ViVa© Actuators Operate the Valves of an *EVIC* Gas Powered Camless Engine

Featuring the NEW ViVa© 12mm Actuator

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Introduction

The Viking AT ViVa© actuators are piezo electric devices designed as a solenoid replacement. Back in October 2014 I successfully demonstrated a 3mm ViVa© actuator operating the intake valve of my 12cc *EVIC* Mk2 engine. The next step was to obtain the larger 12mm ViVa© actuator to see if it was up to the much more difficult challenge of operating the exhaust valve. To open the exhaust valve the actuator must overcome the high cylinder pressure at the end of the engine's power stroke.

"These actuators are now operating the valves of my Mk2 EVIC engine with speeds up to 8600 rpm. The actuators use significantly less electrical power, about 25% of that used by the solenoids." – David Bowes

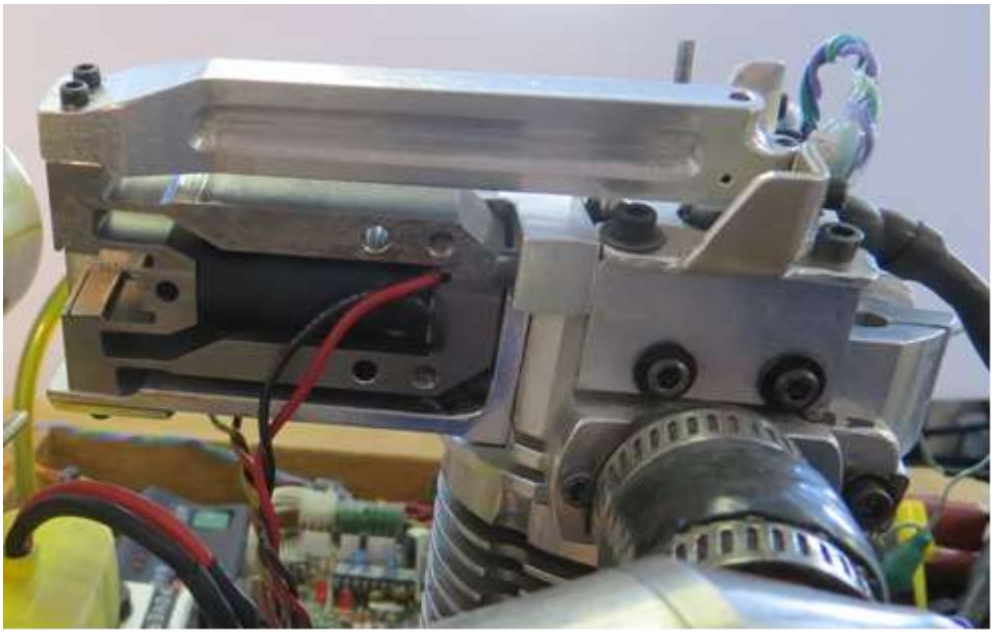
Normally poppet valves on internal combustion engines are opened by a cam and closed by a valve spring. The valve spring must supply sufficient force to prevent valve float, to prevent the valve from separating from the cam. When the cam is replaced by a solenoid that pushes the valve open, a valve spring is still required to close the valve. The valve spring must supply sufficient force to move the valve and the solenoid armature to the closed position. For both the cam operated valve and the solenoid operated valve, the valve is not normally connected to the cam or the solenoid armature.

In my October tests the 3mm ViVa© actuator successfully operated the intake valve but with relatively low valve lift. To improve intake valve operation and to increase valve lift, I decided to parallel two 3mm actuators. This proved to be quite easy and worked well. The two actuators operate the intake with more lift and without a valve spring.

Two 3mm ViVa Actuators with a common actuator arm control the Intake Valve

The exhaust valve was the next challenge. While the intake valve can be operated with only one pound of force the exhaust valve requires at least 10 pounds of force to overcome the worst case cylinder pressure that can be in the range of 5 to 8 atmospheres. I started with the basic 12mm ViVa© actuator without arms. My first attempt with this actuator was unsuccessful. The mounting bracket and arm that I made proved to be too flexible when attached to the actuator. So instead of the exhaust valve opening my 1/4" thick aluminum arm and my 1/16" sheet aluminum, the mounting bracket just flexed!

Fortunately, when I talked to the folks at Viking AT they immediately recognized the problem and pointed me in the right direction. My second attempt at the arm was much stiffer but it took me three tries to get a satisfactory, but not a perfect, mounting bracket. After some initial tests, I made the decision to machine a very stiff mounting bracket out of solid aluminum. Now, all the force generated by the 12mm actuator goes to open the exhaust valve.



A 12mm ViVa Actuator controls the Exhaust Valve.

(Note the size of the control arm, near the top of the picture.)

The control arms for both valves have magnets at the valve ends that enable linear Hall Effect sensors to measure the valve positions. The information is fed to my computer control system so that the controls can actively measure and control the valve positions. I also use them so that I can monitor the valve positions with my digital storage oscilloscope. That way I can see exactly what is happening as the valves open and close and use this information to improve my controls and software.

Testing the Camless *EVIC* Engine with ViVa Actuators

One of the really exciting things about this technology is how little electrical power is required to operate the valves. It is a fraction of that required by my previous solenoid system.

Conclusions and Next Steps

This paper illustrates how Viking AT ViVa© actuators can operate the intake and exhaust valves of a small internal combustion engine. These actuators are now operating the valves of my Mk2 EVIC engine with speeds up to 8600 rpm. The actuators use significantly less electrical power, about 25% of that used by the solenoids. While the solenoids provided more valve lift the ViVa© actuators open and close the valves faster and as a result engine performance is similar.

I am still using a valve spring to close the exhaust valve. My next step will be to remove this spring and connect the exhaust valve directly to the actuator. Then I should be able to tune the control software for higher engine speed and greater engine performance.

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