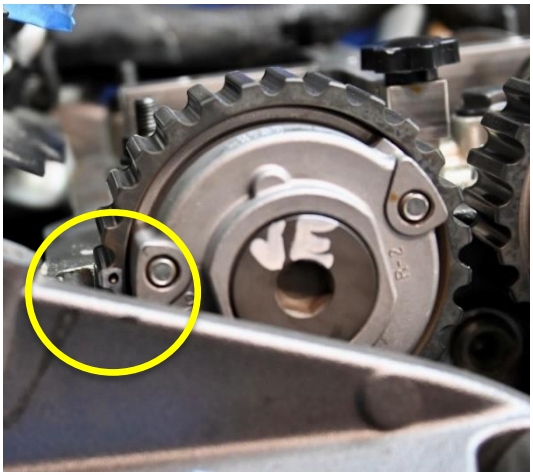
Install the belt for the vertical cylinder first.

Use the reaction tool to set/hold the camshafts in place.

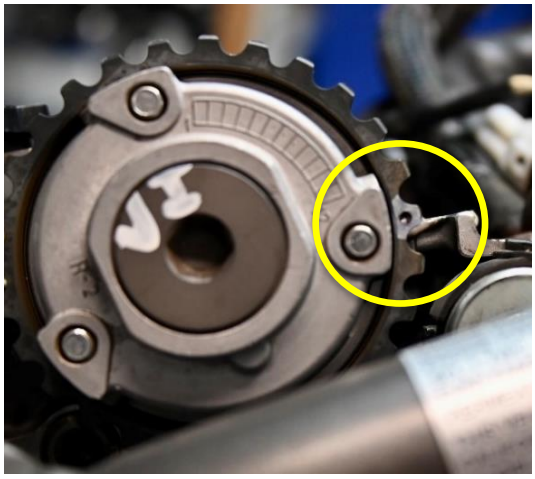


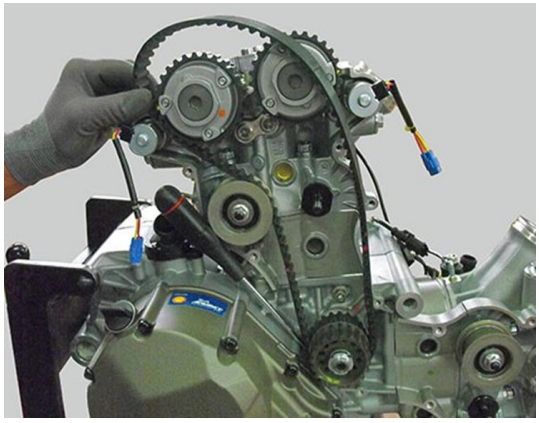
Note: there is spring pressure on the intake cam. Manually rotate the Variator so the flat portion on the camshaft fits neatly into the reaction tool. Use the M6 x 25mm bolts (with plastic knob) to secure the reaction tool to the cylinder head: holding the camshafts in place.

The marks on the camshafts will align with the plane of the top of the cylinder head (see Picture).

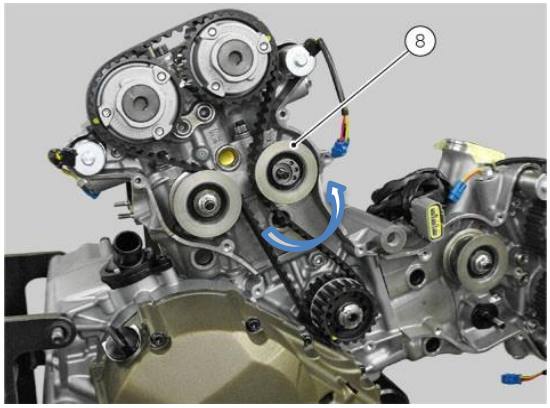


Check the Variator alignment. The marks (dimples) on the Variatiors will align with the plane of the "head flat surface".





Install the belt on the vertical cylinder: bottom pulley first and work your way up. Use a screwdriver (as shown) to secure it onto the Intermediate Shaft pulley.



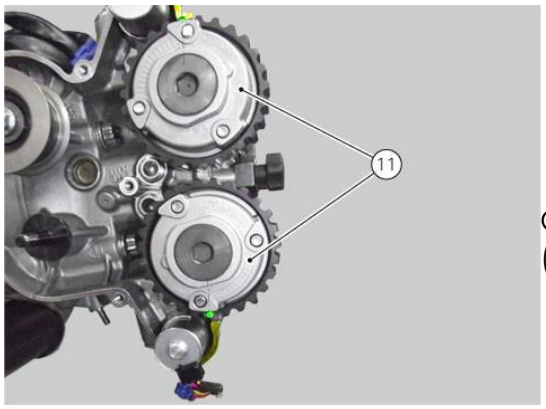
If previously removed, fit the belt tensioner (8), new wave washer, and new Fuji nut. Put slight tension on the belt by rotating the tensioning pulley counter clockwise and gently tighten the Fuji nut. **DO NOT TORQUE** the Fuji nut at this time.

When putting tension on the belts, rotate the tensioning pulley counter clockwise.

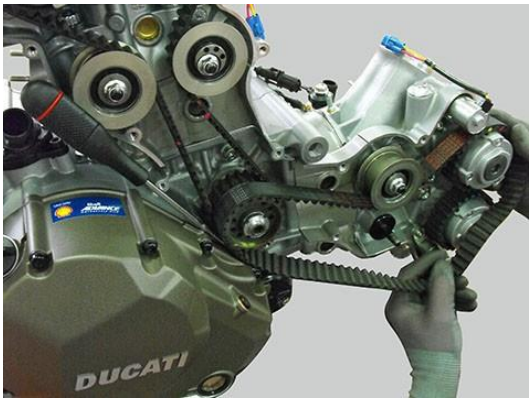
Remove the reaction tool from holding the vertical cylinder camshafts in place.

Install the reaction tool onto the horizontal cylinder camshafts.

Note: There is no spring tension on the horizontal cylinder camshafts and alignment is easy.



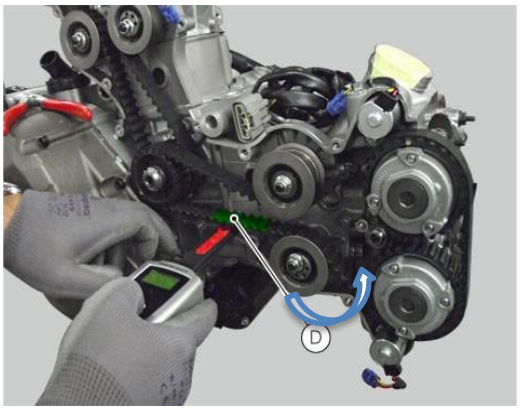
Check the alignment of the Variators (11): the marks (dimples) are aligned with the "head flat surface".



Install the belt for the horizontal cylinder. Place a screwdriver, as shown, to hold the belt in position.

If previously removed, fit the belt tensioner , new wave washer and fasten with a new Fuji nut . Do not tighten to torque.

Remove the reaction tool. From the horizontal cylinder.



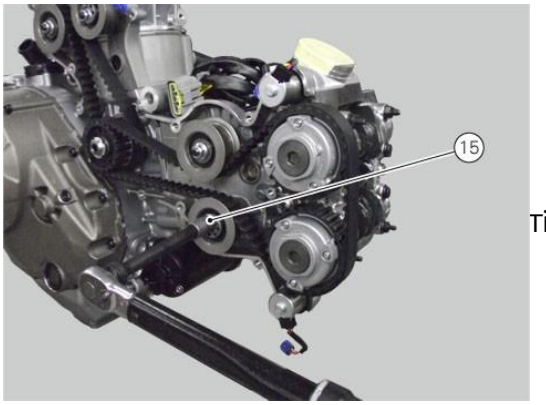
Check the horizontal cylinder belt tension at the indicated point (D). Tension the belt according to the table below.

Add tension to the belt by rotating the tensioning pulley counterclockwise; towards the Variator.

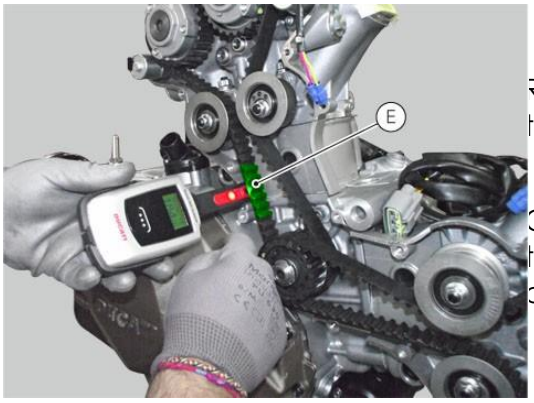
{Rotating the tensioning pulley clockwise causes the idler and tensioning pulley to begin to interfere with each other.

Use a needle nose pliers and insert the ends into the indent in the pulley carrier to add/remove tension.

	Assembly Value (new belt)	**Assembly Value (used belt- after one engine heat cycle)**
Cold belt tension adjustment	90 ± 5 Hz (horizontal) 90 ± 5 Hz (vertical)	80 ± 5 Hz (horizontal) 80 ± 5 Hz (vertical)



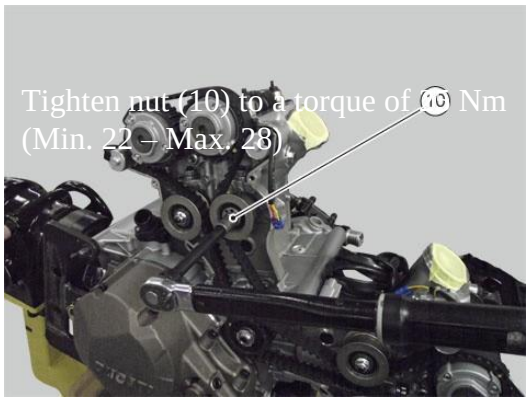
Tighten nut (15) to a torque of 25 Nm (Min. 22 – Max. 28).



Rotate the crankshaft by 270° counter clockwise to bring the vertical cylinder to TDC.

Check the vertical cylinder belt tension at point (E). Tension the belt according to the table. Rotate the engine one complete revolution and recheck the tension.

T



Valve clearance adjustment and belt replacement

are now complete.

Remove all the previously installed tools.

Refit the cylinder head covers.

Refit the timing belt covers.

Refit all interferences.