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A Review Paper on the Study of 4-Stroke Solenoid Engine

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Abstract: In this, we study a solenoid engine which drives the engine with the help of the solenoid actuator in place of combustion of fuel as such in internal combustion engine and electric motor in electric vehicle. Basically this engine works on the principle of electro-magnetism. With the help of electromagnetism principle we have decided to drive the engine and provide an alternative to electric motor in electric vehicle to compensate its various losses and avoid drainage of battery with a quick rate. It works like a normal fuel engine but now power source is battery with is totally pollution free and eco-friendly.

Keywords: Solenoid actuator, Electromagnetic engine, Crankshaft.

Introduction:

An Engine or motor is a machine designed to convert one form of energy into mechanical energy. Heat engines burn fuel to create heat, which is then used to create a force. Electric motors convert electrical energy into mechanical energy.

Heat engine: A heat engine may also serve as a prime mover-a component that transforms the flow or changes in pressure of a fluid into mechanical energy. An automobile powered by an internal combustion engine may make use of various motors and pumps, but ultimately all such devices derive their power from the engine. Another way of looking at it is that a motor receives power from an external source, and then converts it into mechanical energy, while an engine creates power from pressure (derived directly from the explosive force of combustion or other chemical reaction, or secondarily from the action of some such force on other substances such as air, water, or steam.

But the use of this engine typically has a negative impact upon air quality and ambient sound levels. There has been a growing emphasis on the pollution producing features of automotive power systems. Exhaust from a spark ignition engine consists of the following: nitrogen 70 to 75% (by volume), water vapour 10 to 12%, carbon dioxide 10 to 13.5%, hydrogen 0.5 to 2%, oxygen 0.2 to 2%, carbon monoxide: 0.1 to 6%, unburnt hydrocarbons and partial oxidation products (e.g. aldehydes) 0.5 to 1%, nitrogen monoxide 0.01 to 0.4%, nitrous oxide<100 ppm, sulphur dioxide 15 to 60 ppm, traces of other compounds such as fuel additives and lubricants, also halogen and metallic compounds, and other particles. Carbon monoxide is highly toxic, and can cause carbon monoxide poisoning, so it is important to avoid any build-up of the gas in a confined space. Catalytic converters can reduce toxic emissions, but not completely eliminate them. Also, resulting greenhouse gas emissions, chiefly carbon dioxide, from the widespread use of engines in the modern industrialized world is contributing to the global greenhouse effect – a primary concern regarding global warming.

Electric Vehicle: An electric vehicle (EV), also referred to as an electric drive vehicle, uses one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery, solar panels or a generator to convert fuel to electricity. EVs include road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft. An electric motor uses electrical energy to produce mechanical energy, usually through the interaction of magnetic fields and current-carrying conductors. The reverse process, producing electrical energy from mechanical energy, is accomplished by a generator or dynamo. Traction motors used on vehicles often perform both tasks. Electric motors can be run as generators and vice versa, although this is not always practical. Electric motors are ubiquitous, being found in applications as diverse as industrial fans, blowers and pumps, machine tools, household appliances, power tools, and disk drives. They may be powered by direct current (for example a battery powered portable device or motor vehicle), or by alternating current from a central electrical distribution grid. The smallest motors may be found in electric wristwatches. Medium-size motors of highly standardized dimensions and characteristics provide convenient mechanical power for industrial uses. The very largest electric motors are used for propulsion of large ships, and for such purposes as pipeline compressors, with ratings in the thousands of kilowatts. Electric motors may be classified by the source of electric power, by their internal construction, and by their application.

Hybrid Electric Vehicles: The hybrid vehicle (HV) is powered by both a gasoline engine and electric motor. The HV runs using power from an internal combustion engine and electric motor. The engine provides most of the vehicle's power, and the electric motor provides additional power when needed, such as accelerating and passing. The hybrid vehicle operates on a gasoline and electric energy principle. A hybrid car features a small fuel-efficient gas engine combined with an electric motor that assists the engine when accelerating. The electric motor is powered by batteries that recharge automatically while you drive. Five main parts make up the hybrid vehicle: the battery, internal combustion engine (ICE), generator, and power split device, and electric motor. But some disadvantages of electrical vehicles are-

- Limited in the distance that can be driven before the complete drainage of the battery.
- Accessories, such as air conditioning and radios drain the battery.
- Weight of the vehicle increases due to electric motors, batteries, controller etc.
- Cost increases as the parts are costly.

Comparison between I.C. Engine, Electric Vehicle and Hybrid Vehicle:

Table1.1 Comparison between I.C, EV and HV

	Internal Combustion Engine	**Electric Vehicle**	**Hybrid Vehicle**
Efficiency	Converts 20% of the energy stored in gasoline to power the	Converts 40% of the energy stored in gasoline to	Converts 75% of chemical energy from the batteries to power the wheels.

	vehicle.	power vehicle.	
Speed (average top speed)	124 miles per hour	110 miles per hour	30-95 mph
Acceleration (average)	0-60 mph in 8.4 seconds	0-60 mph in 6-7 seconds	0-60 mph in 4-5 seconds
Maintenance	• Wheel • Engine • Fuel/gas • Bodywork/paint • Electrical • Lights	Same as internal combustion engine.	Doesn't require as much maintenance because it does not use a gasoline engine. No requirements to take it to Department of Environmental Quality for an emissions inspection.
Mileage	Can go over 300 miles before refuelling. Typically get 19.8 gallons per mile.	Typically get 48 to 60 mpg.	Can only go 100 to 200 miles before recharging.

Solenoid Engine: In our project we have decided to create a solenoid engine which drives the engine with the help of the solenoid actuator in place of combustion of fuel as such in internal combustion engine and electric motor in electric vehicle.

Basically our project is based on the principle of electro-magnetism. With the help of electromagnetism principle we have decided to drive the engine and provide an alternative to electric motor in electric vehicle to compensate its various losses and avoid drainage of battery with a quick rate.

A solenoid is a coil wound into a tightly packed helix. The term solenoid basically refers to a long, thin loop of wire often wrapped around a metallic core which produces a magnetic field when an electric current is passed through it. Solenoids are important because they can create controlled magnetic fields and can be used as electromagnets. The term solenoid refers specifically to a magnet designed to produce a uniform magnetic field in a volume of space (where some experiment might be carried out).

In engineering, the term solenoid may also refer to a variety of transducer devices that convert energy into linear motion. The term is also used to refer to a solenoid valve, which is an integrated device containing an electromechanical solenoid which actuates either a pneumatic or hydraulic valve or a solenoid switch, which is specific type of relay that internally uses an electromechanical solenoid to operate an electric switch; for example,

an automobile starter solenoid. The solenoid coil engine is like a normal internal combustion engine. Here the crankshaft is driven by the use of solenoid coils instead of burning of fuel.

Solenoid pulls the crankshaft or convert its reciprocating motion into rotary motion of the crankshaft while current passing through it. A solenoid actuator is responsible for 90^{o} rotation; hence 4 solenoid actuators are used to complete a cycle of 360^{o}.

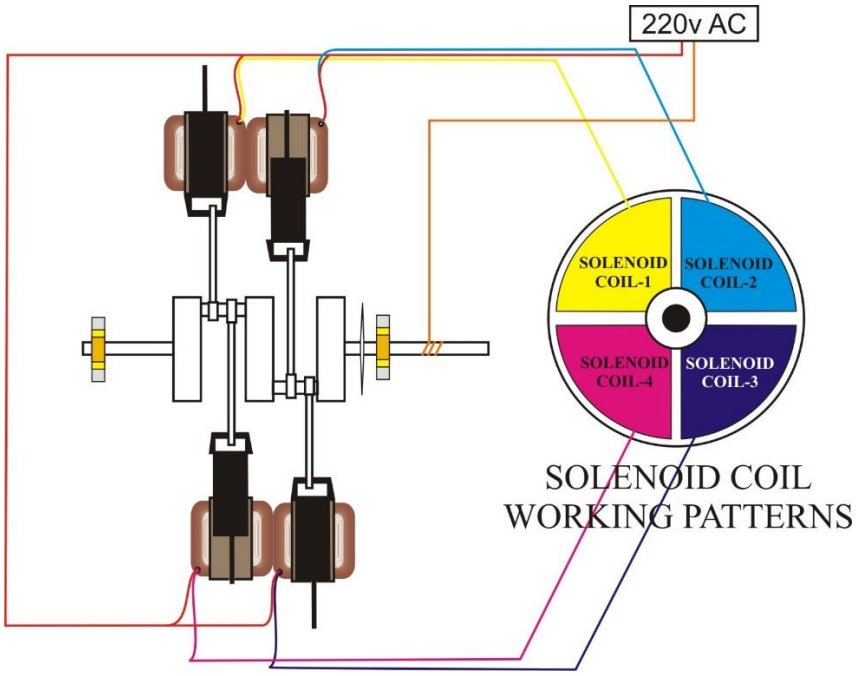

Fig.1. Schematic Diagram of 4-Stroke Solenoid Engine

As a result of extensive literature survey we have reached the condition that a number of works has been done in the field of design, development and fabrication of various solenoid engines. Some of the important works are:

Electric Vehicle with zero-fuel Electromagnetic Automobile Engine (2013) By- J. Rithula, J. Jeyashruthi and Y. Anandhi

The main aim of the project is to design an electromagnetically reciprocating automobile engine. A four-stroke engine is used in the vehicle. The design involves the replacement of the spark plugs and valves by conductors and strong electromagnetic material. The piston is a movable permanent magnet and while an air core electromagnet is fixed at the top of the cylinder. When the electromagnet is excited by A.C. (square wave) supply, for same polarities these magnets will repel and for opposite polarities they will attract, thus causing to and fro movement of the piston. So when cylinder of the four-stroke engine experiences attraction of magnets due to which the piston moves upwards, repulsion takes place inside cylinder in which the piston moves downwards and then during the next stroke vice-versa occurs. The to and fro movement of the piston is converted into a rotary motion by the crankshaft, which in turn is coupled to the wheels which causes the wheel to rotate. So with the help of electromagnets & permanent magnets, the to and fro movement of the piston is obtained using the alternating

attractive and repulsive force of the magnets, which is responsible for the movement of the vehicle. Thus we can run the electric vehicle without a motor and the energy is extracted in a clean way as it does not require fuels, reducing the air pollution.

An Electromagnetic Mechanism which works like an Engine (2013) By- Shirsendu Das

Engine is the main power source of automobiles where combustion takes place and produces heat which converts into mechanical energy. We know internal combustion engines are used in automobiles, aeroplanes etc. but the incomplete combustion produces some harmful gases, which is one main cause of air pollution. Modern science and technology has taken many positive steps for emission control. Like, using CNG and LPG's instead of petrol and diesel. Now technology brings electrical bikes, scooters and cars. The battery of electrical vehicle can charge easily like mobile. They have less running cost and 100% emission free. But they have very less load carrying capacity and not suitable for long run. So basically we have to prefer engines for more power and more running capacity. Here, introduction of a mechanism which has more load carrying capacity and running capacity than electrical vehicles and makes zero emission or pollution has been done.

Like conventional engines this system also has a cylinder, piston (without piston rings), connecting rod, and crankshaft. There is no inlet and exhaust valve or ports and no spark plug also. In this system two solenoids will be used one at top dead centre and other at the bottom dead centre. As we know solenoid behaves like a magnet when electricity is supplied to it. So these two solenoids will reciprocate the piston.

Studies on Electromagnetic Engine (2014) By- Amarnath Jayaprakash, Balaji, G. Bala Subramanian

Over the last century numerous changes were brought to the internal combustion engines. Numerous researches are carried out in hopes of improving the engine characteristics. Increasing the efficiency and reducing the exhaust gases have been dominant in the fields of research. The volume and number of applications of engines have grown steadily, penetrating and conquering new markets relentlessly. The exhaust gases contain numerous pollutants that are extremely harmful though in chronic conditions. Hence, electromagnetic engines were created that uses the combined power of an electromagnet as well as a permanent magnet. These engines cause no air pollution and are a dominant force when this world faces huge crisis due to inadequate fossil fuels. While these engines have already proven their worth as alternative sourced engines, non-polluting and eco-friendly, the current challenge is to make them more efficient and cost effective.

This review paper discuss about worldwide review report on the various configurations and their results. Also, these papers concentrate on magnetic damping properties, residual magnetism and the effect of heat on neodymium magnets. A prototype is designed where relay switches are replaced with position sensors. The key reason behind this study is to provide a clear idea of the current existing methods in configuring an electromagnetic engine and to state the existing problems that exist in constructing these engines.

Electromagnetic Engine (2014) By- Abil Joseph Eapen, Aby Eshow Varughese, Arun T.P., Athul T.N

Increasing fuel prices and pollution are the major demerits of Internal Combustion (IC) engines. Also presently the demand for fuel has increased and in the nearby future, shortage of fossil fuels is being expected due to the ever growing consumption. So, the need of alternative energy has become necessary. The main aim of the project is the

zero point fuel consumption. The working principle of the engine is the magnetic force principle, i.e. magnetic repulsion between the same poles of two different magnets. When similar poles of two different magnets come in contact with each other they repel each other. This phenomenon of repulsion is used in this engine to create motion.

With the diminishing fossil fuel resources and unabated increase in energy costs and environmental concerns, engines using alternate energy sources such as bio-fuel, solar power, wind power, electric power, stored power, etc. are being developed around the world. However, such engines have many limitations. Production of bio-fuel takes enormous resources and they still pollute the environment. They do not meet the ever increasing energy demand as well. Similarly, the solar power is not efficient. Added to all, the initial capital and subsequent maintenance costs for machines that use alternate energy sources are very high. Hence, in the absence of a viable alternative, until now, switching to new technology by changing from traditional Internal Combustion engines has been a challenge.

In this engine, the cylinder head is an electromagnet and a permanent magnet is attached to the piston head. When the electromagnet is charged, it attracts or repels the magnet, thus pushing then piston downwards or upwards thereby rotating the crankshaft. This is how power is generated in the electromagnetic engine. It utilizes only repulsive force that allows the field to dissipate completely, and have no restrictive effects on the rising piston. The electromagnetic engine should ideally perform exactly the same as the internal combustion engine. The power of the engine is controlled by the strength of the field and the strength of the field is controlled by the amount of windings and the current that is being passed through it. If the current is increased the power generated by the engine also increases accordingly.

Magnetic Repulsion Piston Engine (2015) By- Piyush Hota, Mahima Rathore, Danish Shaikh

Demand is growing for the need of alternative fuels for transportation. Electricity with its versatile application is being utilised to switch from conventional combustion vehicles to electric vehicles. The scenario of travelling is changing rapidly with metros, electric rails, electric aeroplanes (solar panel) etc. Basically, it indicates that electrical energy is being used almost everywhere to drive our life. But the current machines we use today are low in efficiency. Hence we require products with more power but also with higher efficiency. Magnetism posses a magnificent opening for development. Bullet trains using the technology of magnetic levitation have proved the strong nature of electromagnetic fields. Keeping in mind the arising needs of industry, in this project we tried to design and experiment, a system called Magnetic Repulsion Piston Engine, which makes use of magnetic force to drive a load.

The working principle is based on attraction and repulsion between a permanent magnet and an electromagnet. The force thus developed is used to generate mechanical power.

Successful development in this field can actively help in switching over internal combustion engines.

Prototype Implementation of Electromagnetic Piston (2016) By- Ashwin Mathew John, Mathew George, Reenu Saji, Shamith Kumar

The presented paper is an electromagnetic piston that works on the basis of magnetic attraction and repulsion. The piston consists of an electromagnet placed between two permanent magnets of same polarity. The permanent magnets, being of same polarity, are held apart due to repulsive forces. When the electromagnet is energized, the magnets are attracted and hence move towards each other. When the excitation is removed, the electromagnet reverts to its original state, and hence the permanent magnets repel and move away from each other. When the electromagnet is energized and de-energized alternatively, the magnets move towards and away from each other, contributing to the reciprocating movement of the piston.

Design and Fabrication of 4-Stroke Solenoid Engine (2019) By- Anamika Tiwari, Anurag Singh, Deepak Agarwal, Ajay Kumar Verma

In present investigation they have designed a solenoid coil engine based on Induction principle which is alternate option of electric Engine in future due to it high load carrying capacity and low cost as compared to electric engine. Through this work new advanced automobile cum electrical technology is implemented to regenerate a new advance electric engine without using a motor and it is possible to totally remove the motor from car which we name as high torque coil engine. It works like a normal fuel engine but now power source is battery with is totally pollution free and eco-friendly.

They have measured the speed at the wheel and at the crankshaft using tachometer successfully. The project was mainly concerned with fabricating a revolutionary engine that runs with the help of solenoid coil. Basically, it's advancement to the electric vehicles where electric motor is used to run the engine but in their project they have used solenoid coils in order to increase the battery life and eliminate the losses of the electric motor so as to enhance the power of the vehicle.

This innovative technology allows extraction of energy in a clean way and reduces the emission to zero level due to which pollution is minimized to a large extent. It has been cost effective as the design is much simpler than the conventional engines of electric vehicle. No cooling is required and many other parts such as valves, cam, ports etc. were eliminated.
They can conclude that the proposed engine is a simple and excellent technique to run the electric vehicle in a highly efficient manner and if used at a large scale production by considering the recommendations mentioned in the future scope the power, speed and efficiency can be enhanced to a greater extent.

Advantages:

- It has less running cost than an internal combustion engine.
- It does not create pollution and can help in checking global warming.
- It takes less amount of charge from battery in every revolution of the crankshaft for few seconds.

FUTURE SCOPE

We select this topic because we want to study a revolutionary engine that will reduce the pollution to a greater extent which has been increasing due to the harmful emissions from the internal combustion engine. These engines run a crankshaft using the solenoid coils and obtain power.

The power obtained through this engine cannot be compared to the power of an electric vehicle because these vehicles use electric motor to run the engine. But the power of the solenoid engine can be reached to the extent of the power obtained through the electric motor if the number of turns in the solenoid coil are increased, doing this would increase the force applied on the piston, hence increasing the power and apart from it studying the effect of other parameters and improving them would also increase the power.

This engine would eliminate the drawbacks of the electric motor used in electric vehicle. The drawback observed during the working of the engine was that it produced a lot of noise and vibrations.

So, if all the parameters were regulated more effectively then we could have attained more power.

References:

[1]. S. Mounty, A. Mirzaian, F.Gustin, A. Berthon, D. Depernet, C.Espanet, "High Torque Density Low Speed Permanent Magnet Machine", International Electric Machine and Drives Conference (IEMDC), 2011, pp. 448-453.

[2]. J.Rithula, J. Jeyashruthi, and Y. Anandhi, "Electric Vehicle with Zero-fuel Electromagnetic Automobile Engine", International Journal of Engineering Research and Technology (IJERT), ISSN 0974-3154,Volume-6, pp. 483-486, November 4 (2013).

[3]. Shirsendu Das, "An Electromagnetic Mechanism which works like an Engine", International Journal of Engineering Trends and Technology (IJETT), Volume-4, Issue 6, June 2013.

[4]. Abil Joseph Eapen, Aby Eshow Varughese, Arun T.P., Athul T.N., "Electromagnetic Engine", International Journal of Research in Engineering and Technology (IJRET), eISSN:2319- 1163, pISSN: 2321-7308, Volume-03, Issue 6, June 2014.

[5]. Amarnath Jayaprakash, Balaji, G. Bala Subramanian, "Studies on Electromagnetic Engine", International Journal of Development Research (IJDR), ISSN 2230-9926, Volume-4, Issue-3, pp. 519-524, March-2014.

[6]. Piyush Hota, Mahima Rathore, Danish Shaikh, "Magnetic Repulsion Piston Engine", International Journal of Science and Research (IJSR), ISSN 2319-7064, Volume-4, Issue-12, December-2015.

[7]. Ashwin Mathew John, Mathew George, Reenu Saji, Shamith Kaur, "Prototype Implementation of Electromagnetic Piston", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering (IJIREEICE), ISSN 2321-2004, Volume-4, Issue-4, April 2016.

[8]. Pratik Kumar Sinha, "High Torque Solenoid Coil Engine", International Academy of Engineering and Medical Research (IAEMR), Volume-2, Issue-3 March -2017.

[9]. Anamika Tiwari, Anurag Singh, Deepak Agarwal, Ajay Kumar Verma, "Design and Fabrication of 4-Stroke Solenoid Engine", International Research Journal of Engineering and Technology (IRJET), Volume-6, Issue-12, December 2019.