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DIFFERENT TYPE OF IGNITION SYSTEM

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The experimental data of a comparative analysis of a spark-ignition system and a nanosecond discharge based ignition system in engines is presented. The effectiveness of the ignition systems used was evaluated on the fuel consumption and the exhaust gases composition during the road and laboratory tests. It has been discovered that using the plasma ignition system rather than a spark ignition system considerably improves the engine performance and reduces tailpipe emissions at the same time. Obtained results are analysed based on the equilibrium calculations of combustion products and on the analytical evaluation of the flame extinguishing layer width near the cylinder walls of the combustion chamber.

Keywords

Spark Ignition, Ignition Period, Combustion

Introduction

Fuel mixture of I.C. engine must be ignited in the engine cylinder at proper time for useful work. Arrangement of different components for providing such ignition at proper time in the engine cylinder is called Ignition system.

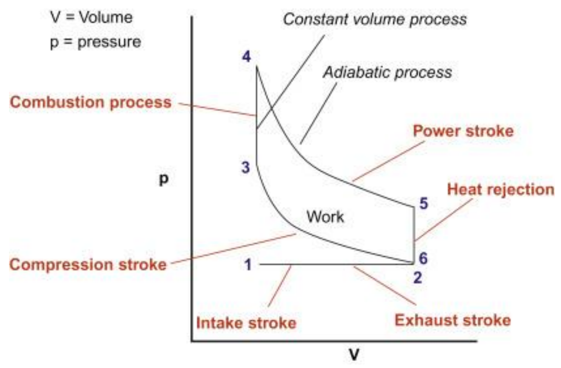
We know that in case of Internal Combustion (IC) engines, combustion of air and fuel takes place inside the engine cylinder and the products of combustion expand to produce reciprocating motion of the piston. This reciprocating motion of the piston is in turn converted into rotary motion of the crank shaft through connecting rod and crank. This rotary motion of the crank shaft is in turn used to drive the generators for generating power. We also know that there are 4-cycles of operations viz.: suction; compression; power generation and exhaust. These operations are performed either during the 2-strokes of piston or during 4-strokes of the piston and accordingly they are called as 2-stroke cycle engines and 4-stroke cycle engines.

Deferent Ignition System

1. Spark Ignition.
2. Compression Ignition.
3. Ignition by Hot Bulb.
4. Ignition by open flame.

1. Spark Ignition

The spark ignition engine exploits the Otto cycle for a four-stroke engine. Types of Reciprocating Engine but the various stages will be examined in greater detail here. The four stages or strokes of the cycle . These comprise an intake stroke when a fuel–air mixture is drawn into the engine, a compression stroke when the mixture is compressed, a power stroke when the mixture is ignited and expands and an exhaust stroke when the combustion gases are expelled from the cylinder. There are a number of commonly used technical terms associated with this cycle. The stroke of the engine is the distance the piston moves from the top of the cylinder to the bottom of the cylinder. This is twice the distance between the centre of the crankshaft and the centre of the bearing attaching the connecting rod to the crankshaft. The position when the piston is at the top of its stroke is called top dead centre (TDC) and the position at the bottom of the stroke is called bottom dead centre (BDC). Since the force developed in the piston during the power stroke is applied to the shaft through the arm as a rotational moment, at both TDC and BDC there is no rotational moment about the crankshaft. On the other hand, the rotational moment will be greatest midway between TDC and BDC. The volume within the cylinder is at its minimum when the piston is at TDC. It is at its maximum when the piston is at BDC. The engine displacement, normally referred to as the size of the engine, is the difference in volume between TDC and BDC. For a multi-cylinder engine, the volume of all the cylinders is added together to give the total engine size. The spark ignition engine is a heat engine which means that is converts heat energy into a mechanical output, or in thermodynamic terms, into work. The actual engine cycle is complex to analyse but it can be simplified or idealised.



Ideal thermodynamic pressure–volume diagram for the Otto cycle.

A thermodynamic schematic of the ideal Otto cycle pressure–volume diagram is shown in Fig. This can be used to determine the efficiency of the engine. The analysis essentially ignores the intake and exhaust strokes of the engine. These involve either drawing air/fuel into the cylinder or expelling the combustion products. In both cases, a valve is open so and the gas in the cylinder is drawn in or expelled at constant pressure and it is assumed that during these stokes no energy is either produced or used. Only the volume within the cylinder changes. These strokes are represented between points 1 and 2. The two remaining strokes define the engine. The first is a compression stroke, 2–3 in the diagram, in which the fuel–air mixture is compressed. This reduces its volume, increases its pressure and increases the temperature because the temperature of a gas rises when it is compressed. At the end of the compression stroke the fuel is ignited and the chemical reaction that takes place releases large amounts of heat. This is considered, in the idealised cycle, to take place instantaneously while the volume within the cylinder does not change. However the pressure of the gases rises dramatically (3–4). The hot, high-pressure gases then force the piston away, expanding the volume within the cylinder as the pressure drops (4–5). At the end of this stroke the exhaust valve is opened and any excess heat and pressure is released (5–6). This is considered in the ideal case to be another instantaneous process. Finally, the exhaust stroke takes place (2–1) while the combustion gases are expelled at constant pressure. In this ideal form, there are two phases in which the both volume and pressure change. The compression stroke is the first and during this work is done on the gas to compress it and so energy is expanded. The second phase is the power stroke in which the expanding gases force the piston to move. This generates power. Mathematically, the net amount of useful work that the engine provides is that generated in the power stroke minus that used during the compression stroke. It is represented graphically by the area within the cycle diagram in Fig.

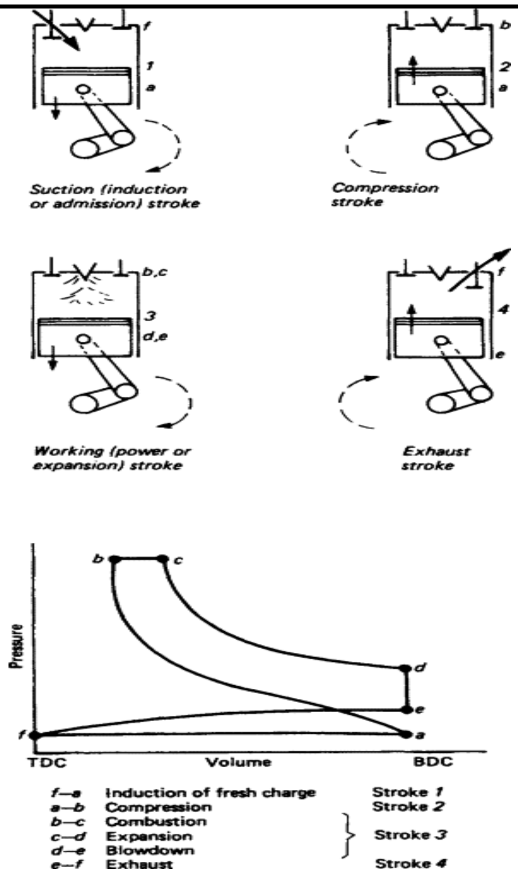


Fig. Four-stroke cycle

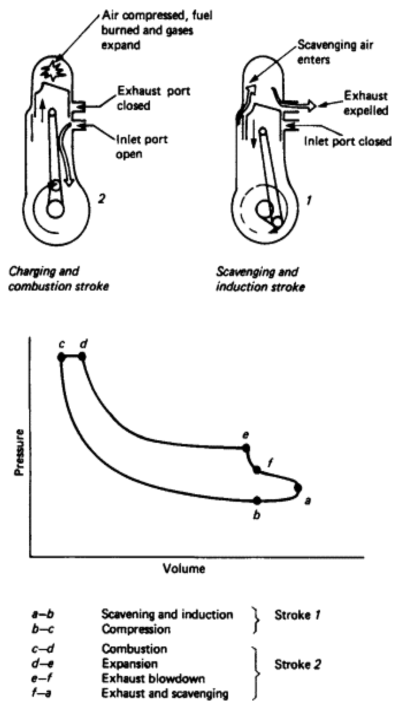


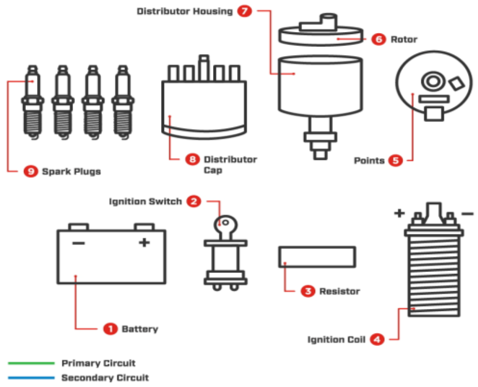
Fig. Two-stroke cycle (valveless form)

There are two methods in spark ignition:

(a) Battery ignition

(b) Magneto ignition

(a) Battery ignition



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The low-voltage circuit consists of:

(a) Battery

(b) Ignition switch

(c) A series register

(d) Primary winding and

(e) Contact breaker

The high voltage circuit consists of:

(a) Secondary winding

(b) Distributor rotor

(c) High voltage wiring and

(d) Spark plugs

If the contact breaker points are closed, when the ignition switch is closed, current flows from the battery through the ignition coil's primary winding. A magnetic field is created around the coil by them. The contact breaker point opens as the piston reaches the conclusion of the compression stroke.
The high-voltage surge is delivered to the centre terminal of the distributor cap where it is picked up by the rotor and directed to the proper spark plug. A spark jumps the plug gap and ignites the compressed air-fuel mixture. This increases the voltage across the secondary winding terminals to a value of 20 to 24 thousand volts.

(b) Magneto Ignition:

Magneto ignition is similar to battery ignition, but the primary current is produced by magneto and not by battery. Magneto may be considered as combination of a generator for producing low voltage current and an ignition coil for producing high voltage current.

Main Components of Magneto Ignition System:

(i) Frame

(ii) Permanent magnet

(iii) Armature

(iv) Soft iron field

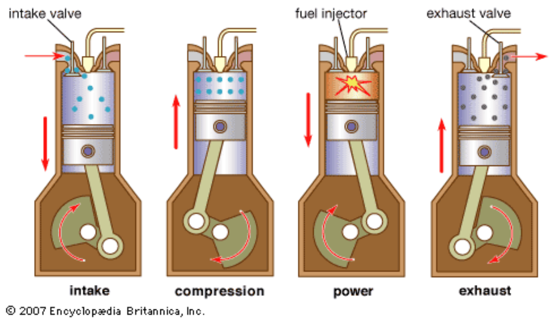
(v) Rotor

(vi) Primary and secondary winding

(vii) Breaker points and

(viii) Condenser.

2. Compression Ignition.



In a compression ignition engine only air or air plus residual combustion gases from the exhaust known as exhaust gas recirculation (EGR) is inducted into the chamber during the intake stroke, and compressed during the compression stroke. Near TDC of the compression stroke, fuel is injected directly into the cylinder using a high-pressure fuel injector. This fuel must then mix with the compressed, heated, air, and residuals already in the chamber to a combustible limit and a portion of the fuel–air mixture subsequently auto ignites. The time between the injection of the fuel and ignition of the first fuel is referred to as the ignition delay. After ignition a portion of the fuel burns in a premixed mode combustion mode with the remainder of the fuel combusting in a diffusion combustion mode. CI engines can run at higher compression ratios since they are based on the auto ignition principle and are not limited by the premixed fuel–air combustion knock in SI engines. CI engines achieve higher efficiencies than SI engines, peaking around 45% (US DOE, 2010). Load is controlled in a CI engine by the amount of fuel injected limited by the amount of charge gas oxygen. CI diesel engines combust fuel in a locally stoichiometric rich zone, but globally lean (excess air), which provides efficiency improvements. Compression ignition engines are typically fuelled with diesel fuel. Phased in from 2006 to 2010 in the US, diesel for on highway use has to have a low sulphur content (EPA, 2006) to reduce particulate emissions and enable use of advanced lean after treatment devices to reduce oxides of nitrogen to meet emissions standards. Compression ignition fuels are characterized by their certain number with the higher the certain number the lower the auto ignition temperature and shorter ignition delay. Alternative CI engine fuels include biodiesel, which is composed of methyl esters and produced from vegetable oils and animal fats, green diesel produced in many different ways, and their blends, all with different advantages and disadvantages. Dimethyl ether (DME) is also an excellent diesel fuel with Volvo currently in an extended evaluation and development program for its trucks. Additional details of fuels are discussed in Section.

The compression ignition engine operating on liquid fuels, or in the dual-fuel mode, works on the principle of fuel being injected into a charge of compressed air and spontaneously ignited by the high temperature of the induced air by the heat of compression. The process converts the heat energy of the fuel into mechanical work.
The two basic working cycles are four-stroke and two-stroke. These are represented diagrammatically in *Figures* together with the appropriate indicator diagrams, which portray the events within the engine cylinder during each cycle.

In the two-stroke engine the working stroke occurs in each revolution of the crankshaft, whereas in the four-stroke engine it occurs once in every two revolutions. It does not follow that, because the two-stroke engine has twice as many power strokes as the four-cycle engine it will produce twice the power. The down stroke of the two-cycle engine combines both power and exhaust strokes. As the intake and exhaust ports are cleared by the piston some mixing of fresh air charge and burned gases takes place (scavenging). Not all the burned gases are exhausted, which prevents a larger fresh charge of air being induced into the cylinder. The resulting power stroke has, therefore, less thrust.

In the four-stroke engine, however, nearly all the burned gases are forced out of the combustion chamber by the up-stroking piston. This allows almost a full air/fuel mixture to enter the cylinder since a complete piston stroke is devoted to induction of the mixture. The power stroke therefore produces relatively more power than its two-cycle counterpart.

Whereas a spark-ignition engine draws a fuel–air mixture into the cylinder during the first stroke of the four-stroke cycle, in a diesel engine only air is admitted at this stage. This air is then compressed much more highly during the succeeding compression stroke than would be the case with a spark-ignition engine, with compression ratios of up to 25:1 typical. When air is compressed adiabatically in this way (just like the air being compressed in a bicycle pump), the compression generates heat so that the air becomes much hotter. In the diesel engine the compression ratio is chosen so that the air temperature rises so high that it is above the ignition temperature of the fuel, in this case diesel. Fuel is admitted into the chamber under pressure towards the top of the compression stroke, when it then ignites spontaneously.

The temperature inside the cylinder of a diesel engine during ignition rises much higher than the temperature in a spark-ignition engine. As a consequence, the production of NO_x is much higher. Typical levels are 450–1800 ppmV or 10 times higher than for the equivalent spark-ignition engine (see Table, but note that as shown in Table 5.4 they can rise even higher). Diesel engines therefore require extensive emission control systems if they are to comply with air-quality regulations, particularly when the units are operating in an urban environment. Against this, diesel engines are capable of burning biodiesel, a carbon dioxide–emission neutral fuel. This can be attractive in some situations.

High- and medium-speed diesel engine	450–1800
Spark-ignition natural gas engine	45–150

Table:-Emissions of Nitrogen Oxides From Internal Combustion Engines

Emission	Emission Range
Nitrogen oxides	50–2500 ppmV
Carbon monoxide	5–1500 ppmV
Particulate matter	0.1–0.25 g/m^3
VOC	20–400 ppmV
Sulphur dioxide	10–150 ppmV

Table:- Range of Emissions From Diesel Engines

3. Ignition by Hot Bulb.

The hot-bulb engine shares its basic layout with nearly all other internal combustion engines, in that it has a piston, inside a cylinder, connected to a flywheel by a connecting rod and crankshaft. Akroyd-Stuart's original engine operated on the four-stroke cycle (induction, compression, power and exhaust), and Hornsby continued to build engines to this design, as did several other British manufacturers such as Blackstone and Crossley. Manufacturers in Europe, Scandinavia and in the United States built engines working on the two-stroke cycle with crankcase scavenging. The latter type formed the majority of hot-bulb engine production. The flow of gases through the engine is controlled by valves in four-stroke engines, and by the piston covering and uncovering ports in the cylinder wall in two-strokes.

In the hot bulb engine, combustion takes place in a separated combustion chamber, the "vaporizer" (also called the "hot bulb"), usually mounted on the cylinder head, into which fuel is sprayed. It is connected to the cylinder by a narrow passage and is heated by combustion gases while running; an external flame, such as a blow torch or slow-burning wick, is used for starting; on later models, electric heating or pyrotechnics were sometimes used. Another method was the inclusion of a spark plug and vibrator-coil ignition; the engine would be started on petrol (gasoline) and switched over to oil after warming to running temperature.

The pre-heating time depends on the engine design, the type of heating used and the ambient temperature, but for most engines in a temperate climate generally ranges from 2–5 minutes to as much as half an hour if operating in extreme cold or the engine is especially large. The engine is then turned over, usually by hand, but sometimes by compressed air or an electric motor.

Once the engine is running, the heat of compression and ignition maintains the hot bulb at the necessary temperature, and the blow-lamp or other heat source can be removed. Thereafter, the engine requires no external heat and requires only a supply of air, fuel oil and lubricating oil to run. However, under low power the bulb could cool off too much, and a throttle can cut down the cold fresh air supply. Also, as the engine's load is increased, so does the temperature of the bulb, causing the ignition period to advance; to counteract pre-ignition, water is dripped into the air intake. Equally, if the load on the engine is low, combustion temperatures may not be sufficient to maintain the temperature of the hot bulb. Many hot-bulb engines cannot be run off-load without auxiliary heating for this reason.

The fact that the engine can be left unattended for long periods while running made hot-bulb engines a popular choice for applications requiring a steady power output such as farm tractors, generators, pumps and canal boat propulsion.

In hot bulb method, there is a bulb in place of a tube. When this bolt is heated by some external source, it causes ignition of fuel in the engine cylinder. It is not a common method used in modern days.

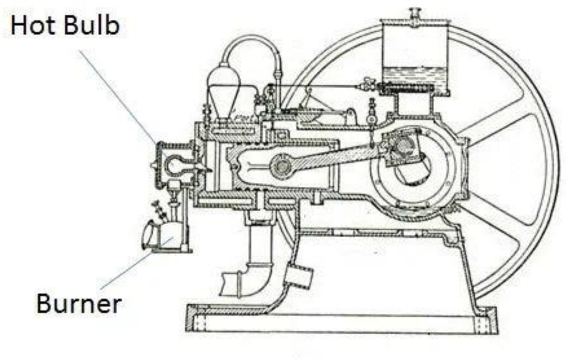


Fig. Ignition by Hot Bulb

4. Ignition by Open Flam

Flame ignition was an early attempt to produce an internal combustion engine. It is not the same as a flame licker, which uses vacuum to create power. Engines suck a fuel/air mixture into the combustion chamber through a slide-gated port. Pressure generated by the ignited charge drives the piston in a power stroke.

Most of these engines used hydrogen, but a few used acetylene or illuminating gas for fuel, such as in the Otto-Lange and Paradox models.

Literature Review

This review has focused on recent developments in ignition systems for engines. High compression, lean burn technology may require higher energy and possibly enhanced ignition systems to improve fuel efficiency and reduce carbon emissions. There are several short term and long term possibilities. The short term could use multiple spark plugs with conventional coils or breakdown (short duration, high power) systems. There are many possible replacements for conventional ignition systems, and each of them has its own advantages and disadvantages. For the long term, it is suggested that more work be done on understanding the chemical kinetics of ignition processes which might lead to new concepts in ignition. Most of the alternative spark systems have potential for high ignition energy when compared to the ignition systems which presently dominate the field. This higher energy is advantageous for engines running on very lean mixture avoiding the poor ignition reliability and irregularity. Let this additional energy ensure better ignition of present engines leading to greater engine efficiency, greater fuel economy and less exhaust emissions that dominate the roads.

Conclusion

In all ignition engines, the combustion process is initiated by a spark or compress or heat between the piston cylinder. This occurs just before the end of compression stroke. Ignition is only a
pre-requisite of combustion. In this unit, we have learnt in detail the different types of
ignition systems. The difference between battery and magneto ignition systems lies only in the source of electrical energy. Battery ignition system uses a battery, magneto ignition system uses a magneto to supply low voltages all other system components in SI engine being similar.
The order or sequence in which the firing takes place, in different cylinders of a multi-cylinder engine is called firing order.

Reference

1) J.W.G. Turner, S.W. Bredda, in Internal Combustion Engines
2) B. Ashok, R. Vignesh, in Automotive Internal Combustion Engines, 2022
3) Sachin Thorat in Automobile Engineering
4) MA Laughton M A BASC, PhD, DSc(Eng), FIEE, FEng, LLJ Mahon CEng, FIEE, FIQA, FIBM, in Electrical Engineer's Reference Book (Sixteenth Edition), 2003
5) J.D. Naber, J.E. Johnson, in Alternative Fuels and Advanced Vehicle Technologies for Improved Environmental Performance, 2014
6) Ignition System in an I.C. Engine by Binita Shah.
7) Jubin V Jose , Doctoral Research scholar, Automotive Lab (National center for combustion research & development or NCCRD) & IC Engines Lab, IIT Madras.
8) A text book of Automobile Engineering by Dr. Kirpal Singh.
9) A text book of Automobile Engineering by Er. Sandy khaple.
10) A text book of Internal Combustion Engine by M.L. Mathur.