DESIGN AND DEVELOPMENT OF PROTOTYPE OF MAGNETIC ENGINE USING NEODYMIUM IRON BORON (Nd$_2$Fe$_{14}$B) AS MAGNETIC MATERIAL

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ABSTRACT

The energy efficiency is the major concern in every engine which made it affordable and fit for commercial exploitation but every engine has difficulties in attaining efficiency level due to many reasons includes input cost, output power in comparison to input cost, etc. Magnetic engine could resolve the efficiency problem as it harness the gravitational pull in positive manner and due to which can save massive amount of fuel as well as resources.

OBJECTIVES

- To make an engine have less running cost.
- To make an engine have less overall cost.
- Pollution free engine.
- To make an engine efficient.
INTRODUCTION

Engine is a machine that converts energy into mechanical force or motion. This is one of the most widely used machines in the world. Engines are used to run automobiles, aircrafts, locomotives, tanks etc.

The different types of engines used in automobiles on basis of power source can be classified as follows:
- Steam powered engines.
- Fuel (petrol, diesel, gas etc.) powered engines.
- Electric powered engines
- Solar powered engines

Engine is the main power source of Automobiles. In IC-Engines the incomplete combustion produces some harmful gasses, which is one main cause of air pollution. According to Data provided by WHO Air pollution killed an estimated 7 million people around the world in 2012; for which exhaust of automobiles contributes significantly.

Modern Science & Technology has taken many positive steps for emission control. Like using CNGs & LPGs instead of petrol & diesel as a fuel in the automobiles.

Now technology brings Electrical bikes, scooters & cars. The battery of electrical vehicle can charge easily like mobile. They have less running cost & 100% emission free. But they have very less load carrying capacity & not suitable for long run. So basically we have to prefer Engines for more power & more running capacity and 100% emission free.

Magnetic forces will be used to make the engine move, by designing the engine in such a way that repulsive and attractive forces make the engine to give rotary as well as to and fro motion.

Magnetic Engine: In magnetic engine repulsion force is utilized to maintain oscillation of a free swinging pendulum and transform its oscillating motion into rotary motion by installing horizontal connecting rod along with a flywheel to display the ultimate motion. The system also contains a servo motor and Infrared sensor based trigger mechanism which triggers the servo and the servo gives extra push to bring the magnet closer to the another so that maximum repulsion can be obtained.

CONSTRUCTION

The magnetic engine is having two major parts which are pendulum and Permanent magnets. The construction of engine is shown by line diagram. It consists of
- Permanent magnets(neodymium)
- Pendulum
- Connecting rod
- Gun trigger mechanism
- IR based 555 timer circuit
- Flywheel
- Batteries(9v)

Permanent Magnet: Magnets are the objects that generate a magnetic field, a force or field that either pull or repels certain material such as nickel and iron. In this engine the neodymium permanent magnets are used.
Neodymium Iron Boron (Nd$_2$Fe$_{14}$B) are composed of rare earth magnetic material and have high corrosive force. This type of permanent magnet is made from an alloy of neodymium, iron and boron to form the Nd$_2$Fe$_{14}$B tetragonal crystalline structure. They have high product range so can usually be manufactured to be small and compact in size. They have low mechanical strength tend to be brittle and low corrosive resistance. Fig 1 shows the Neodymium iron boron magnets.

**Fig 1: Neodymium Magnets**

**Fig 2: Pendulum**

**Pendulum:** A pendulum is a weight suspended from a pivot so that it can swing freely. When a pendulum is displaced sideways from its resting equilibrium position, it is subjected to a restoring force due to gravity that will accelerate it back towards the equilibrium position. When released, the restoring force combined with the pendulum's mass (neodymium magnets) causes it to oscillate about the equilibrium position, swinging back and forth. The time for one complete cycle, a left swing and a right swing, is called the period. A pendulum swings with a specific period which depends (mainly) on its length. Fig 2 shows the pendulum use in the prototype engine.

**Connecting Rod:** In this engine the connecting rod is an engine component that transfers motion from the pendulum to the flywheel and functions as a lever arm. It converts the oscillating motion of pendulum into rotary motion to the flywheel. Connecting rod shows in the fig 3.

**Fig 3: Connecting Rod**

**Gun Trigger Mechanism:** In this mechanism the rotary motion is converted into reciprocating motion. It consists of mainly two components that is motor and rack and pinion arrangement. In this mechanism the power is supplied to the motor which actuates the rack and pinion arrangement. After the power is supplied the pinion starts rotating, the rotational motion of the pinion will cause the rack to move the side, up to the limit of its travel. A permanent magnet is attached at one end of the barrel
of the mechanism and it will repel the motion of the pendulum so that the engine can run. Fig 4 shows the gun trigger mechanism.

Fig 4: Gun Trigger Mechanism

Fig 5: 555 Timer Circuit

**IR Based 555 Timer Circuit:** The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator. This circuit consists of PCB (print circuit board), Capacitor (25V), Resistor (1Kamp), Voltage Regulator (5V), Transistor. Fig5 shows the 555 timer circuit.

**PCB (Printed Circuit Board):** A printed circuit board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. Conductors on different layers are connected with plated-through holes called vias. Printed circuit boards are used in all but the simplest electronic products. Advanced PCBs may contain components - capacitors, resistors or active devices. Fig shows the PCB.

**Capacitor:** Capacitor is an electronic component that stores electric charge. The capacitor is made of 2 close conductors (usually plates) that are separated by a dielectric material. The plates accumulate electric charge when connected to power source. One plate accumulates positive charge and the other plate accumulates negative charge. The capacitance is the amount of electric charge that is stored in the capacitor at voltage of 1 Volt. The capacitance is measured in units of Farad (F). Capacitor shows in the fig7.

**Resistor:** Resistor is an electrical component that reduces the electric current. The resistor's ability to reduce the current is called resistance and is measured in units of ohms (symbol: Ω). Resistors act to
reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits resistors are used to limit current flow, to adjust signal levels. Fig 8 shows the resistor.

Transistor: A transistor regulates current or voltage flow and acts as a switch or gate for electronic signals. A transistor consists of three layers of a semiconductor material, each capable of carrying a current. A semiconductor is a material such as germanium and silicon that conducts electricity in a "semi-enthusiastic" way. It's somewhere between a real conductor such as copper and an insulator. Fig 9 shows the transistor.

Voltage Regulator: A voltage regulator is designed to automatically maintain a constant voltage level. The voltage regulator is needed to keep voltages within the prescribed range that can be tolerated by the electrical equipment using that voltage. Such a device is widely used in motor vehicles of all types to match the output voltage of the generator to the electrical load and to the charging requirements of the battery. Voltage regulators also are used in electronic equipment in which excessive variations in voltage would be detrimental. Fig 10 shows the voltage regulator.

LED (Light Emitting Diode): LEDs are just tiny light bulbs that fit easily into an electrical circuit. But unlike ordinary incandescent bulbs, they don't have a filament that will burn out, and they don't get especially hot. They are illuminated solely by the movement of electrons in a semiconductor material, and they last just as long as a standard transistor. Fig 11 shows the LED.

IR Sensors: A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors.

Operating Principles: All objects with a temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation is invisible to the human eye because it radiates at infrared
wavelengths, but it can be detected by electronic devices designed for such a purpose. The term *passive* in this instance refers to the fact that PIR devices do not generate or radiate any energy for detection purposes. They work entirely by detecting the energy given off by other objects. It is important to note that PIR sensors don't detect or measure "heat" per se; instead they detect the Infrared radiation emitted from an object which is different from but often associated/correlated with the object's temperature. IR sensors shows in the fig12.

![Ir Sensors](image)

**Fig 12: Ir Sensors**

**Flywheel:** A flywheel is a rotating mechanical device that is used to store rotational energy. Flywheels have a significant moment of inertia and thus resist changes in rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. Energy is transferred to a flywheel by applying torque to it, thereby increasing its rotational speed, and hence its stored energy. Conversely, a flywheel releases stored energy by applying torque to a mechanical load. Fig 13 shows the flywheel.

![Flywheel](image)

**Fig 13: Flywheel**

**Batteries:** An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Each cell contains a positive terminal, or cathode, and a negative terminal, or anode. Electrolytes allow ions to move between the electrodes and terminals, which allows current to flow out of the battery to perform work. Fig 14 shows the batteries.

![Batteries](image)

**Fig 14: Batteries**

**WORKING**

As in case of IC Engines, the engine requires an external power to initiate the engine. Similarly, in magnetic engine the external power is necessary to initiate the engine. In magnetic engine, first the initiating torque is given to the flywheel as in IC engines. Due to initiating torque the flywheel will start rotating, this rotary motion of the flywheel is transferred to the pendulum and it will start oscillating with the help of connecting rod and flywheel gear. The pendulum consists of a separator which helps to break the IR rays of IR sensors. The IR sensor act as a regulator sensor and
sense the oscillation to operate servo at perfect time. The IR rays are obtained from the 555 timer circuit. This circuit consists of transistor, resistor, capacitor, voltage regulator and 555 timer. When the circuit brakes it shoots the trigger forward that has a permanent magnet attached to it. The pole of this magnet is same as that of pole face attached to the pendulum. As the pendulum reaches this point it will experience repulsion and will move in opposite direction in this way the to and fro motion of pendulum is continued. This to and fro motion is converted into rotator motion using connecting rod which is attached to the flywheel.

Prototype of the Magnetic Engine

CONCLUSION

In all the designs studied and prepared during experiments the main drawback was heat and forces due to friction. These forces of friction and heat would result to decrease the magnetic effect of magnet. This prototype works on an input of 9 volts and gives an output of about 40 rpm. The prototype made is transferring to and fro motion from a pendulum in which no heat is generated due to friction and no additional forces act on the magnets due to which the magnets cannot lose magnetism easily.

The main aim of the project was realisation of the idea of an engine working with magnetic forces and having high efficiency which is successfully done.

REFERENCES

1) Microcontrolled Electromagnetic Engine Atul Kumar Singh, Prabhat Ranjan Tripathi
2) An Electrotromagnetic mechanism which works like an Engine Shirsndu das Department of ME, TIT Agartal Narsingarh, West Tripura, India
3) http://blog.hasslberger.com/2013/11/german_inventor_solves_permame.html
4) http://amasci.com/neodemo.html
5) http://www.electricstuff.co.uk/neodym.html
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