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Electric Power Generation from Road Humps

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Abstract: Energy serves as the fundamental element crucial for the survival of all life forms across the vastness of the universe. It acts as the cohesive force directing various processes shaping our environment. However, this delicate equilibrium is endangered by the depletion of traditional energy sources, worsened by the ever-growing global population. This dilemma leads to an imminent energy crisis expected to arise in the next five years due to excessive consumption. To navigate this challenging situation, there's a need for a significant shift in approach, urging the adoption of methods to maximize ³ the use of existing energy sources. In our research, there's a promising opportunity to tap ⁸ into kinetic energy, particularly from vehicles traversing over speed bumps. The proposal suggests converting these ordinary road features into dynamic generators, seamlessly transforming kinetic energy into electricity for the grid. This process involves sophisticated mechanisms like rack and pinion systems to efficiently convert kinetic energy into mechanical power, eventually generating electricity for storage and later use. This innovative solution not only addresses energy conservation but also promises economic benefits, utilizing stored energy to power street lights during the night, and enhancing urban landscapes with efficient illumination.

Key Words: Generator; non-conventional energy source; rack and pinion mechanism; chain sprocket; speed breaker.

I. Introduction

Energy scarcity is a global concern due to dwindling conventional sources like coal and oil. Alternative energy sources must be explored to combat this, particularly in regions with burgeoning populations like India. Harnessing the kinetic energy from vehicles passing over roads could be a viable solution. Various mechanisms such as ³ Rack and Pinion can be used for this purpose. Our project uses the Rack and Pinion setup to generate electricity as vehicles traverse speed breakers. This energy generation system aims to produce electricity for street lights, signals, and toll tax collection centers, among other uses. The initiative is eco-friendly, cost-effective, and occupies minimal space, promoting sustainability. By transforming speed breakers into generators, kinetic energy ³ is converted into electricity using a rack and pinion system. This electricity is then stored in batteries for later use. The project employs gear arrangements and electronic devices to extract energy from speed breakers efficiently. It aims to capture the energy released as vehicles traverse speed bumps, converting it into usable electrical energy. The central element of this setup is a U-shaped shaft with bearings, facilitating the conversion of vertical motion into rotational motion. A gear system connects the shaft to a DC generator, which charges electricity storage batteries. This stored energy can then be converted into usable AC power through an inverter for various applications. This energy generation system is particularly suitable for highways, offering a self-sustaining solution to address energy scarcity.

II. Method and Materials

Basic Principles:

When a ¹¹ vehicle moves over a speed breaker, it gains height due to the vertical displacement of the speed breaker. This results in an increase in potential energy. The principle involved is the conversion of potential energy into electrical energy. Instead of wasting this potential energy, we can tap into it and convert it into a useful form of electricity.

By employing an appropriate gear configuration and advanced technology, ² a speed bump can be repurposed to generate energy, enabling the economical production of a significant power output. ¹⁰ The generation of electricity from speed bumps can be achieved through one of three

fundamental mechanisms:

1. Implementation of a roller system
2. Utilization of a crankshaft mechanism
3. Application of 3 a rack and pinion system

Block Diagram

The rack-and-pinion mechanism has a well-established history of yielding substantial output with minimal input. The objective of the project is to develop a system akin to speed breakers that can effectively generate electricity. In this context, the rack and pinion setup experience the force applied

by the speed breaker configuration. Here, the 2 rack and pinion arrangement translate the reciprocating action of the speed breaker into rotational motion. A gear is affixed to the axis of the pinion, facilitating its rotation. 14 The meshing of a pinion into this gear allows for the multiplication of speed at the gear, which is contingent on the gear arrangement, effectively transmitting power from the gear to the pinion.

The presence of two gears of varying sizes is observed in this scenario. The axis of the pinion is linked to the larger dimension of the gear. This larger gear receives the speed that was amplified at the smaller sprocket wheel. All pinions 8 engaged with the gear contribute to continuing the multiplication of speed by a greater factor as the gear rotates at the multiplied speed of the pinion. Consequently, despite the initial lower speed achieved at the first gear due to circular motion, the speed is escalated as power is transferred to higher gears. The rotor in a generator can be propelled at this enhanced speed. The electrical output results from 2 the rotation of the rotor within a stationary magnetic stator, leading to a reduction in the surrounding magnetic flux (emf). After generating an electromotive force (emf), the ensuing alternating current (AC) undergoes conversion to direct current (DC) through a bridge rectifier. This controlled emf is then supplied to the lead-acid battery.

Components:

1. Flywheel: - A flywheel is a mechanical device designed to store rotational energy. It is a heavy wheel attached to a rotating shaft to smooth the transfer of power from an engine to a machine and to resist changes in rotational speed. 9 When energy is input to the flywheel, typically through a motor or some external force, it accelerates and stores that energy in its rotational motion.
2. Shaft: - 13 A shaft is a cylindrical machine component in constant rotation, commonly circular in shape, utilized to transfer power either between different segments or from a power-generating machine to one that consumes power. 8 It serves as a dynamic element, facilitating the movement of power across various locations.
3. Spring: - It is characterized as a flexible object designed to deform under load and regain its initial shape upon load removal. This object functions to dampen, absorb, or regulate energy, be it from shocks or vibrations.

4. Bearings: - It is a mechanical component that provides support for machinery, enabling relative motion between contacting surfaces while carrying loads. Bearings serve to minimize friction and facilitate effective motion transmission.

5. **2 Rack and Pinion:** - In the context of power generation speed breakers, a rack and pinion system may be utilized to harness mechanical energy from the up-and-down motion of the speed breaker. The system typically involves a toothed rack fixed to the speed breaker and a pinion gear connected to a generator or power generation mechanism. As a vehicle passes over the speed breaker, the vertical motion of the rack engages with the pinion gear, causing it to rotate. **12 This rotational motion is then transferred to a generator or power generator, converting the mechanical energy from the vehicle's motion into electrical energy.**

6. Gears: - Gears are mechanical components consisting of toothed wheels or cylinders designed to engage with each other. They are commonly employed to transmit motion and power between rotating shafts in machinery. The teeth on gears mesh in a precise manner, allowing them **3 to control the speed, torque, and direction of rotation.**

7. Chain & Sprockets: - In the context of power-generating speed breakers, a chain and sprocket system might be utilized **2 to convert the up-and-down motion of the speed breaker into rotational motion for power generation.** The chain, consisting of interconnected links, is connected to the speed breaker, and one or more sprockets with teeth mesh with the links. As the speed breaker moves, it sets the chain in motion, causing the connected sprockets to rotate. This rotational motion can then **2 be used to** drive a generator or power generation mechanism, converting the mechanical energy from the motion of the speed breaker into electrical energy.

8. Generator: - In this setup, a DC generator operating at 1000 rpm is utilized to convert mechanical input from mechanical configurations into electrical output. The rotary motion of the shaft, which originates from the curved rack and pinion system, supplies the input to the DC generator.

Specifications of Generator:

- Current Capacity = 1.5 A
- Voltage = 24 V
- Torque = 4 kg

III. Design

Figure 1. Side view

Figure 2. Generation unit

Table 1. Voltage generated vs load.

Vehicle load

(Kg)

Max. Vol. generated

(volts)

Mean Power

(Watt)

220

22.1

33.15

260

23.4

35.1

370

25.5

38.25

455

26.3

IV. Discussion

The production of electricity has emerged as a significant concern in contemporary society, intensifying the need for continuous improvement. Speed breakers offer three distinct avenues for electricity generation; however, due to the experimental nature of the prototype project, real-time tests with heavy vehicles were not feasible. Instead, we employed various weights ranging from 5kg to 40kg, measuring output voltage and current using a multimeter and maintaining a 220-ohm resistance throughout. The obtained results proved insufficient, primarily due to multiple losses such as friction, torque, and mechanical inefficiencies. In response to these challenges, this article delves into the potential of utilizing highway speed breakers as a renewable energy source. Via a rack and pinion system, the kinetic energy of moving vehicles can undergo conversion into the mechanical energy of a shaft. This shaft is linked to an electric dynamo that generates power in direct correlation to traffic volume. Zener diodes play a role in controlling the generator's output to ensure a consistent electricity supply. The hump-shaped speed bump serves as a housing for all this machinery, and the electricity produced finds versatile applications, including powering public utilities such as lamps and traffic signals. Creating a series of these power humps amplifies their electrical output, and various electric devices can be employed to enhance and store this power. The maintenance cost of these humps is essentially zero, making this plan a potential solution to meet future energy needs, at least partially.

V. Conclusion

This project utilizes kinetic energy and downward force exerted by vehicles when losing speed to generate power through a speed breaker mechanism. The wastage factors are harnessed to increase efficiency, reducing frictional losses from previous designs. The mechanism operates smoothly, improving overall efficiency. It functions as a one-side mechanism without the need for additional

equipment to convert roads to one-way use, although modifications can enable two-way functionality. Implementing an energy generator mechanism on roads can provide power to illuminate city streets and boulevards, and supply low-voltage power to cameras or speed sensors, contributing to sustainable urban infrastructure.

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