Electricity Generation through Road Ribs using law of Electromagnetic Induction

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Abstract

Recognizing the importance of developing renewable energy resources, the Highways Agency commissioned a preliminary scoping study in 2001 to explore available methods and assess the possibility of renewable energy generation being exploited within the highway network. Among the various means of transportation, highways cover the widest and in effect the greatest area of our precious landmass. In context of the present scenario, spaces required for energy generation are becoming scarce day by day, and yet paradoxically no substantial effort has been made to make use of the very spaces incorporated by the highways themselves. . The road rib can be designed so that any vehicle, from bicycle to HGV, pass across it and it generate electricity which is then stored at the road side in a battery then used to power any electrical roadside device.

Keywords—Magnets, copper coil, IC-555, NPN transistor, LED.

I. INTRODUCTION

In this technological era, all the modern equipments and advancements rely on the electricity. Electricity serves as a back bone to these achievements. Currently there are various methods for electricity generation. Here is a novel method for generating electricity from road ribs which is eco-friendly [1].

Among the various means of transportation, a highway covers the widest area of landmass. In context of present scenario, spaces required for energy generation are becoming scare day by day. Solar panels have been laid beside road, wind turbines have been installed in breezy areas; but the highways themselves continue to be the least utilized zone[2]. There are following innovative ideas to generate

electricity from road/ highways:

i. Piezoelectric Ceramic roads.
ii. Solar Roadways.
iii. Jet Stream Super ways.
iv. E-Turbine the Highways.
v. Solar and Wind Generators mounted on Highways.
vi. Solar Road Bike Path.
vii. Electricity Generation through Road Ribs.

II. METHODS TO GENERATE ELECTRICITY THROUGH ROAD RIBS

Electricity generating road rib is a conceptual design that makes use of the wasted yet available energy procured from the unused energy that has not been converted from the vehicle fuel. A moving vehicle makes the rib move as well, which helps generate new renewable energy. The methods to generate electricity through road ribs are as follows:

1. Using Crank-shaft mechanism

2. Using Roller mechanism

3. Using Rack- Pinion mechanism

4. By moving wind mill through the high velocity springs downside the road air due to pressure difference produced by

5. By moving a magnet in a coil under the road ribs

III. METHOD USED IN THE PROJECT

Michael Faraday stated that electromotive force (EMF) produced around a closed path is proportional to the rate of change of the magnetic flux through any surface bounded by that path. In practice, this means that an electric current will be induced in any closed circuit when the magnetic flux through a surface

bounded by the conductor changes. This applies whether the field itself changes in strength or the conductor is moved through it [4].

In mathematical form, Faraday's law states that:

$$\mathcal{E} = -\frac{d\Phi_B}{dt},$$ Where

$\mathcal{E}$ is the electromotive force Φ_B is the magnetic flux.

For the special case of a coil of wire, composed of *N* loops with the same area, the equation becomes

$$\mathcal{E} = -N\frac{d\Phi_B}{dt}.$$

A corollary of Faraday's Law, together with Ampere's law and Ohm's law is Lenz's law:

The EMF induced in an electric circuit always acts in such a direction that the current it drives around the circuit opposes the change in magnetic flux which produces the EMF.

The rotor is directly connected to the prime mover and rotates as the prime mover turns. The rotor contains a magnet that, when turned, produces a moving or rotating magnetic field. The rotor is surrounded by a stationary casing called the stator, which contains the wound copper coils or windings. When the moving magnetic field passes by these windings, electricity is produced in them

This project works on one of the fundamental methods of electricity generation i.e.Faraday's Electromagnetic Induction law, which transforms Kinetic energy into electrical energy. Whenever there is a change in flux, e.m.f. is induced. The change in flux can be obtained by either moving a conductor in a stationary magnetic field or by moving a magnetic field in a stationary conductor.

Generating electricity by moving a permanent magnet in a coil of wire is both the oldest power generation technology and today's best option for improved efficiency in converting renewable energies and fossil fuels to electricity.

Here in this project n-p-n transistor is used as a switch. When pin no.3 of IC-555 is positive, transistor is in conduction mode and passes one pulse to the load. And when it is at negative transistor does not conduct and does not pass the current to the load.

IV.DISCRIPTION OF COMPONENTS USED IN THE CIRCUIT

The components used in the circuit of electricity generated road ribs are as following:

A. FIELD SYSTEM: Permanent magnets.
B. COPPER COIL.
C. IC-555
D. AMMETER
E. LED: Two LEDs are used here in the circuit. One is used to show the deflection by electric current generation. Another is used as an load output.
F. Battery: A 9 Volt battery is used for the excitation of I.C.s
G. NPN Transistor- as ramp generator
H. RESISTOR

A **permanent magnet** is an object made from a material that is magnetized and creates its own persistent magnetic field.

A simple coil of copper is used in which magnet is moved

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, and as a flip-flop element. Derivatives provide up to four timing circuits in one package. Here IC-555 is used in monostable mode. In the monostable mode, the 555 timer acts as a "one-shot" pulse generator. The pulse begins when the 555 timer receives a signal at the trigger input that falls below a third of the voltage supply. The pulse begins when the 555 timer receives a signal at the trigger input that falls below a third of the voltage supply. The width of the output pulse is determined by the time constant of an RC network, which consists of a capacitor (C) and a resistor (R). The output pulse ends when the voltage on the capacitor equals 2/3 of the supply voltage. The output pulse width can be lengthened or shortened to the need of the specific application by adjusting the values of R and C.[5]

The output pulse width of time *t*, which is the time it takes to charge C to 2/3 of the supply voltage, is given by

$$t = RC\ln(3) \approx 1.1RC$$

Where t is in seconds, R is in ohms and C is in farads.

While using the timer IC in monostable mode, the main disadvantage is that the time span between the two triggering pulses must be greater than the RC.

LED takes energy to generate a hole-pair, so energy is released when an electron recombines with a hole. In silicon and germanium this recombination takes place through traps and the liberated energy goes into the crystal as a heat.when an electron falls from the conduction into the valence band appears in the form of radiation. Such a p-n diode is called a light emitting-diode.

A 9V battery is used here for the excitation of IC-555
NPN transistior is used here . Here in this project npn transistor BC-547 is used as a current amplifier.

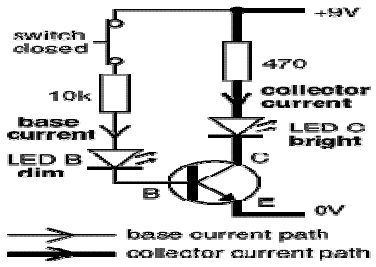

Fig.(i)

ICs cannot supply large output currents so it may be necessary to use a transistor to switch the larger current required for output devices such as lamps, motors and relays. The 555 timer IC is unusual because it can supply a relatively large current of up to 200mA which is sufficient for some output devices such as low current lamps, buzzers and many relay coils without needing to use a transistor[3].

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A transistor can also be used to enable an IC connected to a low voltage supply (such as 5V) to switch the current for an output device with a separate higher voltage supply (such as 12V). The two power supplies must be linked, normally this is done by linking their 0V connections.

Connecting a transistor to the output from an IC:
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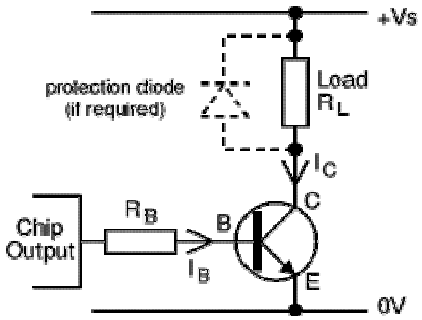
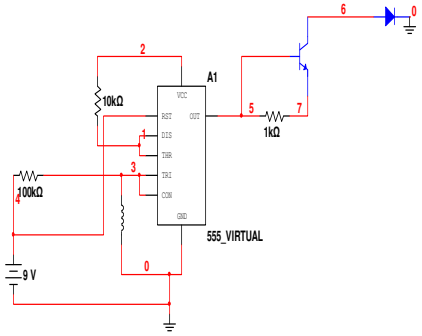
A resistor R_B is required to limit the current flowing into the base of the transistor and prevent it being damaged. However, R_B must be sufficiently low to ensure that the transistor is thoroughly saturated to prevent it overheating, this is particularly important if the transistor is switching a large current (> 100mA). A safe rule is to make the base current I_B about five times larger than the value which should just saturate the transistor[6].



Fig(ii)

V.CIRCUIT DIAGRAM



Fig(iii)

VI.WORKING

In electricity generating road ribs, ribs carry a tiny permanent magnet, which is positioned between a fixed coil downside the ribs, forming a tiny electromagnetic generator. As the magnet vibrates in response to the vehicle movement, it induces a tiny current in the coil according to electromagnetic induction law. An NPN transistor is used in as a pulse generator with IC 555 timer in monostable mode, as a pulse generator, which pass a single pulse dc current to a load. A single pulsed current can be stored in battery or can be used for street lighting. Here in the project it is shown by a small LED. Now during daytime we do not need electricity for lightening the street lamps so we are using a control switch which is manually operated .The control switch is connected by wire to the output of the battery. The control switch has ON/OFF mechanism which allows the current to flow when needed. For the demonstarion BC-547 NPN transistor is used.

VII. REQUIREMENTS FOR THE IMPLEMENTATION OF THE PROJECT

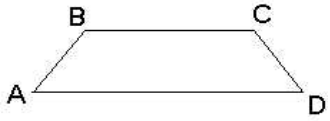
In Indian roads, currently we have speed breakers and ribs of rigid type, made of steel or with tar. When a heavy load crosses the speed breaker and ribs these remain unreformed, which alone limits the speed of vehicles. The national highways come with minimum 8 meters wide, 0.015m thickness. This project requires slight changes in the current roads. This project can be successful by changing the material of road ribs and/or by changing the designing of road ribs[7].

(A) BY CHANGING THE MATERIAL OF ROAD RIBS REQUIRED FOR THIS PROJECT

Using a mechanical system would mean the ribs would be weak so the main development made was to design the rib to be completely self contained and remove any moving parts. The design is a single rubber housing which contains two strips of magnets and a configuration of induction coils. The specific rubber is a 45 shore hard natural rubber which is extremely durable and flexible so allows the rib to function as it is designed to while being able to withstand the heavy loads and impact of passing vehicles. The shape of the internal detail means the coils are never moving parallel to the magnetic flux therefore giving the rib as high as possible induction potential. A further and very important point is its positioning on roads; it is to be placed in braking zones where vehicles should no longer be accelerating. This means any energy taken from the vehicle is not wasting fuel but assisting the vehicles' retardation. A number of other design developments include the use of neodymium magnets, wedge side detail for securing the rib in the road, the cushioning underside detail and flexi-pockets.

(B) BY IMPROVED DESIGNINGOF SPEED BREAKER

The speed breakers/ribs are fitted with helical spring at the base. The shape of speed breaker/rib is trapezoidal, because when a vehicle comes to point A, the load will be acting between A and B. This compresses the speed breaker; this goes down due to the presence of spring. When a vehicle is in between B & C, there will be maximum load on the speed breaker. At the C & D, there will be minimum load on speed breaker.



A hollow trench has to be dig out with dimensions slightly greater than the size of speed breaker. The dimensions are

Height: 0.35m

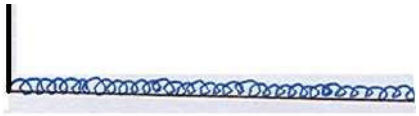
Length: 4m

Width : 0.45m

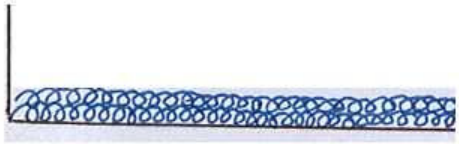
The bottom layer of the trench is filled with concrete or with wooden plates of 0.5m. This is for cushion effect. Above this layer helical springs of n windings is wounded.

The speed breaker is assumed to be a uniformly distributed load.

The self (dead) weight of speed breaker can be represented as



When a vehicle with a maximum load passes, it loads the speed breaker it is represented as



Therefore the total weight on the speed breaker is found to be the sum of initial (dead) weight and the weight of the vehicle (load applied).

Total weight (w)= Dead weight + Vehicle weight

For the design of speed breaker, the design weight can be found by the product of factor of safety and its total weight. The factor of safety determines the maximum level that the beam (speed breaker) can be loaded.

Spring design

The actual height of spring is 0.3m before loading. The deflection of the spring is given by

$\delta = 64\ w\ *n*N*R^3 / (Gd^4)$

Where

δ=deflection (in our case maximum δ =0.1m)

w=designed load

R= mean diameter of coil

d =diameter of wire

n=no of spring turns

G= Modulus of rigidity = 8*10^4 N/mm2

N= No. of springs

The no of turns in the spring to get the deflection of 0.1m is given by

n= δGd^4/ (64 w*N*R^3)

After the vehicle crosses the speed breaker, the air inside the base will be compressed

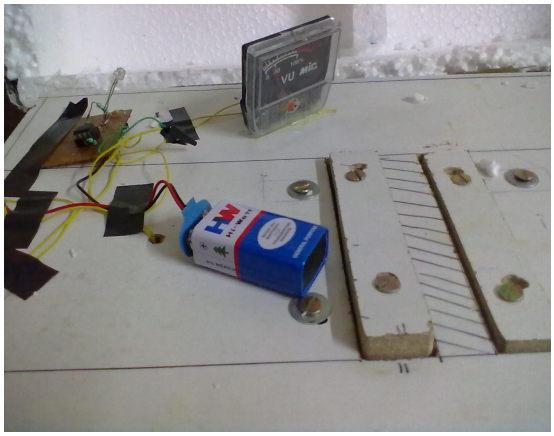


Fig.(iv)

The demonstarion of the circuit of the project was given by the fig(iii)

VIII.CONCLUSION

In this world where there is shortage of electrical power supply and conventional sources, this project will be helpful to solve some of the problems. This project has some advantages which are:-

- The project is economical and easy to install.
-This project is non polluting.
-Maintenance cost is low.
-Installation cost is low.
- Will solve some of the electricity problems of the world.
- The electricity produced by this system can be used to drive an electric motor or for any other purpose.
-This project can be implemented on road and can be used to lighten the street lamps.

-In future it can be used to charge car batteries.

IX.REFERENCES

[1] http://www.ecofriend.com/concept-road-ribs-make-your-vehicle-generate-renewable-energy.html (feb 03,2011)

[2] http://www.ecofriend.com/future-perfect-innovative-ideas-for-renewable-energy-generation-on-highways.html (feb 07,2011)

[3] Millmann Halkias, “Integrated Circuits”, TMH publication.

[4] Kuldeep sahay, “Basic Concept Of Electrical Engineering”

[5].http://en.wikipedia.org/wiki/555_timer_IC

[6]. www.kpsec.freeuk.com/trancirc.htm

[7] www.jamesdysonaward.org/.../Project.aspx?... - United Kingdom