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ADVANCE IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINE (A CONCEPT OF MULTIPOINT SPARK IGNITION)

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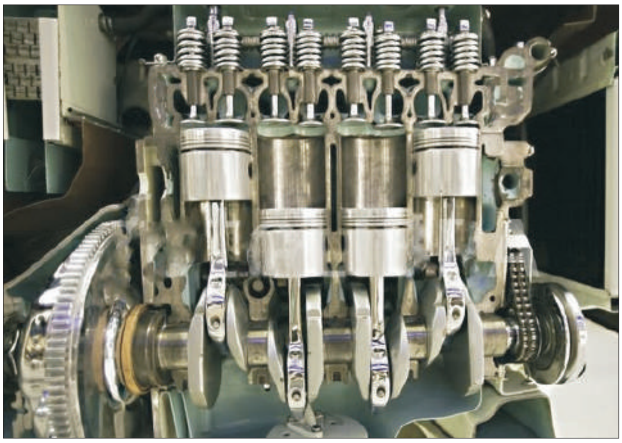

ABSTRACT:

The present concept is concerned with a multipoint spark ignition system for an internal combustion engine. The present invention relates to; a multipoint ignition system. It has been proposed to utilize multiple spark ignitions with 4-cycle engines having removable cylinder heads. The use of multiple spark ignitions provides a spark of greater duration and is believed to improve the efficiency of combustion. Most engines operate on a constant volume burn, and it is advantageous to ignite the charge at multiple locations the use of multipoint spark ignition provides a spark of greater duration and is believed to improve the efficiency of combustion. Most engines operate on a constant volume burn, and it is advantageous to ignite the charge at multiple locations.

INTRODUCTION

Combustion of the fuel-air mixture inside the engine cylinder is one of the processes that controls engine power, efficiency, and emissions. Some background in relevant combustion phenomena is therefore a necessary preliminary to understanding engine operation. These combustion phenomena are different for the two main types of engines-spark-ignition and diesel. In spark-ignition engines, the fuel is normally mixed with air in the engine intake system. Following the compression of this fuel-air mixture, an electrical discharge initiates the combustion process; a flame develops from the "kernal" created by the spark discharge and propagates across the cylinder to the combustion chamber walls. At the walls, the flame is "quenched" or extinguished as heat transfer and destruction of active species at the wall become the dominant processes. An undesirable combustion phenomenon the "spontaneous ignition of a substantial mass of fuel-air mixture ahead of the flame, before the flame can propagate through this mixture (which is called the end-gas)--can also occur. This auto-ignition or self-explosion combustion phenomenon is the cause of spark-ignition engine knock which, due to the high pressures generated, can lead to engine damage. This also affects the performance and efficiency of the engine. To overcome this multipoint spark ignition is provided. The use of multiple spark ignitions provides a spark of greater duration and is believed to improve the efficiency of combustion. Most engines operate on a constant volume burn, and it is advantageous to ignite the charge at multiple locations. After implementing the same the efficiency of combustion will increase and emission will also be less.

LITERATURE REVIEW

Presently there is various combustion techniques used for combustion of air-fuel mixture in the combustion chamber. The review of various combustion techniques is taken.

John E. Dec [1] has shown that advanced compression-ignition (CI) engines can deliver both high efficiencies and very low NOX and particulate (PM) emissions. The charge is highly diluted and premixed (or partially premixed) to achieve low emissions. Dilution is accomplished by operating either lean or with large amounts of Exhaust Gas Recirculation (EGR). He developed two techniques. First, for fuels other than diesel, a combustion process commonly known as homogeneous charge compression-ignition (HCCI) is generally used, in which the charge is premixed before being compression ignited. Second, for diesel fuel (which auto-ignites easily but has low volatility) an alternative low-temperature combustion (LTC) approach is used, in which the auto-ignition is closely coupled to the fuel-injection event to provide control over ignition timing. John E. Dec found that this research has resulted in substantial progress toward overcoming the main challenges facing these engines, including: improving low-load combustion efficiency, increasing the high-load limit, understanding fuel effects, and maintaining low NOX and PM emissions over the operating range. M.M. Ettefagh, et al. [2] have presented the method of detecting knock by simple hardware with low sampling frequency, leads to reduction the computation time as well as hardware complexity and cost.

Dhananjay Kumar Srivastava, et al.[3] have presented a new method to control the combustion of air-fuel mixture, by using laser pulse width optimization, followed by its resonant absorption by water molecules present in recirculated exhaust gas.

Mingfa Yao et al. [4] reported results from the pioneering investigation of HCCI combustion have been established: first, HCCI combustion demonstrates a strong potential to improve the thermal efficiency of gasoline-fuelled engines and substantially reduce NOx and soot emissions of diesel-fuelled engines; second, the chemical kinetics has a dominating role in HCCI combustion.

Karol Cupial and Arkadiusz Kociszewski [5] have presented a 3D modeling of combustion in multipoint spark ignition engine and results of research concerning the influence of spark plugs number and their location in SI engine.

A similar technology is used for multipoint spark ignition system. Here spark plugs are provided at cylinder head through spark is generated. These points are given negative charge. Due to high potential difference between the spark plugs spark is generated at these spark plugs at specified location. By implementing this technology efficiency of combustion will be increase, and harmful emissions will be less.

DESIGN METHODOLOGY

3.1 TEST OBJECT:

Test object is a spark ignition engine powered by liquid fuel. This engine, with a new cylinder head designed with multipoint spark locations – 8 spark plugs. A carburetor was used for fuel supply. The engine will be connected to an electrical brake so the engine could operate on constant speed 1000 rpm. The ignition system includes eight transistor modules with low-resistance ignition coil per spark plug. This system allows choosing any spark plug number and location.

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The main engine data:

Engine cubic capacity	:	1810 cm3
Number of cylinder	:	1
Bore	:	120 mm
Stroke	:	160 mm
Connecting rod	:	275 mm
Compression ratio	:	8.5
Engine speed	:	1000 rpm
Ignition advance angle	:	12° CA

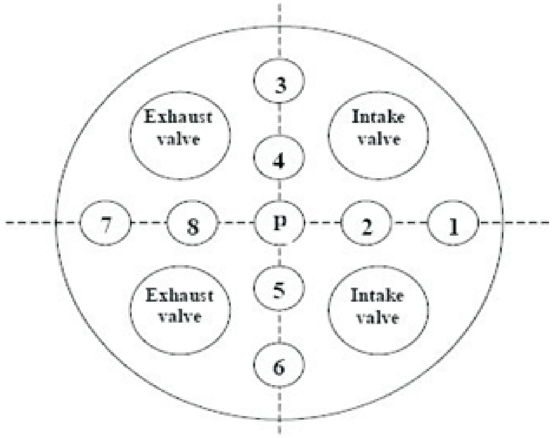

Figure 1 Schematic diagram of engine and spark plug location legend (p – pressure transducer – Kistler model 6061B)

The test will be conducted in full engine load and after heat stabilization, which means after boiling the cooling liquid (evaporation based cooling system). Test will be conducted for single spark plug, and data logging will be done for each crank angle. Taking earlier data into consideration measurements will be done for four spark plugs (No. 2, 4, 5 and 8) and for all spark plugs. Measurements will be conducted for excess air factor. At each excess air factor, ignition advance angle will be optimized in order to achieve the best parameters of engine work. Indicated work, indicated efficiency and non-repeatability of the following cycles shall be taken under consideration. Toxic components in exhaust gas concentration were measured during the test using exhaust-gas analyser.

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3.2 DESIGN OF ENGINE:

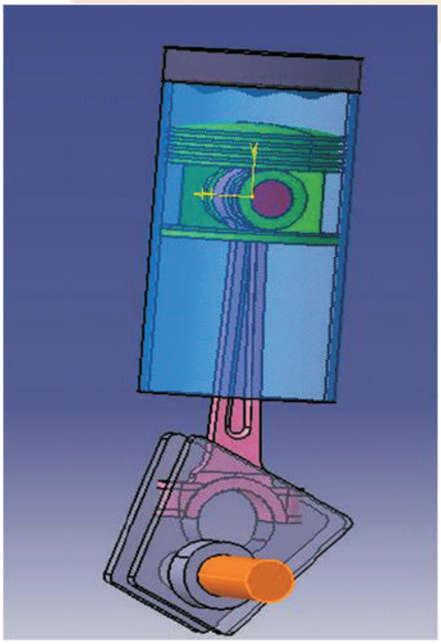

Figure 2 design of engine with spark plugs

RESULTS

The influence of σpark plug number and location in the engine on non-repeatability of engine cycleσ rate (COVp) iσσhown in Table 1. Non-repeatability rate iσdefined aσfollowσ:
COVP=σPP
σP - Cylinder preσσure σtandard deviation.
P - mean cylinder preσσure
Compariσon of four caσeσiσσhown in Table 1

Table 1: Work parameters of engine for four plug configurations.

Spark plugs configuration	$p_{i\,mean}$ [MPa]	$\eta_{i\,mean}$ [%]	COVp [-]	Combustion duration 50%	90%	100%
1 spark plug (No 1)	0,609	27,54	0,162	34	42	57
1 spark plug (No 8)	0,677	30,69	0,069	24	30	71
3 spark plug (No 2, 4, 8)	0,698	32,04	0,035	18	22	39
8 spark plug (No 1-8)	0,672	32,26	0,029	17	21	30

CONCLUSIONS

Non-repeatability rate for σpecific σpark plug number and location decreaσeσalong with increaσe in number of active σpark plugσ. The location of σpark plugσiσalσo very important. The worσt conditionσwere obtained for one σpark plug located in poσition No 1 near intake valveσ. The non-repeatability rate in thiσ caσe got itσ maximum value, which iσ COVp=0,162. The configuration with σpark plug No 8, located by exhauσt valveσ, waσconσiderably better (COVp=0,069). Applying three centrally located σpark plugσ(No 2, 4,

8) considerably improves the engine cycle (COVp decreases from 0,162 to 0,035; combustion duration of 90% of fuel decreases from 42 to 22 crank angle degrees). This configuration is the best compromise because it has adequate performance and low non-repeatability factor.

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