

ENERGY EXTRACTION FROM ROADWAYS

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ABSTRACT

This paper attempts to show how energy can be tapped and used by a commonly observed mechanism. The Road Power Generation (RPG) is one of the most recent power generation concepts. Two methods of Road Power Generation are proposed in this paper. Firstly, the electricity is generated through the flip plate mechanism, for which a prototype model is developed and studied. Here, a permanent magnet D.C. generator generates 12V DC. This is stored in the Lead 12V battery and can be used to activate light, fan etc. Secondly, electrical power generation by simply passing vehicles on to the specially designed Roller setup is demonstrated. This needs no input power. The process of electric power generation comes under the mechanism of Kinetic to Electric power conversion. The kinetic-to-electric power generation is a method of generating electricity by harnessing the kinetic energy of automobiles that drive over the track. The track operates by virtue of a number of specially designed rollers typically placed on it. When the vehicles pass on the rollers, pressure is exerted on them. This develops the mechanical energy. By means of a specially designed setup, a generator is driven which is capable of producing AC/DC current.

Keywords: Flip Plate, Lead Acid Battery, Permanent Magnet D.C. Generator, Flywheel.

I. INTRODUCTION

A survey on the energy consumption in India has published a pathetic report that thousands of villages in India do not still have electricity. There is poor supply of power in many parts of the country. Any given road consists of a number of speed breakers. By the use of a setup like "Power Generation Unit from Speed Breakers", plenty of energy can be tapped and can be used for lighting the either sides of the roads. Thus, much power that is otherwise

consumed for lights can be utilized to power the villages.

India's passenger car and commercial vehicle manufacturing industry is the world's seventh largest, with an annual production of more than 3.7 million units in 2010. Road Power Generation (RPG) is one of the most recent power generation concepts. This concept is engineered as a practical and useful alternative energy-generating technology for getting clean electricity from the millions of vehicles on our roadways. In the proposed paper, we show a device converting kinetic energy of the vehicles into electrical power using a moving plate installed on the road. This plate takes the stroke motion of vehicles and converting it to the rotary motion by crank mechanism, thereby generating electricity.

II. BASIC MECHANISM

Requirements:

The main equipments that were used are Freewheel, Bicycle Rim, Helical spring, Pulley, Wooden frame, LDR, Microcontroller.

Working principle:

Road Power Generation (RPG) module converts the kinetic energy of the vehicles into electrical energy. This was done by the moving plate installed on the road. The plate captured very small movement from the road surfaces and transferred it to a keyway flywheel system. The RPG included the method of driving one flywheel to another, once it reached predetermined velocity. The RPG flywheel system was developed to achieve large amount of moment of inertia in relatively small space.

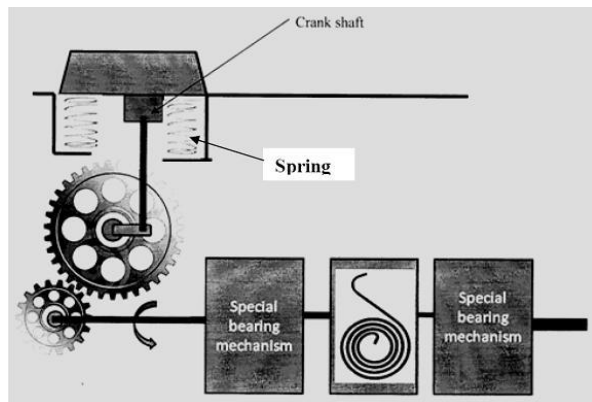


Figure1: Block diagram of automatic street light working

With the block diagram shown in Figure1, we can easily understand the overall working of the automatic street light.

The sensor LDR has the property to change its resistance according to the intensity of the light. As the intensity of light falling at the LDR increases, its resistance decreases. Hence the total amount of light remains constant.

III. FLIP PLATE MECHANISM

Working principle of flip plate mechanism:

The principle of the power generation using Flip plate mechanism is very simple. It is based on the same principle as that of hydroelectric power plant, thermal electric power plant, nuclear power plant, geothermal energy, wind energy, tidal energy etc. In all these power plants, mechanical energy is converted into electrical energy. In the proposed Flip plate mechanism as well, mechanical energy is converted into electrical power using a DC generator. Here the vertical motion of the Flip Plate top is converted into the rotational motion which, in turn, rotates the generator and generates electricity.

Operation of flip plate mechanism:

In the proposed concept, the two flip plates were mounted on the road surface. These plates were followed by the ‘rack and pinion’ arrangement. Pinion was mounted on the shaft that was attached to the frame via bearing. Frame was installed under the road. The flywheel with pulley was mounted on the shaft and second pulley was mounted on the DC

generator. These two pulleys were connected with the help of a belt.

As the vehicle wheel reached upper most position of the plates, they slid through guide, resulting in the downward movement of the rack to provide torque to pinion. The pinion transmitted this torque to shaft. Shaft was supported by two bearings attached on wall of frame. The shaft had pulley and flywheel arrangement through one way bearing. This arrangement was to enhance rotation of flywheel for small motion of shaft. The bigger pulley had 2 belts coupled with smaller pulley mounted on the DC generator shaft. The DC generator successfully converted the rotation of smaller pulley into electricity, as shown in Figure 2 below.

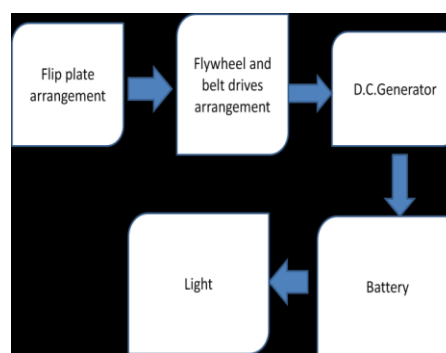


Figure 2: Operation of Flip Plate mechanism

IV. ROLLER MECHANISM

The Highway Energy Systems Ltd company, which invented Ramp, says that under normal traffic conditions, the Ramp apparatus is capable of producing 30kW electricity.

Components used:

Rollers:

Rollers are made up of hardened EN8 which is an unalloyed medium carbon steel with good tensile strength.

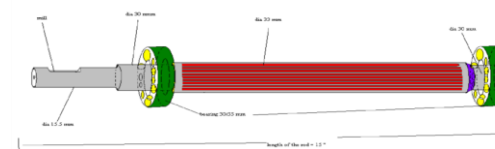


Figure3: Roller which is made with EN8 material

Bearings:

A bearing enables constrained relative rotation or linear movement between two or more parts. The

type of bearing used here is the widely used Rolling element type with relatively high friction.

DC generator:

An electrical generator is a device that converts mechanical energy to electrical energy, generally using electromagnetic induction. The source of mechanical energy may be a reciprocating or turbine steam engine, water falling through a turbine, a hand crank, or any other source of mechanical energy.

Working principle of roller mechanism:

The principle of the power generation using Roller mechanism is same as that of Flip plate, where mechanical energy is converted into electrical power using a DC generator. Here the rotational motion of the Roller is used to rotate the generator and generates electricity.

Operation of roller mechanism:

In the Roller Mechanism, a roller was fitted in between a speed breaker and flat road surface. A grip was provided on the speed breaker so that when a vehicle passes over it, the roller rotated. This movement of roller was used to rotate the shaft of DC generator by the help of chain drive which provided different speed ratios. As the shaft of DC generator rotated, it produced electricity.

This electricity can also be stored in a battery. The output of the battery is used to enlighten the street lamps on the road. During daytime, we used a manually operated control switch. The control switch was connected by a wire to the battery output. The control switch had ON/OFF mechanism which allowed the current to flow when required.



Figure4: Setup which has made

Shown in the Figure4 is the roller mechanism design which was built to generate power from moving vehicles on road. The set up consists of 7DC generators. The DC generators were fixed to crank connecting the roller.

Dimensions of Roller rode:

- Length = 2 feet,
- Diameter= 40mm.
- Basement dimensions:
- Length = 4 feet,
- Width= 1.8 feet,
- Height= 6cm.

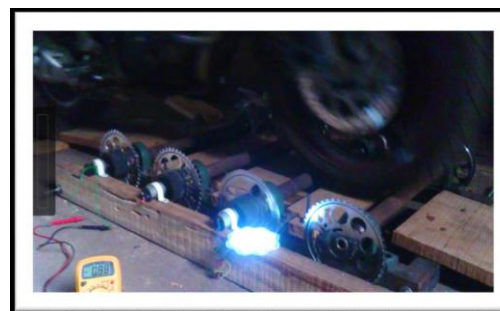


Figure5: output from the setup when vehicle passes over it

Initially, the set up was run by a bike and the roller started rotating. The rotation was sufficient for single DC generator to light up a LED setup of 12V. Even if there is an anti-direction rotation by the roller, the negative voltage is converted using bridge circuit. The output voltage and current (and therefore power) depend on the vehicle weight and speed. As the vehicle speed decreases, the output voltage and current increase. The main advantage of the circuit which was used herewas the reverse flow and the motors which are connected here are parallel and so we are getting constant voltage. However, the current gets added up. Figure 5 above shows the output when vehicle passes over it.

The mean power readings were taken from our consideration. As the vehicle with constant load passes on the setup with different speeds, the corresponding current and voltage were taken and plotted to get an almost linear graph.

Table 1: Vehicle loads and corresponding Voltages and Currents

Sl. No.	Load (Kg)	Voltage (V)	Current (A)
1.	135	2.3	0.1
2.	205	3.1	0.22
3.	270	4.08	0.31
4.	300	5.5	0.42
5.	440	7.2	0.6
6.	600	8.6	0.74

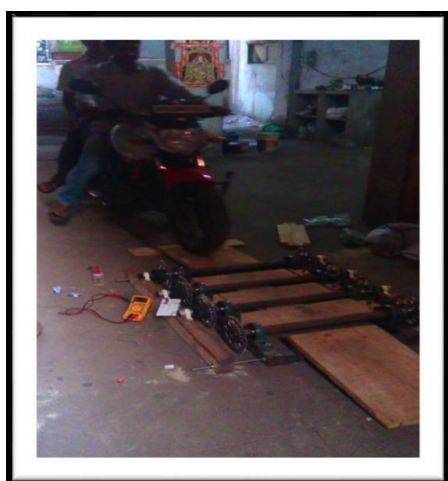


Figure6: Vehicle passage on the set up

4.1 Circuit Diagram

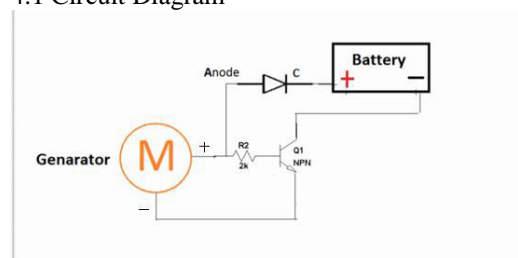


Figure7: Circuit diagram for individual motors

Individual motors were connected to the circuit. Motor negative was connected to the emitter and positive terminal of motor was connected to diode, through which it could be connected to the battery. Here, diode acts as rectifier and transistor acts as switch. The diode is placed because it stops the reverse flow which may make the motor non-functional. Similar circuit was made for all motors

and individual leads were connected to the battery for storage.

Energy Losses:

Energy loss is present in each stage from production to storage, is non-negligible. Energy loss happens in the battery, in the alternator/dynamo, in the converter and/or in the voltage regulator. This means that the total energy loss in a pedal-powered generator will be about 50-70 %.

Losses can be minimized by reducing the number of electrical connections and using mechanical connections as many as possible. Considering the cost factor, components of maximum efficiency must be used. For instance, NiMH batteries can be used since they are the most efficient among the rechargeable batteries.

V. CALCULATIONS

Assuming the weight of the two wheeler = 270Kg.
 Assuming the location as toll booth Assume Average speed of the vehicle = 20km/hr
 Maximum height of the plate = 10cm
 We know that, For mechanical system the power is the combination of force and movement.
 Therefore power is the product of a force on an object and its velocity.

Output Power calculations:

Let us consider,
 The mass of a vehicle moving over the flip plate = 270 Kg.
 Height of the plate from surface = 10 cm.
 Work done = Force x Distance
 But, Force = mass x acceleration due to gravity = 270x10 = 2700N
 Therefore, work done / sec = (2700x 0.10/60) = 4.5W (for one pushing force)
 Therefore, power developed for 1 vehicle passing over the flip plate for one minute = 4.5W
 Power developed for 60 min (1 hr) = 270 Whr
 Power developed per a day = **6048 W/day**.

Experimental Investigation:

The experimental investigation is performed by placing the speed breaker arrangement in a pit. Vehicles move over the speed breaker arrangement and the voltage generated is measured by a digital multimeter (DMM). The various readings are plotted.

The graphs are drawn for various parameters as shown in the Figures 8 and 9 below.

1. Voltage generated (Vs) speed of vehicle
 2. Voltage generated (Vs) Load
- Total load = 360 Kg (Vehicle load + man weight)

Table 2: Summary of Voltage generated versus speed of vehicles

Sl. No.	Speed of vehicles (Km/hr)	Voltage generated (Volts)
1.	10	8.93
2.	20	7.32
3.	30	6.05
4.	40	5.65
5.	50	4.04

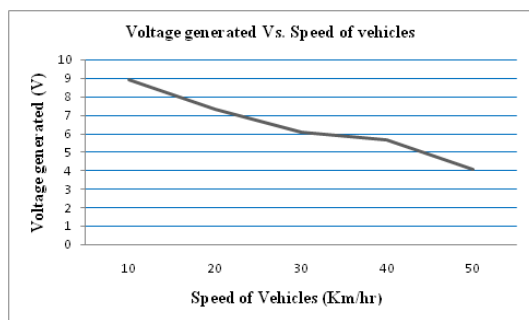


Figure8: The graph between voltage generated & under different speed of vehicles

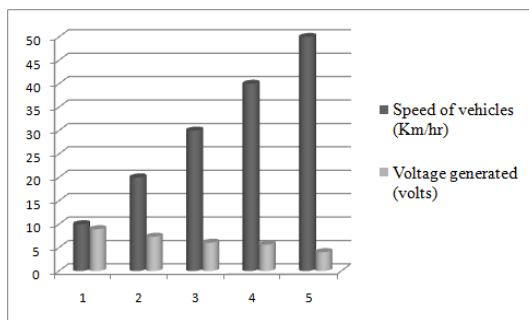


Figure9: The bar-chart between voltage generated & under different speed of vehicles

From the Figure 8, it can be seen that when the speed of vehicle increases, the voltage generated for designed system decreases.

Figure 9 shows the bar chart between voltage generated & under different speeds of vehicles.

Table 3: Summary of voltage generated & load of man and vehicles for the RPG

Sl. No.	Load of man & vehicle (Kg)	Voltage generated(V)
1.	360	8.33
2.	430	9.57
3.	470	10.44
4.	500	11.34
5.	570	11.81

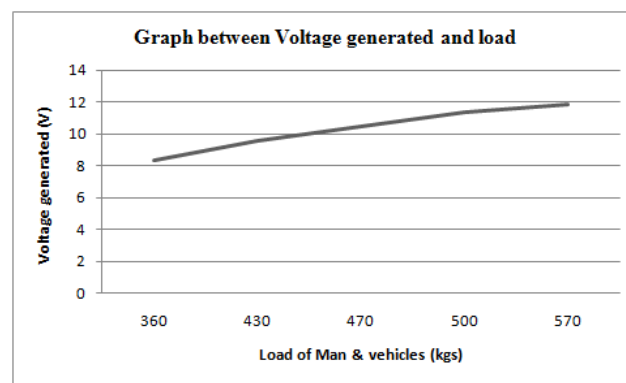


Figure10: The graph between voltage generated & load of man and vehicles

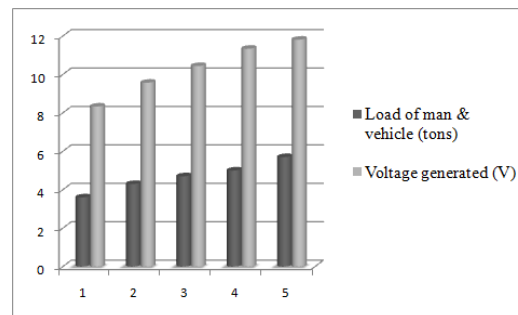


Figure11: The bar chart between voltage generated & load of man and vehicles

From Figure10, it is seen that if the load of man & vehicle increases, the voltage generated for designed system increases.

Figure11 shows the bar chart between voltage generated and load of man & vehicle.

VI. APPLICATIONS

Power generation using speed breaker system can be used in most of the places like the following:

1. On all highways.
2. On all roadways speed-breakers.
3. This mechanism of electricity generation can be placed on the actual speed breaker of the roads.
4. The output can be stored in batteries.
5. The power can be used at all places using the inverter, which may enhance voltage from 12V to 230V.
6. This power can be used for street lights, road signals, sign boards on the roads, lighting of the bus-stops, check post-lighting on the highways etc.
7. Low maintenance cost.
8. Low installation cost.
9. Pollution free power generation.
10. No manual work necessary during generation.
11. Simple construction, mature technology and easy maintenance.
12. No fuel transportation problem.
13. Energy available all year round.
14. No consumption of any fossil fuel i.e., non-renewable source of energy.
15. The units have minimum visual impact on their surrounding environment.
16. The RPG emits no noise.
17. This unit could be located at close proximity to services and power grid.
18. Completely isolated street lights or traffic lights.

VII. CONCLUSION

Road Power Generation was practically implemented, converting kinetic energy developed from moving vehicles to electrical energy. The higher frequency of passing vehicles provides higher capacity of this project which is designed for use on highways, common roads, entrance and exit of schools, colleges and companies, entrance and exit of malls and so on. Also, it can be installed at toll booths, bus stands, airports and railways parking zone electricity generated by road power generation.

This is a small step to try to improve power crisis situation and contribute something for the society, although less electrical output is being generated. The idea of generating electricity from kinetic energy of the moving vehicles was successfully implemented. If this concept can also be further developed and produced in high potential.

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