Digital Twin and Triple Spark Ignition in Four-Stroke Internal Combustion Engines of Two-Wheelers

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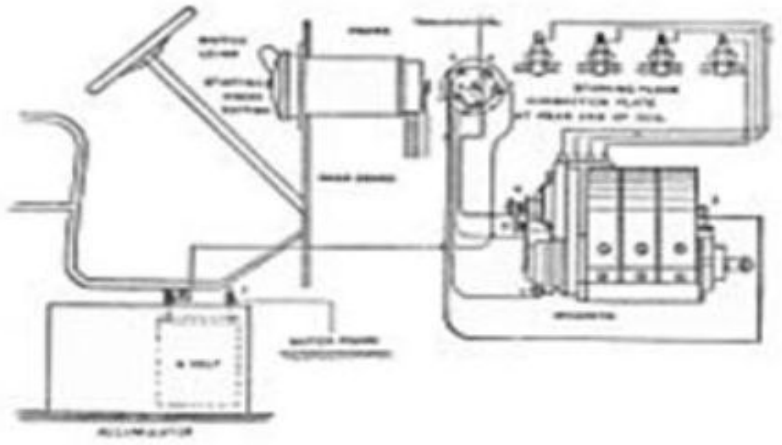
Abstract - Today it is a common trend. It has become a fashion for the people especially living in urban areas to ride such vehicles. Now the companies even want to launch such vehicles that attract the younger generation. This can be achieved by technology known as DTSi. Due to DTSi (digital twin spark ignition) system it is possible to combine strong performance and fuel efficiency. The improved engine efficiency modes have also resulted in lowered fuel consumption. The efficiency of these small engines were enhanced with increased power output just by increasing the number of fuel igniting element i.e. Spark Plug. Spark ignition is one of the most vital systems of an engine. Any variation in the spark timing and number of sparks per minute affects the engine performance severely. Thus a good design and control of the system parameters becomes most essential for optimum performance of an engine. Due to Digital Twin Spark Ignition system it is possible to combine strong performance and higher fuel efficiency. DTSi offers many advantages over conventional mechanical spark ignition system. In this paper we will get to know how mechatronics is useful in instrumentation. Conventional engines employed a single spark plug in its engine for igniting the mixture of fuel and air. But to have more effective burning of the mixture in order to increase the power output and reduce the wastage of this mixture as unburnt, the number of spark plug was doubled for efficient burning of the mixture. Two spark plugs helped in igniting the fuel from two directions rather than one, as in conventional engines. This new technology was termed as "Twin Spark Ignition System". Although this technological trend proved to be sufficient, a new well-improvised ignition system was given birth and named as "Triple Spark Technology" involving the use of three spark plugs rather than one or two.

I. INTRODUCTION

Conventional Single Spark Plug Ignited Four-Stroke Engine.



An ignition system is a system for igniting a fuel-air mixture. Ignition systems are well known in the field of internal combustion engines such as those used in petrol (gasoline) engines used to power the majority of motor vehicles, but they are also used in many other applications such as in oil-fired and gas-fired boilers, rocket engines, etc. The first ignition system to use an electric spark was probably Alessandro Volta's toy electric pistol from the 1780s. Virtually all petrol engines today use an electric spark for ignition. Magneto Ignition Coil The simplest form of spark ignition is that using a magnet. The engine spins a magnet inside a coil, or, in the earlier designs, a coil inside a fixed magnet, and also operates a contact breaker, interrupting the current and causing the voltage to be increased sufficiently to jump a small gap. The spark plugs are connected directly from the magneto output. Early magnetos had one coil, with the contact breaker (sparking plug) inside the combustion chamber. In about 1902, Bosch introduced a double-coil magneto, with a fixed sparking plug, and the contact breaker outside the cylinder. Magnetos are not used in modern cars, but because they generate their own electricity they are often found on piston-engine aircraft engines and small engines such as those found in mopeds, lawnmowers, snow blowers, chainsaws, etc. where a battery-based electrical system is not present for any combination of necessity, weight, cost, and reliability reasons. Switchable systems

The output of a magneto depends on the speed of the engine, and therefore starting can be problematic. Some magnetos include an impulse system, which spins the magnet quickly at the proper moment, making easier starting at slow cranking speeds. Some engines, such as aircraft but also the Ford Model T, used a system which relied on non rechargeable dry cells, (similar to a large flashlight battery, and which was not maintained by a charging system as on modern automobiles) to start the engine or for starting and running at low speed. The operator would manually switch the ignition over to magneto operation for high speed operation. To provide high voltage for the spark from the low voltage batteries, a 'tickler' was used, which was essentially a larger version of the once widespread electric buzzer. With this apparatus, the direct current passes through an electromagnetic coil which pulls open a pair of contact points, interrupting the current; the magnetic field collapses, the spring-loaded points close again, the circuit is reestablished, and the cycle repeats rapidly. The rapidly collapsing magnetic field, however, induces a high voltage across the coil which can only relieve itself by arcing across the contact points; while in the case of the buzzer this is a problem as it causes the points to oxidize and/or weld together, in the case of the ignition system this becomes the source of the high voltage to operate the spark plugs.

II. DTSI (DIGITAL TWIN SPARK IGNITION SYSTEM)

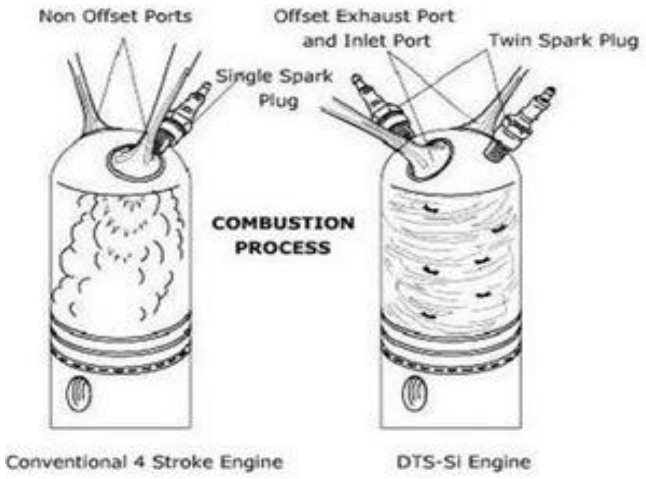
It is very interesting to know about complete combustion in automobile engineering, because in actual practice, perfect combustion is not at all possible due to various losses in the combustion chamber as well as design of the

internal combustion engine. Moreover the process of burning of the fuel is also not instantaneous. However an alternate solution to it is by making the combustion of fuel as fast as possible. This can be done by using two spark plugs which spark alternatively at a certain time interval so as increase the diameter of the flame & burn the fuel instantaneously. This system is called DTSI (Digital Twin Spark Ignition system). In this system, due to twin sparks, combustion will be complete.

This paper represents the working of digital twin spark ignition system, how twin sparks are produced at 20,000 Volts, their timings, efficiency, advantages & disadvantages, diameter of the flame, how complete combustion is possible & how to decrease smoke & exhausts from the exhaust pipe of the bike using Twin Spark System.

How Does It Work?

Digital Twin Spark ignition engine has two Spark plugs located at opposite ends of the combustion chamber and hence fast and efficient combustion is obtained. The benefits of this efficient combustion process can be felt in terms of better fuel efficiency and lower emissions. The ignition system on the Twin spark is a digital system with static spark advance and no moving parts subject to wear. It is mapped by the integrated digital electronic control box which also handles fuel injection and valve timing. It features two plugs per cylinder.



This innovative solution, also entailing a special configuration of the hemispherical combustion chambers and piston heads, ensures a fast, wide flame front when the air-fuel mixture is ignited, and therefore less ignition advance, enabling, moreover, relatively lean mixtures to be used. This technology provides a combination of the light weight and twice the power offered by two-stroke engines with a significant power boost, i.e. a considerable "power-to-weight ratio" compared to quite a few four-stroke engines.

Moreover, such a system can adjust idling speed & even cuts off fuel feed when the accelerator pedal is released, and meters the enrichment of the air-fuel mixture for cold starting and accelerating purposes; if necessary, it also prevents the upper rev limit from being exceeded. At low revs, the over boost is mostly used when overtaking, and this is why it cuts out automatically. At higher speeds the over boost will enhance full power delivery and will stay on as long as the driver exercises maximum pressure on the accelerator.

Main characteristics
• Digital electronic ignition with two plugs per cylinder and two ignition distributors.
• Twin overhead cams with camshaft timing variation.

• Injection fuel feed with integrated electronic twin spark ignition.
• A high specific power.
• Compact design and Superior balance.

Construction

Digital spark technology is currently used in Bajaj motor cycles in India, because they have the patent right. Digital twin spark ignition technology powered engine has two spark plugs. It is located at opposite sides of combustion chamber. This DTS-I technology will have greater combustion rate because of twin spark plug located around it. The engine combust fuel at double rate than normal. This enhances both engine life and fuel efficiency. It is mapped by the digital electronic control box which also handles fuel ignition and valve timing.

A microprocessor continuously senses speed and loads of the engine and respond by altering the ignition timing there by optimizing power and fuel economy.

Advantages & Disadvantages

Advantages

• Less vibrations and noise
• Long life of the engine parts such as piston rings and valve stem.
• Decrease in the specific fuel consumption
• No over heating
• Increase the Thermal Efficiency of the Engine & even bear high loads on it.
• Better starting of engine even in winter season & cold climatic conditions or at very low temperatures because of increased Compression ratio.
• Because of twin Sparks the diameter of the flame increases rapidly that would result in instantaneous burning of fuels. Thus force exerted on the piston would increase leading to better work output.

Disadvantages

• There is high NOx emission
• If one spark plug get damaged then we have to replace both
• The cost is relatively more

Applications

It uses in automotive engines. In India Bajaj has patented for dts-i technology. At present platina, xcd125, 135, discover150, pulsar135, 150, 180, 200, 220 etc. are using the dts-i(digital twin spark ignition system). Which means the petrol enters into the cylinder burns more efficiently.

Hence the application of these technologies in the present day automobiles will give the present generation what they want i.e. power bikes with fuel efficiency. Since these technologies also minimize the fuel consumption and harmful emission levels, they can also be considered as one of the solutions for increasing fuel costs and increasing effect of global warming.

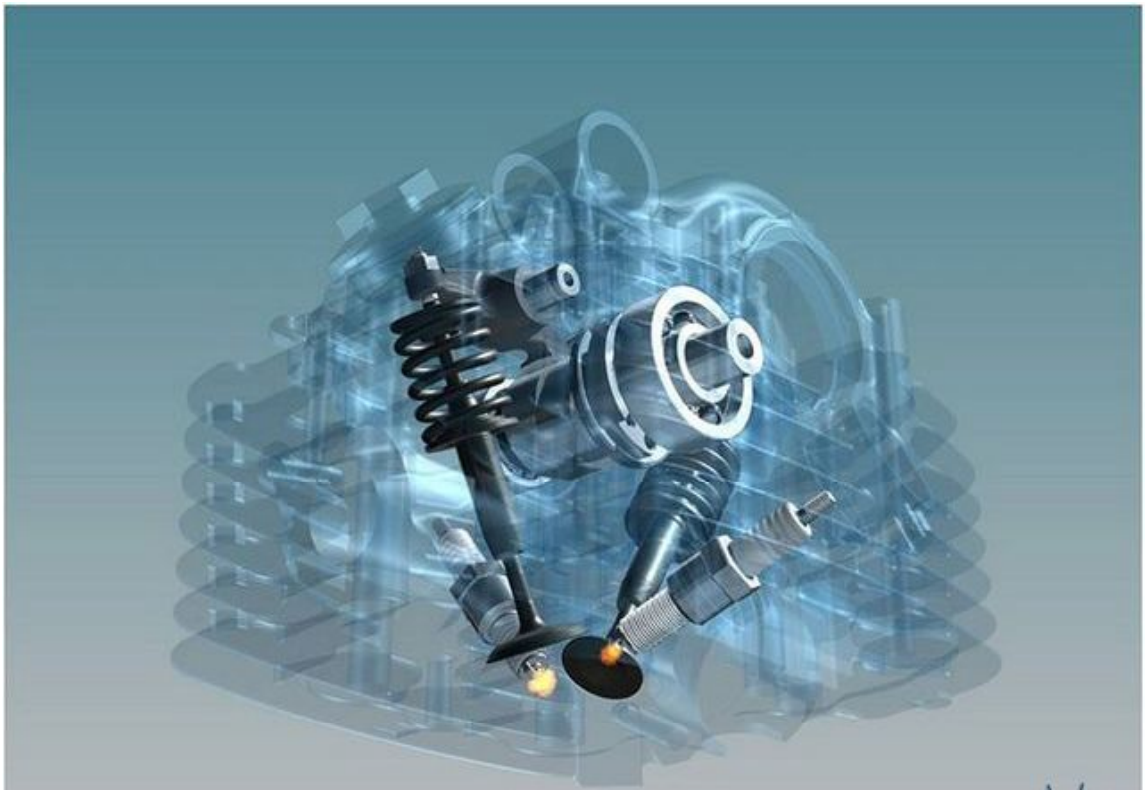
The perfect Combustion in Internal Combustion engine is not possible. So for the instantaneous burning of fuels in I.C. engine twin spark system can be used which producing twin sparks at regular interval can help to complete the combustion.

III. DIGITAL TRIPLE SPARK IGNITION

At the heart of the new Pulsar is its cutting-edge engine which sets new benchmarks in performance, emission and incidentally also fuel efficiency. The DTS-i (Digital Twin Spark-ignition) technology launched in 2003 marked a unique first in the history of Indian Motoring. The new Pulsar takes this technology altogether to another level with a SOHC 4-valve Triple Spark engine controlled by an advanced Electronic Control Unit for an absolutely unmatched performance. To support this exhilarating heart-pumping performance the bike comes with liquid cooling and a six speed gear box.

The Pulsar 200NS chassis comprises a pressed steel perimeter frame and a Rectangular tube section swing arm delivering over three times the lateral stiffness of a P220 frame. These deliver outstanding high speed handling and cornering stability. The centrally located muffler and the unique gas filled Nitrox mono suspension further improve the ride and handling of the bike due to low & centralized CG position. The Pulsar design character has evolved with the performance & dynamics. It's become stronger, more aggressive with a street fighter stance. The look just begs you to ride it. Once astride, the sporty Speedo console, triple-tree clip-ons, the signature clips and the

illuminated switches evoke the design, fit and finish so far exclusively reserved for much more expensive super sports bikes. The new 200cc Pulsar is probably the most stunning sports bike in its class oozing raw muscular appeal.



To make use of 3 spark plugs, the pulsar engine houses a pent roof combustion chamber which in turn allows housing 3 spark plugs in the engine chamber. Out of the three plugs, the primary plug is the center one and is mounted in an angle and enters the chamber at the top-center. The other two secondary plugs are mounted below, each opposite each other and one of them being vertically underneath the primary plug. The secondary plugs fires a bit after the primary one has fired and the timings are controlled by the ECU depending on various parameters like throttle position, engine revs,load on engine and many other stuffs. According to Bajaj, these plugs gain a advantage in low-rev riding condition where it extracts the best economy.

IV. CONCLUSION

Hence it can be concluded that the application of these technologies in the present day automobiles will give the present generation what they want i.e. power bikes with fuel efficiency. Since these technologies also minimize the fuel consumption and harmful emission levels, they can also be considered as one of the solutions for increasing fuel costs and increasing effect of global warming. The digital spark ignition is the best alternative for conventional ignition control. Computerized control gives accurate timing for all operating condition. At the same time use of two spark plug improves thermodynamic efficiency and power available. In case of three spark plugs the major disadvantage is more heat is produced inside the cylinder, to overcome this draw back by providing sufficient cooling system(research is going on this problem). We can hope for still better technologies, which can achieve still better results because there is no end for innovation.

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