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Camless Engine using Laser LDR Circuit

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Abstract

This Paper gives an overview about the latest camless engine designed using laser LDR circuit. Engines that are being used in today's automobile consist of a cam shaft which lifts up and closes the fuel inlet and outlet valves of the engine. Due to the inefficiency of the cam shaft to open up and close the engine fuel valves on time, it does not follow the ideal valve timing diagram and gives less output power and fuel economy then the calculated one. Lack of efficiency to open up and close the engine valves on time also result in presence of hydrocarbon and unburnt fumes in the engine exhaust. In order to overcome all these inefficiencies, a camless engine is developed in which the valves of the engine are actuated hydraulically with the help of a laser LDR Circuit. In the proposed system a laser LDR circuit is fitted over the crank shaft of the engine which senses the exact time of opening and closing of engine valve. The developed engine gives better power output and fuel economy by making the engine to follow the ideal valve timing diagram and hence eliminates all the inefficiencies of the engine by making today's automotive engines more environment friendly by producing less hydrocarbons and unburnt fumes. The newly developed camless engine can be used in any type of automobile which uses IC engine as a power unit.

Keywords: Camless Engine, Engine using Laser-LDR Circuit, Hybrid Engine, Laser Interferometer, Valve Actuation System

1. Introduction

Nowadays, the whole world is going through pollution problems. In urban areas, harmful automotive emissions are responsible for anywhere between 50 to 70 per cent of air pollution. This percentage of pollution can be reduced to a great extent by modifying the car engines so to give better fuel economy and power output.

In order to improve fuel economy and power output one of the modifications that can be done in engines is to consume or fully burn the fuel that goes in the combustion chamber of the engine. In conventional cam operated engine, valves of the engine opens or closes as per the profile of cam of the engine which led more amount of fuel to go in the combustion chamber than the necessity. This can be solved by the automation of actuation of breathing and exhaust channels of the engine in which valves can be operated either electromechanically or hydraulically thus eliminating the need of cam shaft i.e., a camless engine. Operating valves electromechanically or hydraulically led us to open and close the valve on time thus allowing appropriate amount of fuel to go in combustion chamber. Thus same power can be obtained at the less expense of air-fuel mixture which may improve the fuel economy of the vehicle.

2. Solutions Proposed

In the proposed system, poppet valves of the engine are replaced by the hydraulic actuators. These types of actuators may get signal from an Electronic Control Unit (ECU) to open and close the engine valves on time. A sensing system is also used which may send signal to the ECU at the time of opening and closing of engine valves, ECU then processes the received signal and further send appropriate signal in the form of electrical pulses to the hydraulic actuators to open and close the engine.

In the proposed design, the sensing system used is a laser light and LDR based circuit system. In this, a disc with a pin hole is attached on the crank shaft and it helps to track the orientation of the crankshaft. Hence, it helps to detect the instance at which the hole on the rotating disc comes in front of the laser beam[1]. This signal goes

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to the Electronic Control Unit (ECU) which counts the Revolutions per Minute (RPM) and helps to time the valves as per the crankshaft orientation. As the disc is outside the engine block, the laser light and LDR based circuit system used can be of low working temperature range. Therefore, reducing the cost of the system and making it possible for this technology to be used more often.

3. System Architecture and Design

The[2] device designed is an engine which uses hydraulic actuators to actuate the engine valves on time. Instances of opening and closing of valves is being determined by a sensing system which send signals to the ECU which control the instances of opening and closing of engine valves. Figure 1, gives an overview of the major parts and process of system designed.

- Laser and LDR based circuit system.
- Electronic Control Unit.
- Hydraulic actuation system.
- Common Parts of a hydraulic actuation system are as follows:
    - Hydraulic Pump.
    - Oil Reservoir.

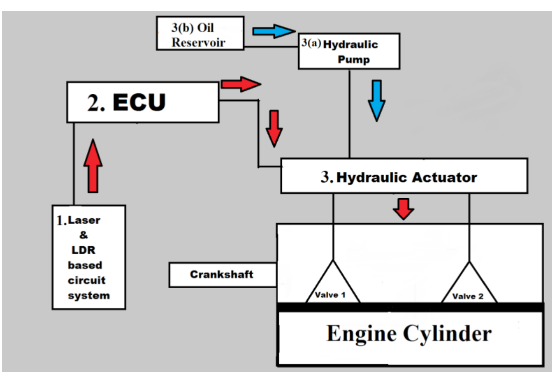

Figure 1. Block diagram of the proposed system.

4. Detailed Description of the System Designed

In the proposed engine design, Laser and LDR system is being used. This system is attached outside the engine block which senses and helps in valve actuation of the engine. Various steps involved in the working of the system are as follows:

4.1 Components of the Sensing System

4.1.1 Laser Light

In Figure 2 a laser light emitting device is used. This is fixed outside the engine block, somewhere near the crankshaft. The light is made to fall upon the disc attached on the crankshaft.

Figure 2. Laser light emitter.

4.1.2 LDR

In Figure 3 a Light-Dependent Resistor (LDR) is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. In the dark, a LDR can have a resistance of the scale of Mega Ohms (MΩ), whereas, in presence of light, it can have a resistance of the scale of few hundred ohms. If the incident light falling on the LDR exceeds a certain frequency, the photons absorbed by the semiconductor give the bound electrons energy to jump to the conduction band. Thus, the free electrons conduct electricity and reduce resistance. Thus, this phenomenon is used to detect the presence and absence of laser light.

Figure 3. Light dependent resistor.

4.1.3 Circular Disc

In Figure 4 a disc is attached on the crankshaft of the engine outside the engine block. A hole is made on the disc. As the hole comes in front of the path of the laser light, the light is allowed to pass through. This light then falls on the LDR which further sends the signal to the ECU (Electronic Control Unit).

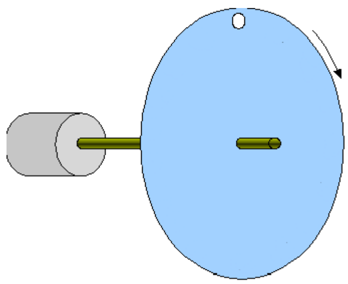

Figure 4. Circular disc.

4.2 Incorporating the Electronic Control Unit (ECU) with the Experimental Unit

In Figure 5 ECU, sometimes referred to as car's computer is a generic term used for embedded system that controls electrical system of motor vehicle. ECU like engine control module, power train control module, break control module are common types of ECUs used in the car. In[3] a normal vehicle may consist up to 80-90 ECUs. In the proposed system, as soon as the hole on the rotating disc comes in front of the laser, a signal is sent to the ECU which counts the Revolutions per Minute (RPM) and helps to time the valves as per the crankshaft orientation. Along with this, ECU also operates the opening and closing of valves and hence, ensures optimal engine performance.

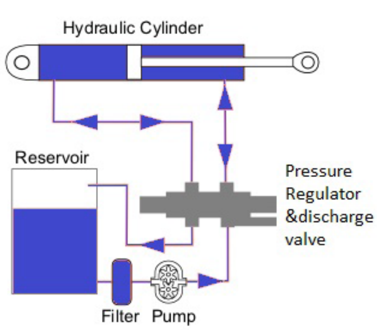

Figure 5. Hydraulic actuation system.

4.3 Incorporating the Hydraulic Actuation System with the ECU and the Engine Assembly

In our proposed system, in[4] actuation of the engine valves is done automatically using a Laser LDR based circuit which determines the instances of valve actuation and sends signals to the hydraulic actuation system which actuate the valves of engine at the required instances as per the programming of Electronic control unit.

4.3.1 Components of a Hydraulic Actuation System

- Reservoir.
- Pump.
- Pressure Regulator and discharge valves.
- Double Acting Hydraulic Cylinders.

Reservoir: It stores the required quantity of hydraulic oil which will be supplied to the system at a pressure greater than that of inside the cylinder block. Thus, energizing the engine valves connected to hydraulic cylinders.

Pump: It pumps the hydraulic oil from the reservoir to the hydraulic cylinders as well as raises the pressure of the oil to the required extent.

Pressure Regulators and discharge valves: Oil is usually supplied at very pressure from the pump to the further system at a desired valve equivalent to the pressure inside the cylinder block using a pressure regulatory discharge valves.

Double Acting Hydraulic Cylinders: The main purpose of hydraulic cylinders is to actuate the valve of engine directly. Pressurized oil from the regulatory discharge valves is supplied to the hydraulic cylinders.

As the signal from the Laser LDR based circuit fitted over the crank shaft of the engine is sent to the Electronic control Unit. It is being processed by the ECU unit and sends to the discharge valves of the hydraulic system to response and supply pressurized oil from the pump to the cylinders fitted over the valves of engine. As the pressurized oil enters the cylinder it moves the engine valves in the direction of piston rod movement and simultaneously opens and closes the valves at the required instances, according to the programming of the ECU.

5. Laser LDR Circuit Attached to Engine Shaft Acting as a Sensing System

In Figure 6, detailed drawing of the Laser LDR Circuit which is attached to engine shaft and acting as a sensing system is shown. This drawing has been drawn using the SOLIDWORKS software. The following components are shown in this figure.

- Engine Crank Shaft.
- Disc rotating along with engine shaft having a pin hole to allow laser beam to pass through it.
- Sunk key contacting above said disc to engine shaft.
- Engine casing/Body.
- LDRs connected to a stationery disc.
- Supports through which stationery disc is attached to engine body.
- Disc over which LDRs are mounted remains fixed i.e., does not along with engine shaft.
- Outside casing of the system which also supports the laser beam source.
- Laser light.
- Laser beam reaching to the LDR through a hole on disc 2.

6. The Valves Actuated through Double Acting Hydraulic Cylinders

Detailed Drawing of the valves actuated through double acting hydraulic cylinders which are energized by the hydraulic actuation system is shown in Figure 7. Its drawing is also prepared in the SOLIDWORKS software. The following components are shown in this figure.

- Piston of the engine.
- Engine Casing.
- Engine poppet valves.
- Double acting hydraulic cylinders, getting pressurized oil from the pump.
- Hydraulic cylinder inlet/outlet port no. 1.
- Hydraulic cylinder inlet/outlet port no. 2.

7. Observational Equipments to be used

To analyse the performance and other essential parameters of the engine following equipments can be used.

- Torquemeter.

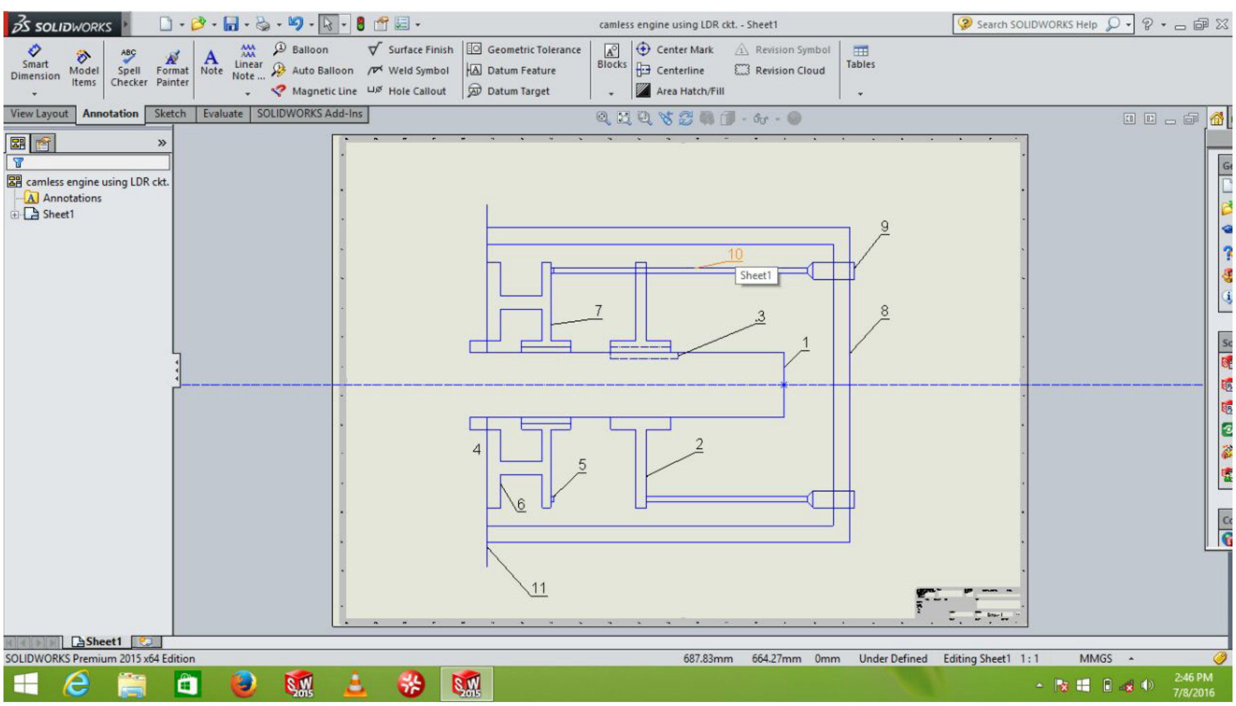

Figure 6. Drawing of the laser LDR circuit.

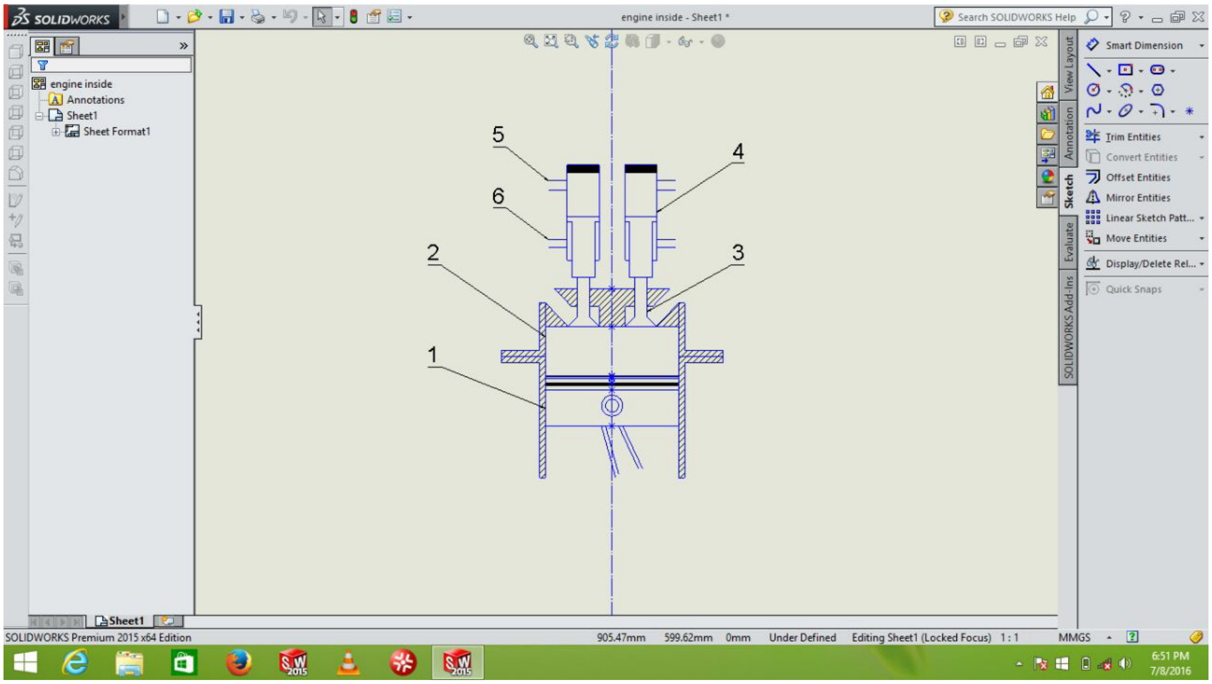

Figure 7. Drawing of the valves actuated system.

- Tachometer.
- Exhaust emission analyser.
- Fuel Flow meter.

7.1 Torquemeter

A torquemeter could be used to measure and compare the output torque of the engine developed to the conventional cam-operated engine of same capacity at a given velocity as shown in Figure 8.

Figure 8. Torquemeter.

7.2 Tachometer

A tachometer shown in Figure 9 could be used to measure and compare the output speed of the engine developed to the conventional cam-operated engine of same capacity at given torque.

Figure 9. Tachometer.

Combination of the observations by the two devices could be used to measure the output brake horse power of the engine at given speed of the engine or at a given torque value.

7.3 Exhaust Emission Analyser

An exhaust emission analyser shown in Figure 10 is used to check the quality the of the fumes and hydrocarbons coming out of the exhaust pipe of the designed engine and comparing it with the emission parameters of the conventional cam- operated engines.

Figure 10. Exhaust emission analyser.

7.4 Fuel Flow Meter

A fuel flow meter shown in Figure 11 will be used to measure and compare the amount of fuel consumed by the engine developed to the conventional cam-operated engine at same power output.

Figure 11. Fuel flow meter.

8. Proposed Outcomes of the System Designed

In[5] proposed engine design may work over ideal valve timing diagram. Thus, it gives better power output with same amount of fuel consumption along with less production of fumes and unburnt hydrocarbons for the same size of the engine. Proposed system may also be able provide better mechanical efficiency at the cost price of conventional cam-operated engines for the same size of the engine.

Valve timing diagram is shown in Figure 12 for the camless and conventional cam-operated engines will give a brief idea about the difference in the valve timing of the two engines. Thus it gives us an idea about the difference in the mechanical efficiency, pollution caused by the two engines and the difference in performance parameters of the two engines.

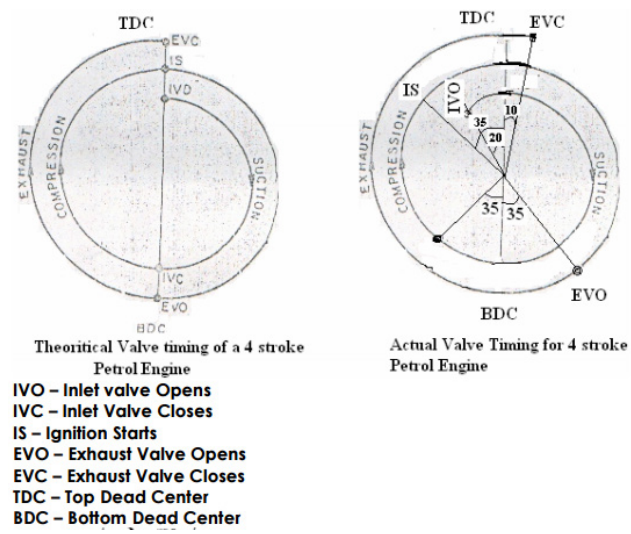

Figure 12. Valve timing diagram shown.

9. Conclusion

The designed camless engine may have better and more accurate valve actuation system than the conventional cam-operated engines. It will also reduce the global carbon footprint due to the automobile emission by the complete burning of fuel in the combustion chamber, complete burning of fuel will also help in reduction of So_2 and No_x from the environment. The proposed camless engine will also consume less amount of fuel for the production of same amount power.

Designed camless engine also provides economic benefits by reduction in consumption of fuel. Moreover, proposed engine can be easily fitted to the pre running automobiles by making appropriate changes in the conventional cam- operated engines. Manufacturing of camless engine of this type will cost almost equivalent to the cost of conventional engines.

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