A Review on Camless Engine

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Abstract— To eliminate the cam, camshaft and other connected mechanism the camless engine makes the use the three vital component the sensor the electronic control unit and the actuator, mainly five sensors are used in connection with the valve operation. The internal combustion engine is a device which basically converts the heat energy into mechanical energy. The cam has been an integral part of the IC engine from its invention. As with the demands for better fuel economy, more power, and less pollution, motor engineers around the world are pursuing a radical "camless" design that promises to deliver the internal combustion engine's biggest efficiency improvement in years. The article looks at the working of the electrohydraulic camless engine, its general features and benefits over conventional engines. In this article we focused on a basic overview of camless engine along with its design principle, components and its merits over other conventional engines.

Key words: Camshaft, Solenoid, Camless Engine, Hydraulic, Valve

I. Introduction

The cam has been an integral part of the IC engine from its invention. The cam controls the "breathing channels" of the IC engines, that is, the valves through which the fuel air mixture (in SI engines) or air (in CI engines) is supplied and exhaust driven out. Besieged by demands for better fuel economy, more power, and less pollution, motor engineers around the world are pursuing a radical "camless" design that promises to deliver the internal - combustion engine's biggest efficiency improvement in years. The aim of all this effort is liberation from a constraint that has handcuffed performance since the birth of the internal-combustion engine more than a century ago. Camless engine technology is soon to be a reality for commercial vehicles. In the camless valve train, the valve motion is controlled directly by valve actuator - there's no camshaft or connecting mechanisms. Precise electrohydraulic camless valve train controls the valve operations, opening, closing etc. The engines powering today's vehicles, whether they burn gasoline or diesel fuel, rely on a system of valves to admit fuel and air to the cylinders and let exhaust gases escape after combustion. Rotating steel camshafts with precision-machined egg-shaped lobes, or cams, are the hard-tooled "brains" of the system. They push open the valves at the proper time and guide their closure, typically through an arrangement of pushrods, rocker arms, and other hardware. Stiff springs return the valves to their closed position. In an overhead-camshaft engine, a chain or belt driven by the crankshaft turns one or two camshafts located atop the cylinder head.

A single overhead camshaft (SOHC) design uses one camshaft to move rockers that open both inlet and exhaust valves. The double overhead camshaft (DOHC), or twin-cam, setup does away with the rockers and devotes one camshaft to the inlet valves and the other to the exhaust valve. In The figure 1 basic construction of camless engine is shown.

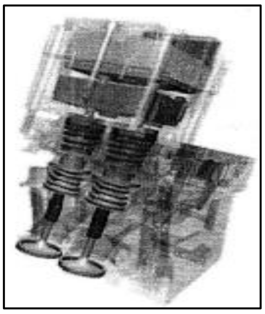


Fig. 1: Camless Engine

A. *Objectives*

1) To improve the efficiency of the engine.
2) To reduce fuel consumption.
3) To reduce the weight and volume of the engine.
4) To provide flexible valve timing
5) To improve power over existing

II. Working of Push Rod Engine

Pushrod engines have been installed in cars since the dawn of the horseless carriage. It is a rod that goes from the camshaft to the top of the cylinder head which push open the valves for the passage of fuel air mixture and exhaust gases. Each cylinder of a pushrod engine has one arm (rocker arm) that operates the valves to bring the fuel air mixture and another arm to control the valve that lets exhaust gas escape after the engine fires. There are several valve train arrangements for a pushrod.

A. *Crankshaft*

Crankshaft is the engine component from which the power is taken. It receives the power from the connecting rods in the designated sequence for onward transmission to the clutch and subsequently to the wheels. The crankshaft assembly includes the crankshaft and bearings, the flywheel, vibration damper, sprocket or gear to drive camshaft and oil seals at the front and rear.

B. *Camshaft*

The camshaft provides a means of actuating the opening and controlling the period before closing, both for the inlet as well as the exhaust valves, it also provides a drive for the ignition distributor and the mechanical fuel pump.

III. Working

When the spark plug ignites the air fuel mixture pressure quickly builds forcing the rotor to move the pressure of the combustion forces the rotor to move in the direction that makes the chamber grow in a volume. The combustion gases continue to expand moving the rotor and creating power until the peak of the rotor passes the exhaust port. Once the peak of the rotor passes the exhaust port the high pressure combustion gases are free to flow out the exhaust as the rotor continues to move the chamber starts to contract forcing the remaining exhaust out of the port. The peak of the rotor passes the intake port and the whole cycle starts again. When the crank shaft turn the cam shaft the cam lobs come up under the valve lifter and cause the lifter to move upwards. The upward push is carried by the pushrods through the rocker arm. The rocker arm is pushed by the pushrod, the other end moves down. This pushes down on the valve stem and cause it to move down thus opening the port.

Fig. 2: Single Cam & Valve

Since the timing of the engine is dependent on the shape of the cam lobes and the rotational velocity of the camshaft, engineers must make decisions early in the automobile development process that affect the engine's performance

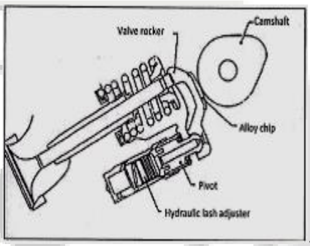


Fig. 3: Conventional Valve Train Mechanism

The resulting design represents a compromise between fuel efficiency and engine power. Since maximum efficiency and maximum power require unique timing characteristics, the cam design must compromise between the two extremes. Recognizing this compromise, automobile manufacturers have been attempting to provide vehicles capable of cylinder deactivation, variable valve timing (VVT), or variable camshaft timing (VCT). These new designs are mostly mechanical in nature. Although they do provide an increased level of sophistication, most are still limited to discrete valve timing changes over a limited range.

A. Overview

To eliminate the cam, camshaft and other connected mechanisms, the camless engine makes use of three vital components - the sensors, the electronic control unit and the actuator.

Mainly five sensors are used in connection with the valve operation. One for sensing the speed of the engine, one for sensing the load on the engine, exhaust gas sensor, valve position sensor and current sensor. The sensors will send signals to the electronic control unit. The electronic control unit consists of a microprocessor, which is provided with a software algorithm. The microprocessor issues signals to the solid-state circuitry based on this algorithm, which in turn controls the actuator, to function according to the requirements.

B. Camless Valve Train

In the past, electro hydraulic camless systems were created primarily as research tools permitting quick simulation of a wide variety of cam profiles. For example, systems with precise modulation of a hydraulic actuator position in order to btain a desired engine valve lift versus time characteristic, thus simulating the output of different camshafts. In such systems the issue of energy consumption is often unimportant. The system described here has been conceived for use in production engines. It was, therefore, very important to minimize the hydraulic energy consumption.

C. Design Approach Tor Camless Engine

The camless engine was created on the basis of an existing four-cylinder, four-valve engine. The original cylinder head with all the valves, springs, camshafts, etc. was replaced by a new cylinder head assembly fully integrated with the camless valve train. The camshaft drive was eliminated, and a belt-driven hydraulic pump was added. There was no need for lubrication, and the access for engine oil from the engine block to the cylinder head was closed off. No other changes to the engine have been made.

D. Cylinder Head

Two cross sections of the cylinder head are shown in Figure 6. The aluminum casting is within the original confines and contains all hydraulic passages connecting the system components. The high-pressure and low-pressure hydraulic reservoirs are integrated into the casting. The reservoirs and the passages occupy the upper levels of the cylinder head and are part of the hydraulic system. The hydraulic fluid is completely separated from the engine oil system. A finite element analysis was used to assure the cylinder head integrity for fluid pressures of up to 9 MPa. The lower level of the head contains the engine coolant. The engine valves, the check valves and the modifiers are completely buried in the body of the head. The solenoid valves are installed on the top of the cylinder head and are kept in their proper locations by a cylinder head cover. Hydraulic and electric connections leading to the hydraulic pump and the electronic controller, respectively, ate at the back end of the cylinder head. The height of the head assembly is approximately 50 mm lower than the height of the base engine head.

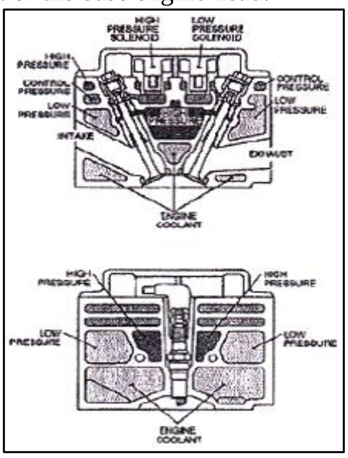


Fig. 4: Cross Section of Cylinder Head

1) AT Mega 16 Micro-Controller

It is an 8 bit high performance micro-controller of ATMELS MEGA AVER family with low power consumption. It is used on enhance reduced instruction set computing architecture With 131 powerful instruction. It has four 8 bit ports designated as port A, port B, port C, port D for internal and external uses.

2) Voltage Regulator IC

The 7805 voltage regulator employ built in current limiting, thermal shutdown, and safe opertating area protection which makes them virtually immune to damage from output overloads. 7805 is a three terminal positive voltage regulator.

Fig. 5: 7805 Voltage Regulator IC

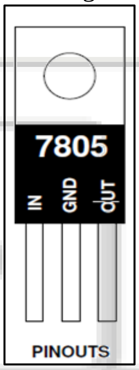


Fig. 6: Pin out Diagram of 7805 IC

3) LCD 1602ZFA

16*2 character LCD.
5*8 dots with cursor.
Built in a controller (KS0066 Or equivalent)
+5 volt power supply.

4) Sensor

A sensor is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. We have used obstacle sensor.

5) Actuator

Actuators are used to control the both intake and eshaust valve. We have used the linear actuator. An actuator is a type of motor for moving or controlling a mechanism or a system. It is operated by a source of energy and converts that energy into some kind of motion.

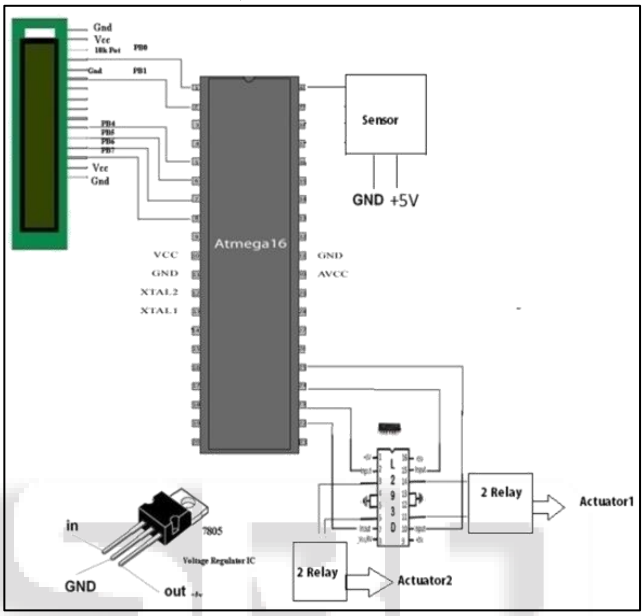
6) Component of Camless Engine

Main components of camless engine are:

1) Engine Valve
2) Solenoid Valve

7) Engine Valve

A cross section of a engine valve assembly is shown in figure 7. The valve piston is attached to the top of the valve, and both the valve and the piston can slide inside a sleeve. The sleeve opening above and below the valve piston allows the hydraulic fluid to enter and exit. A seal in lower part of sleeve prevent the leakage of fluid into the intake or exhaust port. The excess pressure on the seal is reduced by leak off (not shown in figure). The excess pressure otherwise increase the friction in the seal. There is tight hydraulic clearance between the valve and the sleeve. However the clearance between the sleeve and the cylinder head is relatively large, which improves the centering of the valve in its seat. Circulation of hydraulic fluid through the chambers above and below the valve piston cools and lubricates the valve. All the forces acting on the valve are directed along its axis. Absence of side forces reduces stresses, friction and wear.



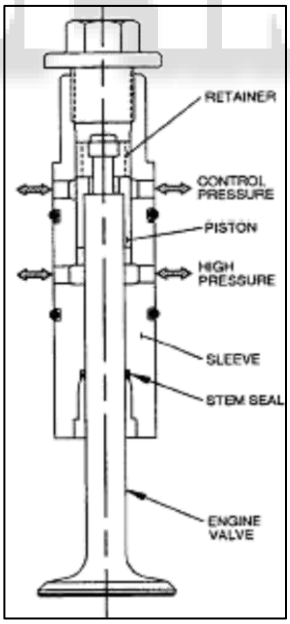


Fig. 7: Engine valve

8) Solenoid Valve

Solenoid has conically shaped magnetic poles. This reduces the air gap at the time of stroke. The normally closed valve is hydraulically balanced during its movement. Only slight unbalance exists in the fully-open and fully- closed positions. A strong spring is needed to obtain quick closing time and low leakage between activation. The hydraulic energy loss is the greatest during the closing of either the high or low pressure solenoid, because it occurs during the highest piston velocity. Thus, the faster the solenoid closure, the better the energy recovery. The valve lift and the seat diameter are selected to minimize the hydraulic loss with large volume of fluid delivered during each opening. Both high and low pressure solenoid valves are of the same design. Figure 8 shows a cross section of solenoid valve.

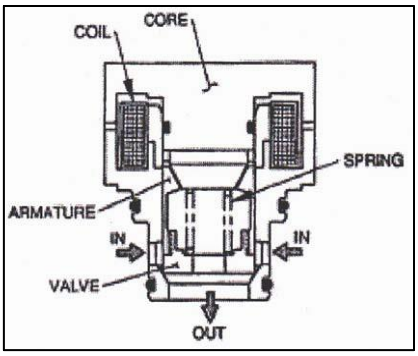


Fig. 8: Solenoid Valve

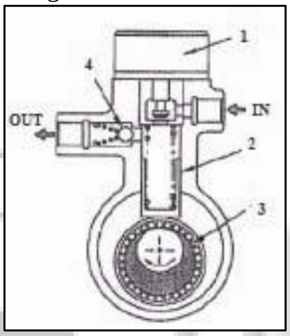


Fig. 9:

1) Solenoid valve
2) Plunger
3) Eccentric
4) Check valve

E. Advantages of Camless Engine

1) It has better fuel economy 7-10% increase.
2) High torque and power 10-15% increase.
3) Lower exhaust emission.
4) It improves ideal stability.

IV. Conclusions

1) An electro hydraulic camless valve train was developed for a camless engine. Initial development confirmed its functional ability to control the valve timing, lift, velocity, and event duration, as well as to perform selectively variable deactivation in a four-valve multi-cylinder engine.
2) The system employs the hydraulic pendulum principle, which contributes to low hydraulic energy consumption.
3) The electro hydraulic valve train is integral with the cylinder head, which lowers the head height and improves the engine packaging.
4) Review of the benefits expected from a camless engine points to substantial improvements in performance, fuel economy, and emissions over and above what is achievable in engines with camshaft-based valve trains.

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