ELECTROMAGNETIC ACTUATOR FOR A CAM LESS ENGINE

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ABSTRACT

Internal combustion engine require cam to open and close inlet and exhaust valve with the help of cam shaft using engine power. At high speed cam have its limitations. Since the valve use power of the engine it reduces the engine break power and its rpm. With the increased electrifications of the vehicles, variable valve train based on electricity driven actuators presents interest for investigation for gasoline engines for vehicular application. Actuators can be used to both open and close valves, or to open valves closed by springs or other means. Camshafts normally have one lobe per valve, with a fixed valve duration and lift. The camshaft rotates at half the rate of the crankshaft. Although many modern engines use camshaft phasing, adjusting the lift and valve duration in a working engine is more difficult. Some manufacturers use systems with more than one cam lobe, but this is still a compromise as only a few profiles can be in operation at once. This is not the case with the cam less engine, where lift and valve timing can be adjusted freely from valve to valve and from cycle to cycle. It also allows multiple lift events per cycle and, indeed, no events per cycle.

KEYWORDS: *Internal combustion, Electromagnetic actuators, valve train, cam*

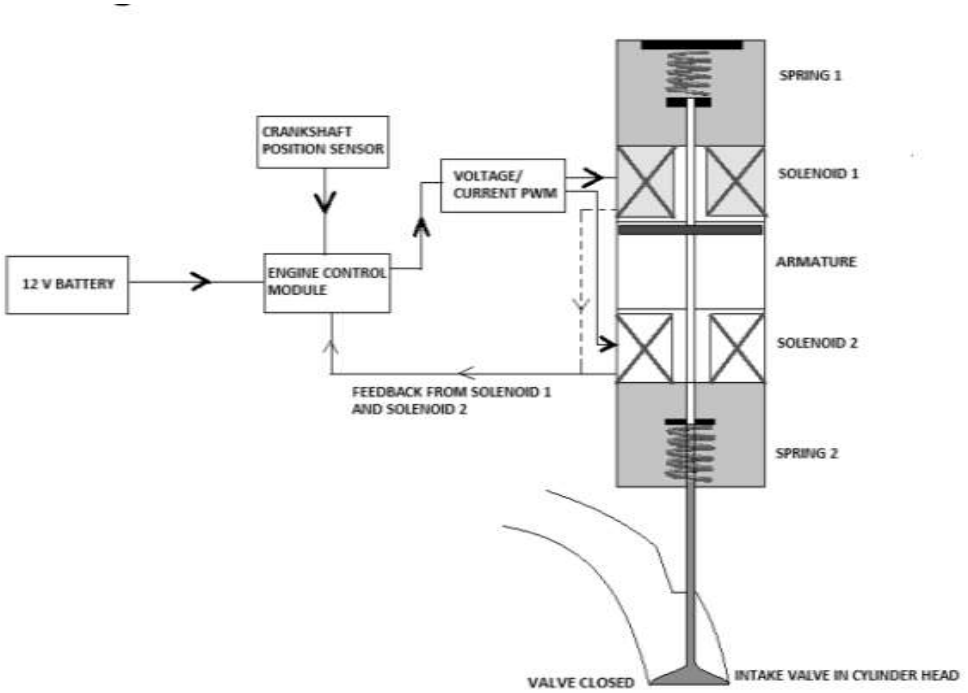
INTRODUCTION

Electromagnetic actuators are a full variable engine valve train, with the associated control law. The valve train is responsible for the gas exchange in the engine. The variable profiles, regulating the opening and the closing of the valves, help to improve the efficiency of the engine and are useful for the internal combustion engines to reach the future emissions and fuel consumption standards. Cam is an integral part of an engine as it controls valve actuation which in turn is responsible for supply of air-fuel mixture into the combustion chamber and for the removal of exhaust gases from the combustion chambers. Although a significant numbers of engine valve-actuation systems including cam-based and cam less mechanisms have been already introduced by several researches and companies, only few types of these systems (mainly cam-based) have been employed on commercial vehicles due to the liability, durability and cost issues. Cam-based valve systems offer reliable and durable functionality, the cam less valve trains can vary valve lift and more timings to a greater extent comparing to the cam-based types. Among various categories of cam less mechanisms, the electromagnetic actuator system is the most desired one. The cam less valve train is considered to be a promising solution to improve the engine performance. Most of the cam less valve trains based on reluctance force suffer the problem of high impacts at valve seating, which restricts its mass production. The difficulty for the engine valves actuators in the case of Full Cam- less engine is to cover the large range of forces and dynamics, required for operating correctly all intake and all exhaust valves. Cam less engine means that such electromagnetic valves are deployed to the complete intake and exhaust side.

WORKING

A solenoid is simply a specially designed electromagnet. A solenoid usually consists of a coil and a movable iron core called the armature. Here's how it works. When current flows through a wire, a magnetic field is set up around the wire. If we make a coil of many turns of wire, this magnetic field becomes many times stronger, flowing around the coil and through its centre in a doughnut shape. When the coil of the solenoid is energized with current, the core moves to increase the flux linkage by closing the air gap between the cores. The movable core is usually spring-loaded to allow the core to retract when the current is switched off. The force generated is approximately proportional to the square of the current and inversely proportional to the square of the length of the air gap. When an electrical current is passed through the coils windings, it behaves like an electromagnet and the plunger, which is located inside the coil, is attracted towards the centre of the coil by the magnetic flux setup within the coils body, which in turn compresses a small spring attached to one end of the plunger. The force and speed of the plungers movement is determined by the strength of the magnetic flux generated within the coil.

When the supply current is turned "OFF" (de-energised) the electromagnetic field generated previously by the coil collapses and the energy stored in the compressed spring forces the plunger back out to its original rest position. This back and forth movement of the plunger is known as the solenoids "Stroke", in other words the maximum distance the plunger can travel in either an "IN" or an "OUT" direction, Electromechanical actuators are generally made with two solenoids and two springs. the ECM receives input from the crankshaft position sensor to close the valve, which activates Solenoid 1 by taking current from the battery. The current is passed through a pulse width modulator which tunes the amplitude of the current to control the speed of valve seating. The magnetic field created by Solenoid 1 attracts the armature in the upper position. Spring 1 is compressed and thus closes the valve. Solenoid 2 pulls the armature down to open the valve



ADVANTAGES:

1) Enables the development of higher torque throughout the entire rev range which in turn improves fuel economy
2) Cylinder Deactivation can be achieved during the idling phase
3) Exhaust gas recirculation is improved
4) Reduces friction losses
5) Reduces the inertia of moving parts.

DISADVANTAGES:

1) High Cost
2) Increased power consumption
3) Air gap between the solenoids may demand a higher magnitude of current during certain Period.
4) The control strategy for valve seating velocity needs to be modified
5) Alternative designs: The armature can be eliminated and the two solenoids in the above design can be replaced with two armatures each having a current carrying coil. The remaining circuitry remains the same. The magnetic field generated in one armature is opposes the other thus retracting or elongating the spring as per the request of the ECM
6) To eliminate the camshaft, poppet valves can be replaced by electromechanical ball valves 7) Electro hydraulic valve train can also be employed to eliminate the camshaft

CONCLUSION:

A control law structure with a nonlinear feed forward and a plating strategy allow a real improvement of the convergence valve trajectory to a desired trajectory and make the actuator less sensitive to disturbances and parameter variations. The article presents an interesting approach coupling experimental measures and a simulation design. The development of the control law is based on an experimentally validated control model. The precision of the actuators and the robustness of the control law are important parameters for the integration of the actuators in the engine cylinder head. The electromagnetic actuators give the possibility to manage the engine gas exchange on a very performant way. The precision of the control law attests the controllability of the actuators technology and thus the good performances of the engine. The precise controlling of the actuators on the intake side is especially important for the regulation of the airflow in the engine and this for gasoline engine concerns directly the regulation of the engine torque. The respect of the velocity requirements during the valve landing is an important step and insures the respect of the noise criteria and the mechanical durability of the system. These results are promising for the development of the engine control law that manages the gas exchanges of the engine. Future steps of the work could be the integration of the actuators in the engine cylinder head, the integration of the electronics and the development of the control strategies for full Cam less engine.

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