Design of Electromagnetic Piston Engine Working Based on Microcontroller Program

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Abstract

Engine is the main power source of Automobiles, where combustion takes place & produces heat which converts into mechanical energy. We know internal combustion Engines are used in Automobiles, Aeroplane etc. But the incomplete combustion produces some harmful gasses, which is one main cause of air pollution. The main drawbacks of IC engines are increasing in fuel prices and pollution. Also presently the need for fossil fuel has increased. Due to ever growing consumption, shortage of the fossil fuels is being expected in nearby future so we need to find alternative energy.

This is based on attraction & repulsive force of the magnet. I.e. magnetic attraction between the different poles or repulsion between the same poles of two different magnets attracts or repulse respectively. This phenomenon of attraction & repulsion is used in this engine to create motion. The working of the magnetic engine greatly appear like working of a two-stroke engine. A four cylinder prototype engine is fabricated and each cylinder fired by taking the input signal from programmed microcontroller for perfect timing. The designed model is tested for working calculations. The engine can be used to carry out various operations that involve application of force or displacement of objects. "This mechanism provides an eco friendly, has high efficiency that can replace any engines working fossil fuel, solar power, bio-fuel, hydro power, wind power or other energy sources".

Keywords: *IC engines, Fossil Fuel, Microcontroller, Eco Friendly, Efficiency.*

1. Introduction

In today's World, practically speaking it is impossible to imagine a life without IC Engines, which is one of the greatest man made inventions. IC Engines are primarily used in automobiles, which is a major mode of transportation to mankind. IC engines work mainly on gasoline and diesel which are derived from fossil fuels. The demand for automobiles keeps on increasing as the Population increases. With this increase, the rate of fossil fuel consumption also increases. This creates a situation that brings up a need to switch to alternative sources of fuel to produce the power similar to that of IC engines. The challenge is not to create an engine that operates on an alternate fuel but to produce higher efficiencies. The next source of energy that strikes our minds is definitely electrical energy. Now-a-days, automobiles operate fully either on electrical energy or hybrid engines that works both on electrical energy and combustion energy [1]. *D*uring the early 1800s, many interesting and little understood electrical experiments were

conducted both here and abroad that eventually led to the discovery of the electric motor. In 1800, Volta invented an early form of battery that greatly strengthens electrical experiments that previously depended on a form of capacitance for electrical energy [2]. In 1831, Michael Faraday discovered the magnetic field and hence the effect of an electrified coil on steel and on a permanent magnet and vice versa. Faraday's experiments and his discoveries lead to many useful inventions, along with the multipolar motor by Jacobi in 1838, the telegraph by Morse and Wheatstone in 1840, the dynamo by Gramme in 1871, and the telephone by Bell in 1876 to mention a few [3]. In the early 1830s Michael Faraday & Joseph Henry conducted a series of experiments make use of newly discovered phenomenon of electromagnetism. This work gives a way to a number of scientists to develop practical electric motors [4]. The early electromagnetic machines can be mostly divided into two categories. The first is the reciprocating engines. The problem that faced during the experimenters was converting the reciprocating motion into a rotary motion. Contemporary steam engines solved this problem by the use of connecting rods and cranks and initially it seemed logical to follow suit [5]. The second category was the rotary engines invented by Paul-Gustav Foment. These did away with the connecting rods and linkages of the reciprocating engine and evolved into the modern electric motor. Although the electric motor was an important development as a new power source, the alternatives at that time being water, wind, or steam, it would be many years before it became widely used. The problem was that the only practical source of electricity supply in the 1840s was batteries; reliable electrical power distribution did not become available until well into the second half of the nineteenth century. In the 1840s it was estimated that an electric motor powered by zinc/carbon batteries cost seventy times more to run than a coal fired steam engine of equivalent power. This is the story of the rise and fall of the little known electro-magnetic engine [6]. Speaking of electrical energy, it is quiet hard to store large amounts. Thus a method has to be developed that uses electrical energy in combination to produce better efficient engines. Government has taken many a steps to reduce the vehicular emission by setting emission standards. However, evolution of scientific methods for emission inventory is crucial. Therefore, analysis is done on the emissions from various vehicles by using IVE model .The quality of air in developing countries like India has reached a horrifyingly low level [7]. Pistons and cylinders arrangements of a conventional internal combustion (IC) Engine are replaced by the permanent magnet and electromagnetic materials respectively which bring about the invention of reciprocating electromagnetic engine by S. Sherman Blalock [8]. Multi-cylinder electromagnetic engine for the automobile cylinders consists of samarium cobalt type of magnets in pistons placed at right angle to the pistons [9]. Improvement in this field has induce the invention of Maps Engines which are assimilated with various machineries and equipments whose application are in fields such as ship engine, aircraft engine, lawn mower, and locomotive engine [10].

2. Working Principle

2.1 Existing Model

In I.C engine when the piston reaches to top dead centre (TDC), the compressed mixture of air-fuel is ignited, usually by a spark plug. The result of expansion stroke, pressure from the compressed air-fuel mixture moves the piston back to bottom dead centre (BDC) with tremendous force called as power stroke. This is the main source of the engine's torque & power in conventional engine. In present-day vehicles which running with electric power are efficient than diesel or petrol vehicles. They are 96% cleaner than fuel-powered automobiles. The maintenance of electric automobiles is optimum. The only drawback faced by these vehicles is high initial cost and unable to run long distances. Most of electric automobiles about to hit the market can only run about 160km. also; there is a need for charging stations installation as the power densities of batteries are less to travel over long distances and also getting a full charge of vehicle takes around a long time.

2.2 Existing Model of Electromagnetic Engine

The idea behind this project is to modify the existing internal combustion reciprocating engine into an electro-magnetically reciprocating engine. It is done by replacing the spark plugs by electromagnets and conductors. The design consists of four pairs of piston and cylinder arrangements. permanent magnets is seated on the head of the piston with its south/north pole always facing the fixed magnet. If a magnetic material is wound by a current carrying conductor, then it will act as a magnet whose field strength depends on the amount of current flowing through the conductor. Electromagnet is excited when we supply ac current (square wave), it gains negative and positive charges for each half cycle of the power supply. For any instance, the electromagnet will function as South Pole for positive supply and North Pole for negative for other or vice versa as shown in fig 1. This phenomenon leads to the repulsion and attraction of the permanent magnet on the head of piston due to which the piston reciprocate inside the cylinder. So when the magnets of cylinders 1 & 4 experience attraction causing the piston moves upwards, the magnets inside cylinders 2 & 3 experience repulsion making the piston move downward. This reciprocating motion of the piston inside the cylinder is coupled to crankshaft which rotates wheels and causes the motion of the vehicle.

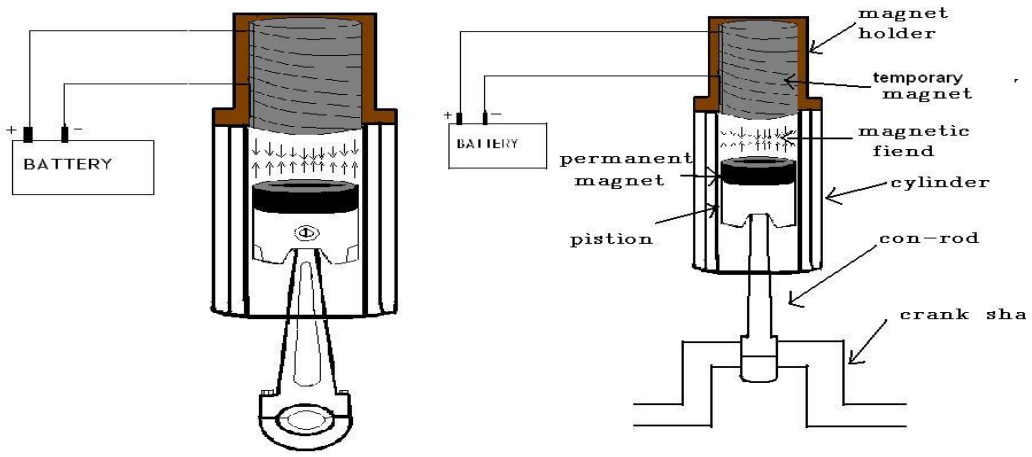


Figure.1 Working Principle of Electromagnetic Piston

2.3 Working of Proposed Model

Electromagnetic piston engine is an engine in which the movement of the piston is done by the electromagnetic force. Electromagnetic piston engine is a realization of the concept through which the piston can be reciprocated by the electromagnetic coil. EMPE consists of two coils with no core; the piston is inserted 10% in the coil as a core. When the coil is exited, the electro magnetism produced in the coil pulls the piston in, up to the centre of the piston. Then the coil is de-energized and next coil is activated pulling the other piston in. this reciprocating moments in the piston is connected to the crank shaft through connecting rods. The connecting rods are connected to the pedal like crank which rotates the engine effectively. The control system plays a vital role which alternatively activates the coils. A high current is passed through the coil to produce the electromagnetism which creates the sufficient thrust to engine.

3. Components Description

Table.1 components Used

Component Name	Quantity
Microcontroller	01
Field Effect Transistor	04
Filters	02
IC's	01
Crystal Oscillators	01
Resistors	05
Switches	01
Variable Resistor	01

Printed Circuit Board	01
Steel Bars	04
Plywood Boards	03
Wood Pieces	04

3.1Steel Bars

Used for Pistons, We used 4 Steel bars of 0.8Cm of Diameter; Crank Shaft also done by steel bars itself. Crank shaft is made at 90^0 angles to each position at a length of 4cm; all 4cm's of bars are welded by gas welding method with filler material brass.

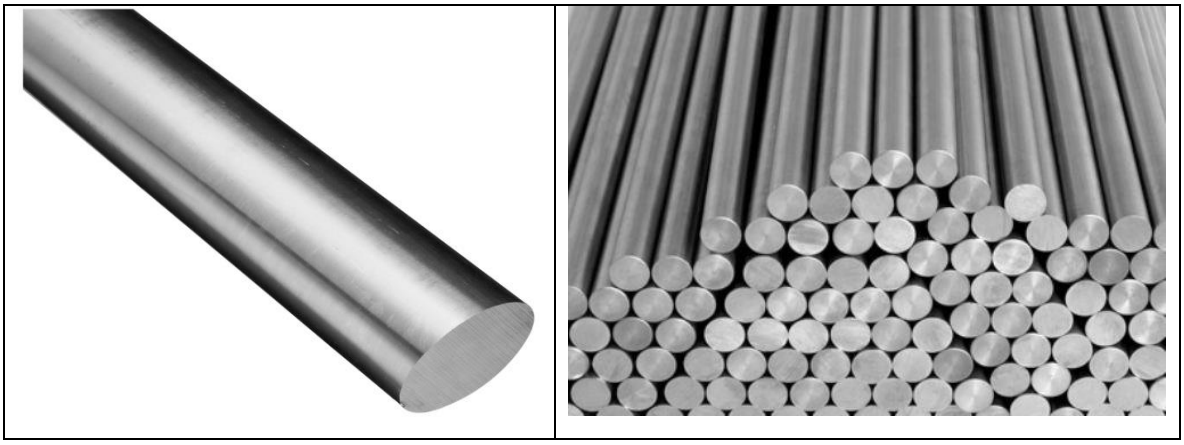


Figure.2 Steel Bars

3.2Flywood

Used for construction base for model. Flat type and T –type shapes are used for Construction of Model.

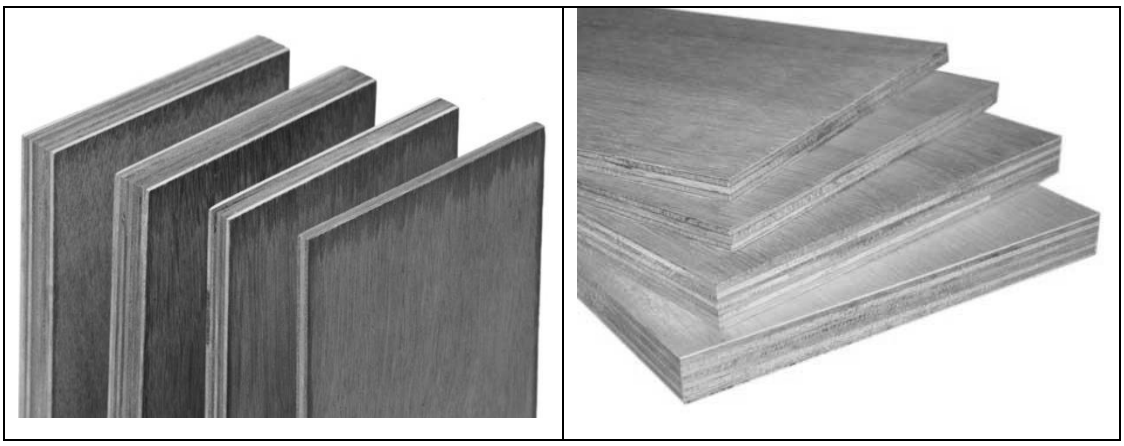


Figure.3 Fly Wood Pieces

3.3IC L293D

An IC is also known for motor driver and it abbreviated as integrated circuit chip, is usually used to controlling motors in autonomous robots. Integrated Chips act as a connection between microprocessors and the motors in the robot. The commonly used motor driver IC's is L293 series such as L293D, L293NE, etc. These ICs are used to control two DC motors simultaneously. L293D chip consist of 2 H-bridges. H-bridge is the simplest circuit used to controlling a low rated current motor. In this project we recommended the motor driver IC as L293D only.

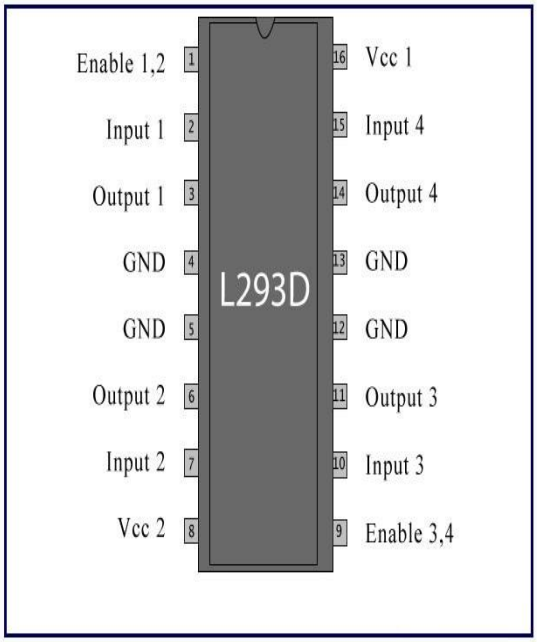


Figure.4 Pin Configuration of L293D

3.4Field Effective Transistor (FET)

The IRF3205 leading-edge N-Channel HEXFET® Power MOSFETs from International Rectifier implements hi-tech processing solutions to attain incredibly minimal on-resistance per silicon space. Field effective transistor used for regulate the power supplied to coils and time interval between the four coils (i.e time of engage and time disengage). We used four FET's are used in this model.

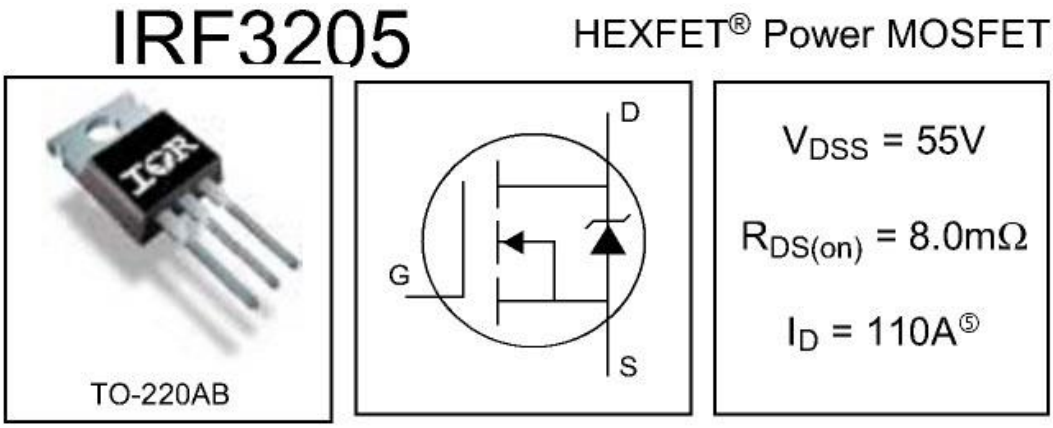


Figure.5 Circuit Diagram of FET

3.5 Microcontroller

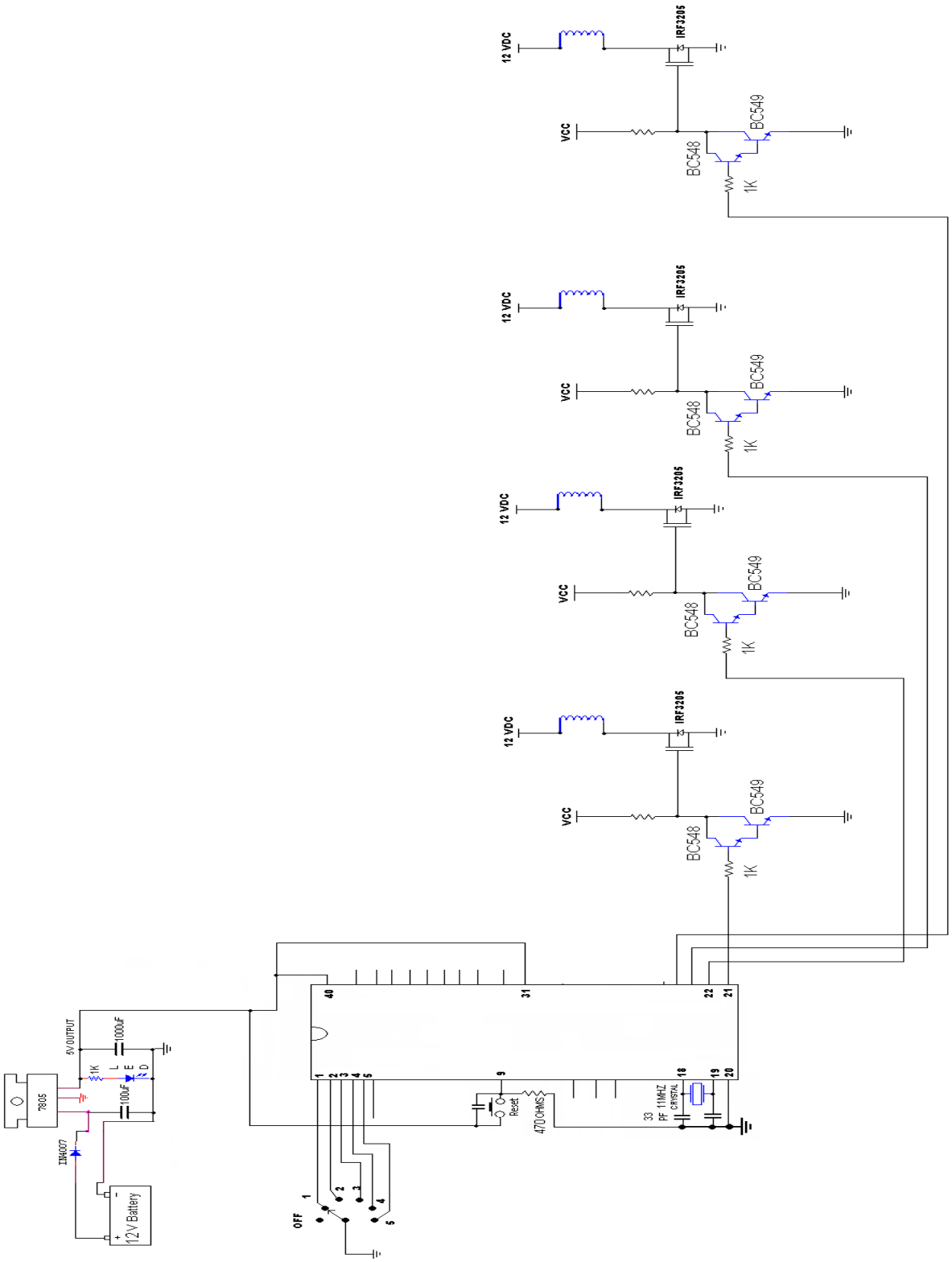


Figure .6 Circuit Diagram of Electromagnetic Piston Engine Model

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR Flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications. Series AT89S52 type of microcontroller is used in this model design, which has 8k flash memory size and 256 bytes RAM.

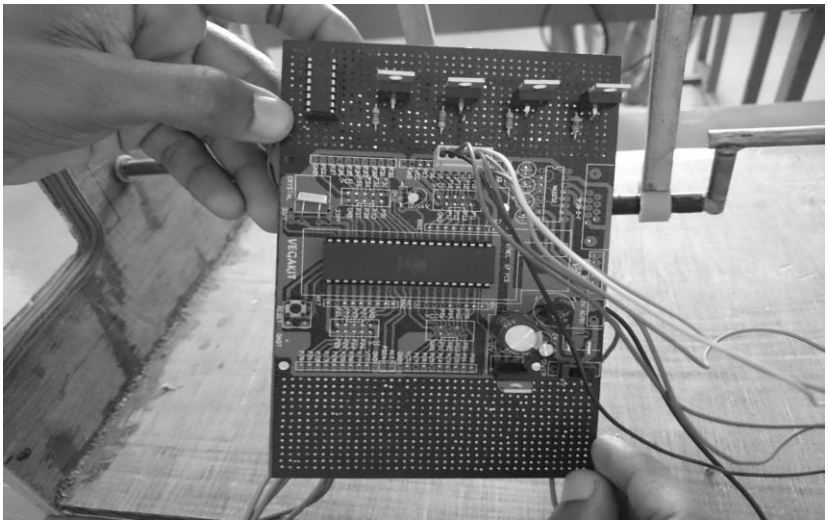


Figure.7 AT89S52 Type of Microcontroller

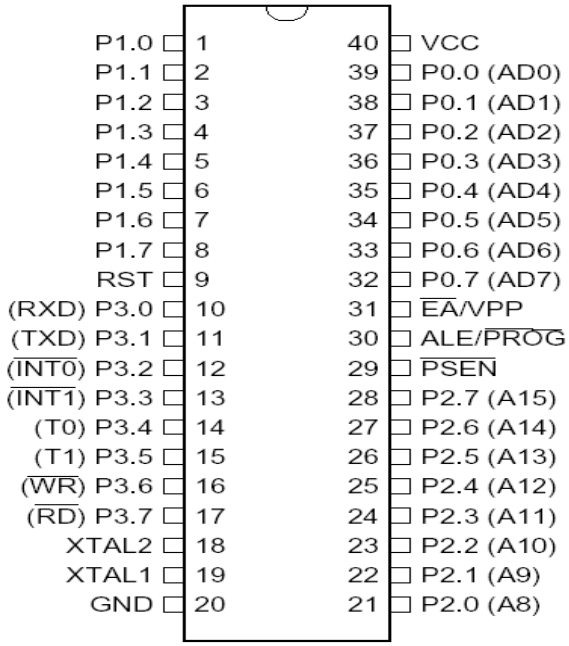


Figure.8 Pin Configuration of AT89S52 Microcontroller

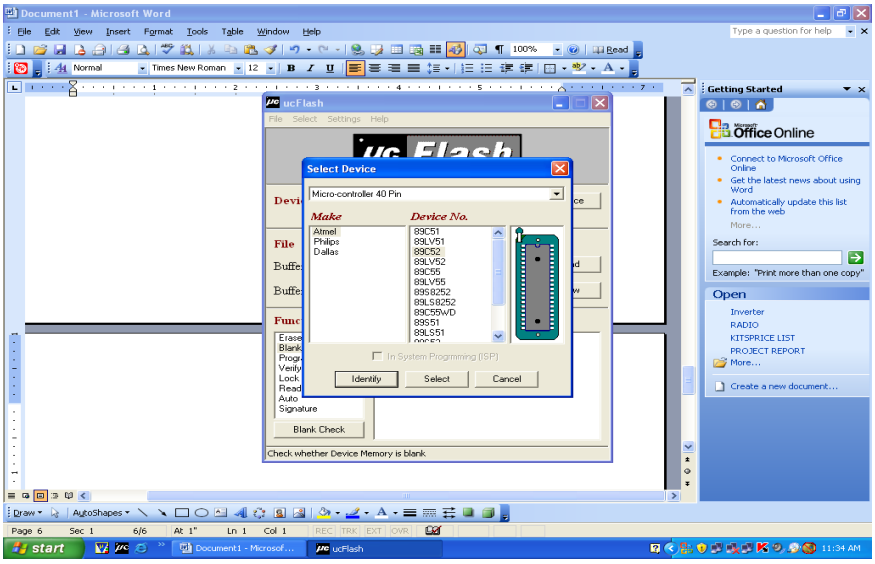


Figure.9 MC Program Debugging Screenshots

Figure.10 MC Program Debugging using Flash Magic

3.6 Program

```
#include<stdio.h>
#include<reg51.h>
void delay(int);
sbit pis1=P2^0;
sbit pis2=P2^1;
sbit pis3=P2^2;
sbit pis4=P2^3;
int on,temp,off;
void main()
{
```

```
	P0=P1=P3=0xff;
	P2=0x00;
	for(;;)
	{
		while(P1!=0xff)
		{
			if(P1==0xfe){on=4500;}
			if(P1==0xfd){on=3500;}
			if(P1==0xfb){on=3000;}
			if(P1==0xf7){on=2500;}
			if(P1==0xef){on=2000;}

			off=(on/80);
			off=(on/4)-on;
			pis1=0x01;pis2=0x00;pis3=0x00;pis4=0x00;
			delay(on);
			pis1=0x00;pis2=0x00;pis3=0x00;pis4=0x00;
			delay (off);
			pis1=0x00;pis2=0x01;pis3=0x00;pis4=0x00;
			delay(on);
			pis1=0x00;pis2=0x00;pis3=0x00;pis4=0x00;
			delay (off);
			pis1=0x00;pis2=0x00;pis3=0x01;pis4=0x00;
			delay(on);
			pis1=0x00;pis2=0x00;pis3=0x00;pis4=0x00;
			delay(off);
			pis1=0x00;pis2=0x00;pis3=0x00;pis4=0x01;
			delay(on);
			pis1=0x00;pis2=0x00;pis3=0x00;pis4=0x00;

			delay(off);
		}
		while(P1==0xff)
		{
			pis1=0x00;pis2=0x00;pis1=0x00;pis2=0x00;
			while(P1==0xff);
		}
	}
}
void delay(k)
{
	int i;
	for(i=0;i<=k;i++);
}
```

4. Experimental Procedures

The power supply is given by 12v battery. The 1N4007 is connected to allow the power flow in unidirectional. Low forward voltage drop and High surge current capability. The voltage regulator (KA7805R) is connected, which has the capability to convert the 12v supply to 5v. The block diagram of power supply system is shown in the fig no 6. From the output of 12v, 7v is grounded through the pin2 of the voltage regulator. We get 5v output through the pin3.The microcontroller is connected to the voltage regulator trough the capacitors of 1000µf and 100µf. The capacitors will filter harmonics produced in the power signal. The microcontroller will takes the 5v from the voltage regulator for its working purpose. The model of microcontroller used is AT89S52, which is a 40 pin microcontroller. The microcontroller diagram is shown in the fig no 8. It is used for programming purpose. The whole action of piston movement is done according to the program. The Keil & Flash magic software is used for programming. The Keil 8051 Development Tools are designed to solve the complex problems facing embedded software developers.

Figure.11 Prototypes Electromagnetic Piston Engine

An Embedded system is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. The 40 pins will have some specific task. The pin no.1- 8 belongs to Port1. Pin no.9 is the Reset. Pin no.10 -17 belongs to Port3. Pin no.18 & pin no.19 are the clock pulse. Pin no.20 is ground. Pin no.21-28 belongs to Port2. Pin no.29, 30&31 are the external interrupts to connect extern devices. Pin no.30-39 belongs to Port0. Pin no.40 is connected to V_{cc} (supply voltage). Only Port2 is upward port, while Port1, Port3, Port0 are downward ports. Port0 is unidirectional i.e. we can use this port either for input purpose or for output purpose, where as the remaining ports are Bidirectional i.e. any pin we can use as input or output or simultaneous. Port0, Port1 and Port 2 are only parallel,

where as Port3 is either serial or parallel. Through the Pin no.19 continuous highs are converted to pulse and give to pin18. Pin19 is input clock voltage. The four output pins of port2 are connected to IC L293D. The diagram of this amplifier is shown in fig no 4. It is the driving section of the system. It will convert the 5v supply from microcontroller 12v, which is required for the operation. L293D has 16 pins. 1&16, 8&9 pins are connected to Vcc. The pins 2,15,7 and 10 are connected to outputs of microcontroller. Pins 4&5, 12&13 are grounded. The pins 2, 14, 6 &11 are four outputs of L293D, which are connected to four FETS. FET is field effect transistor; four FETS are used for four coils. It is act like a switch. The FETs used are of IRF3205 as shown in the fig no 5. These will works on heavy currents i.e. 100amps 12-40v. These are used to engage and disengage the power to the coils. When the positive is connected to base; given by the microcontroller. The resistance will decrease across the FET. Then it will allow the flow of current from emitter to collector, hence the coil will be activated. If negative is connected to base. Then the resistance will increase and it stops the flow of current, hence the coil will be deactivated. FETs are connected by the 220Ω resistors. Terminal-1 is base. Terminal-3 is grounded and terminal-2 is connected coil. A printed circuit board is used for circuit connection.

When the current passed through the coil the magnetic field is produced perpendicular to the flow of current, according to flaming right hand rule. At the electron entry we get a south pole. At the exit of electron we get a north pole. Once this electromagnetic field has been produced from a given charge distribution, other charged objects in this field will experience a force (in a similar way that planets experience a force in the gravitational field of the Sun). The block diagram of circuit part is shown in the fig no 6. The piston rods are surrounded by four copper coils. Piston is a solid ferromagnetic material. Pistons will move by crankshaft connected by the connecting rod. The four connecting rods attached to the crank shaft are perpendicular to each other making a total angle of 360◦. When a piston shifted up according to the action of microcontroller and power supply, the next piston is replaced by the position of first one because of the perpendicular arrangement, and so on. When cut off the supply the piston falls down due to gravity. If the piston is not at center of mass, when we activate the coil, it will try to come to its center of mass. Only one coil is activated at one time, by taking 12v power supply.

5. Results

5.1 Calculate

Input Voltage (V) = 12 Volts

Input Current (I) = 1Amp

Input Power = V x I

= 12x1=12 w

Area (A) = $\pi/4 \times D^2$

$= 0.785 \times (0.03^2)$

$= 7x10^{-4}$

Force on Piston $F = N^2I^2A$

N = No. Of Turns

$F = (90^2) \times (1^{2)} \times (7x10^{-4})$

$F = 5.67N$

Torque T =F x Displacement

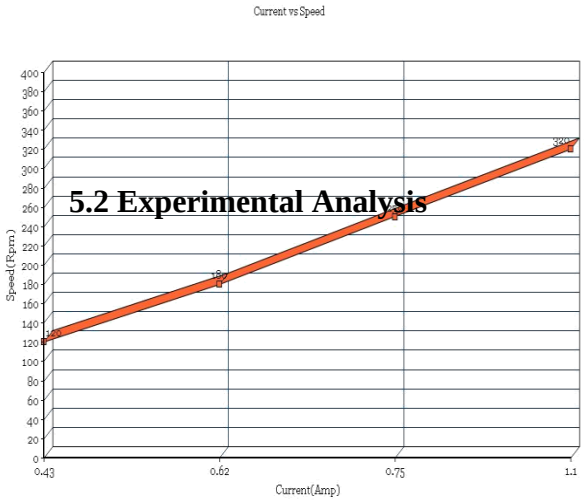
$T = 5.67x4.8x10^{-2}$

$\approx 0.3N\text{-}m$

Table.2 Efficiency at Different Speed

Speed(rpm)	Current	Input power	Output power	Efficiency
130	0.43	5.16	3.76	73%
240	0.62	7.44	5.6	75%
290	0.75	9	7.85	87%
360	1.1	13.2	10.04	76%

5.2 Experimental Analysis



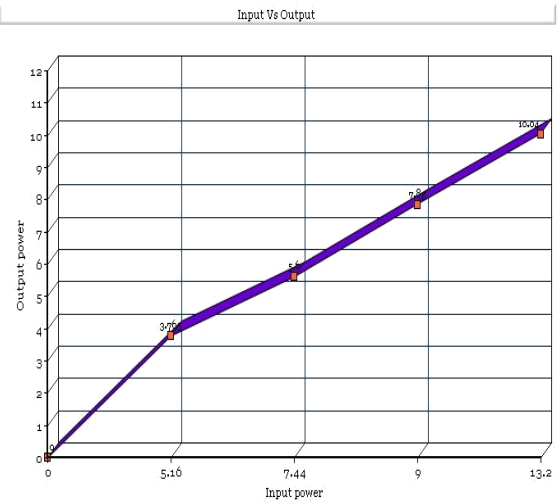


Figure.12 Speed vs. Current Graph **Figure.13 Output vs. Input Graph**

6. Conclusion

- Engine which works on Electromagnetic reciprocating principle was successfully manufactured.
- It uses electrical input and no fuel is consumed. The prototype generates no pollution and eco-friendly.
- As there is no combustion taking place inside the engine cylinder little heat is generated. Cooling system may eliminate this heat. By making slight modifications in design it is possible to produce high power and efficiency.
- In high power engines, the number of batteries will increase which may increase the total weight of vehicle and consume a lot of space.

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