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Design of Hardware Model for Electricity Generation by Speed Breaker through Rack And Pinion Mechanism

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Abstract - *In the present scenario power becomes major need for human life. Due to day-to-day increase in population and lessen of the conventional sources, it becomes necessary that we must depend on non-conventional sources for power generation. While moving, the vehicles possess some kinetic energy and it is being wasted. This kinetic energy can be utilized to produce power by using a special arrangement of rack and pinion also called as "POWER HUMP". This paper is about the hardware model of electricity generation through speed breaker using new technique called as rack and pinion mechanism.*

Keywords: Kinetic Energy, Rack and Pinion Mechanism, Speed Breaker Model, Electric Dynamo.

1.INTRODUCTION

In the present scenario electricity becomes the major need for human life. Energy crisis is due to two reasons, firstly the population of the world has been increased rapidly and secondly standard of living of human beings has increased. India is the country, which majorly suffers with lack of sufficient electricity generation. In this paper we are looking forward to conserve the kinetic energy that gone wasted, while vehicles move. The number of vehicles passing over speed breaker on road is increasing day by day. So we use that energy of vehicles to generate electricity. Beneath speed breaker, setting up an electro-mechanical unit known to be power hump, could help us conserving this energy and use it for electricity generation.

[1] B. Santosh Sarma1, V. Jyothi, D. Sudhir "Design of Power Generation Unit Using Roller Mechanism" (IOSR-JEEE) the author suggested that by using simple drive mechanism such as Roller, some interfaced Electrical components and chain drive Mechanism. [2] Pranay Vijay Ashtankar, Pratik H. Bendle, Krunal Kene, Milind R. Kalbande, Pratik Makhe "Road Power Generation (RPG) by Flip plate Mechanism" (IJSETR), Author said that the electricity is generated through the flip plate mechanism.[3] Hasan Qureshi, Amir Shaikh, Fareed Mansuri "Electricity Generation from Speed Breaker by using Rack and Pinion" (IJRAT), According to author to construct an unit which is capable of producing electricity using kinetic energy of vehicles passing over the speed breakers with the help of rack and pinion arrangement beneath it.[4] A. Padma Rao , A. Kiran Kumar and S. Suresh "Power Generation from Speed Breaker by Rack and Ratchet Mechanism" (IJCET), The author suggested that the renewable sources of energy become more popular because of non-polluting and easily available from the nature. [5] Miss. Shraddha Deshpande, Miss. Bhagyashri Kulkarni, Prof. Ashish Joshi "Electricity Generation Using Speed Breaker" (IRJET), Author suggested that the mechanism of electricity generation from speed breakers.[6] K. Saicharan Teja, K. Sandeep Reddy, K. Anil Kumar, K. Varun Raj, Venkata Phani. " Electricity generation from speed breaker using crank and shaft mechanism" (IJMETMR), Author gives the information about the crankshaft mechanism that transforms rotary movement in to linear movement, or vice versa.[7] Abhishek Gupta, Nikita Mittal, Pushpendra Pal Singh, Ram Arora, Ramakrishna Dhakar, Purab Chand "Electricity generation from speed breaker by using rack and pinion" (IJEER). [8] Aniket Mishra, Pratik Kale, Atul Kambale "Electricity generation from speed breaker by using rack and pinion" (IJES), Author suggested that this technique gives how to utilize the energy which is wasted when the vehicles passes over a speed breaker.[9] Ramakrishna Prabu, G.Ethiraj" Electricity generation by speed breaker" (IJAREEIE), Author gives the information about the Electricity Generation by Speed Breaker.[10] Pravin K Ghule "Electricity generation from speed breaker using rack and pinion" (IJARIIE), Author suggested that this technique gives how to utilize such energy source and in which we had studied various mechanism which can installed to convert such wasted energy into useful form.

The organization of paper is as: Section (I) gives the introduction and literature review of hardware model. Section (II) consist of hardware model and components, operational block diagram of electricity generation from speed breaker using rack and pinion mechanism and working, section(III) discussed about system analysis which includes design of rack and pinion and power calculations. Section (IV) includes the advantages, disadvantages and

applications of proposed model. Finally section (V) provides comparison of different mechanisms and the conclusion from the discussion on proposed system.

2. Hardware Model:

Hardware model is shown in Fig 2.1 and 2.2 it consist of mechanical parts rack and pinion, chain and sprocket, flywheel, shaft, hump and electrical parts such as dynamo generator. The side view and front view of the hardware model is shown in Fig. 2.1 and 2.2 repectively.

Fig. 2.1 Side View of the Hardware Model

Fig. 2.2 Front View of the Hardware Model

3 Components of hardware model

The various mechanical and electrical components are explained as follow:

3.1 Rack and Pinion: A rack and pinion is a type of linear actuator comprises of a pair of gears which convert reciprocating motion into rotational motion or vice versa. A circular gear called the pinion engages teeth on a linear gear bar called the rack. Here, the rack is the element producing reciprocating motion and pinion rotates due to this reciprocating motion. The rack is displaced vertically due to the weight of the vehicle passing on the speed breaker and thus it reciprocates. As the rack reciprocates, it turns pinion to rotate. The rack is the flat part which has teeth, while the pinion is a gear.

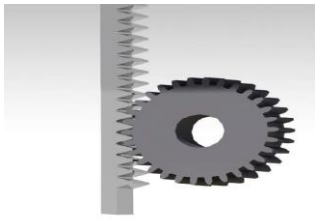

Fig.3.1 Rack and Pinion

3.2 Chain and Sprocket: The sprocket arrangement is made of two sprockets. One of the sprocket is larger in dimension than the other sprocket. Both the sprockets are connected with chain which transmits the power from the larger sprocket to the smaller sprocket.

Fig 3.2 Chain and Sprocket.

3.3 Spring: A spring is defined as an elastic body, whose function is to compress when loaded and to recover its original shape when the load is removed. The various important applications of springs are as follows:

- To apply forces, as in brakes, clutches and spring loaded valves.
- To measure forces, as in spring balances and engine indicators.

Fig.3.3 Spring

3.4 Shaft: Shaft is a rotating element, which is used to transmit power from one place to another place. It must have high torsion rigidity and lateral rigidity. The transmission shaft usually refers to a circulating cross-section, with support transmission element like gears, pulleys.

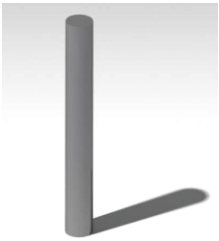

Fig.3.4 Shaft

3.5 Bearing: A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts.

Fig 3.5 Bearing

3.6 Fly Wheel: Flywheel is rotating mechanical device that is used to stored rotational energy. Flywheels have a significant moment of inertia and thus resist changes in rotational speed. The amount of energy stored in flywheel is proportional to square of its rotational speed. Energy is transferred to a flywheel by applying torque to it, thereby increasing in its rotational speed and hence its stored energy. Conversely a flywheel releases stored energy by applying torque to a mechanical load thereby decreasing its rotor speed.

Fig.3.6 Flywheel

3.7 Belt and Pulley Arrangement

By using the belt pulley arrangement, revolutions of the generator shaft can be increases four times the shaft speed. in belt pulley arrangement, pulley is connected to the one end of shaft and further this pulley is connected to the generator shaft with help of belt.

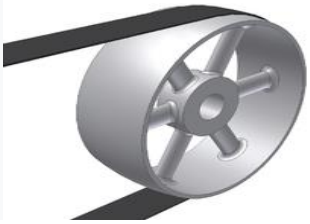

Fig.3.7 Belt and Pulley

3.8 Dynamo Generator: A dynamo is an electrical generator that produces direct current with the use of a commutator.

4. Block Diagram:

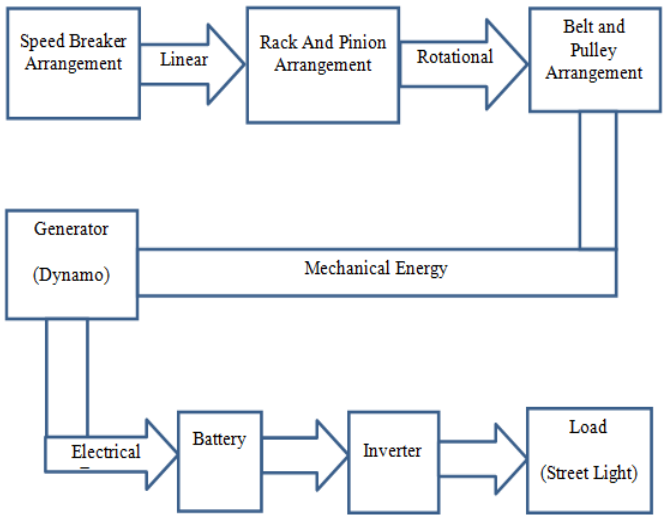

Fig.4 Block Diagram of Electricity Generation from Speed Breaker

5. WORKING:

This paper explains the mechanism of electricity generation from speed breakers. When vehicle moves on the speed breaker, the rack it will be pushed down. The rack is attached with the pinion. Then, reciprocating motion of the speed-breaker is converted into rotary motion using the rack and pinion arrangement where the axis of the pinion is coupled with the sprocket arrangement. The sprocket arrangement is made of two sprockets. One of the sprocket is larger in dimension than the other sprocket. Both the sprockets are connected with chain which transmits the power from the larger sprocket to the smaller sprocket. As the power is transmitted from the larger sprocket to the smaller sprocket, the speed that is available at the larger sprocket is relatively multiplied at the rotation of the smaller

sprocket. The axis of the smaller sprocket is coupled to a flywheel. Hence, the speed that has been increased at the smaller sprocket wheel is passed on to flywheel of larger diameter. Therefore, as the flywheel rotates it increases the speed and multiplies the speed to more rotations. Though the speed due to the rotary motion achieved at the larger sprocket wheel is less, as the power is transmitted to flywheel, the final speed achieved is high. This speed is sufficient to rotate the rotor of a generator and is fed into the rotor of a generator. But, we use the belt and pulley arrangement to couple the dynamo generator with the shaft due to following reasons:

- We cannot connect the generator directly to the shaft.
- In order to increase the speed of rotation of the generator.

By using the belt pulley arrangement, revolutions of the generator shaft can be increases four times the shaft speed. In belt pulley arrangement, pulley is connected to the one end of shaft and further this pulley is connected to the generator shaft with help of belt. The rotor of generator start to rotate as it gets the mechanical energy. This rotor rotates within a static magnetic stator cuts the magnetic flux surrounding it, thus producing the electric motive force (emf). This generated voltage is dc. This generated dc voltage is stored in battery during the day time and can be used in night time for providing power to street lights.

5.1 Rack And Pinion Mechanism:

The mechanism used in the assembly is rack and pinion mechanism. It converts reciprocating motion into rotary motion. A rack and pinion is a type of linear actuator comprises of a pair of gears which convert reciprocating motion into rotational motion or vice versa. A circular gear called the pinion engages teeth on a linear gear bar called the rack. Here, the rack is the element producing reciprocating motion and pinion rotates due to this reciprocating motion. The rack is displaced vertically due to the weight of the vehicle passing on the speed breaker and thus it reciprocates. As the rack reciprocates, it turns the pinion to rotate. The rack is the flat part which has teeth, while the pinion is a gear.

Advantages of rack and pinion mechanism:

- This assembly gives good mounting convenience.
- Gear losses are minimum up to 5%.
- Approximate efficiency of rack and pinion mechanism is about 95%.

6. SYSTEM ANALYSIS:

6.1 Rack And Pinion:

Calculations of Rack and Pinion System parameters are given by following formulae

Parameters involved:

Module = Pitch Circle Diameter (D) / No. of teeth (N)

Radius of Pitch Circle (r)

Addendum (a) = module

Circle radius of addendum (ra) = r + a

Pressure angle of pinion (Φ)

Length of path of contact = (a / sin Φ) + {[ra ^2 – (r sin Φ) ^2]} ^0.5 - r sin Φ mm

Length of arc of contact = Length of path of contact / sin Φ

Minimum number of teeth in contact = Length of arc of contact / π m

Angle turned by the pinion = Length of arc of contact x 360 / 2πra

Where 2πra = minimum length of rack

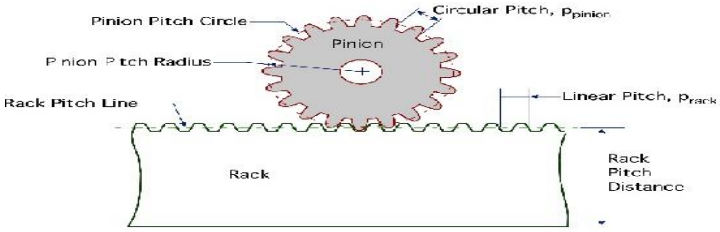

Fig. 6.1 Rack and Pinion Parameters

6.2 Power Calculations:

Power calculation according to project model:

The mass of any vehicle travelling over the speed breaker= 90 Kg (Approximately)

Height of speed breaker = 20 cm

Work done = weight of the body x distance travelled by the vehicle

Here, Weight of the Body = 90 Kg x 9.81 = 882.9 N

Distance travelled by the body = Height of the speed breaker = 20 cm

Power = Work done/Second= (882.9 x 0.2)/60 =2.943 Watts

Output Power developed for 1 vehicle passing over the speed breaker arrangement for one minute = 2.943 watts

Power developed for 60 minutes (1 hr) = 176.58watt

Power developed for 24 hours = 10.594 kw

Power calculations for different weight and heights of speed breaker are calculated in table 6.2.

Table 6.2 Power Calculation

Sr. No.	Vehicle Load (Kg)	Height of Speed Breaker (Cm)	Output Power (W)
1.	90	20	2.943
2.	205	15	5.02
3.	250	15	6.13
4.	320	15	7.84
5.	400	15	9.81

7.1 ADVANTAGES

- Power generation with low cost and using non-conventional energy sources which will help us to conserve the conventional energy sources to meet the future demand.
- By using this method, electricity will be generated throughout the year without depending on other factors.

Sr. No	Parameter	Roller Mechanism	Rack And Pinion Mechanism	Air Piston Mechanism
1	Cost	Cheap	Moderate	Costly
2	Mechanism Setup	Very Easy	Difficult	Very Difficult
3	Maintenance	Less Required	Weekly Basis	Daily Basis
4	Efficiency	50%	70%	85%
5	Design	Easy To Design	Depend Upon Weight Sustaining Capacity	Depend Upon Compressing Power Of Piston

- Easy for maintenance and no fuel transportation problem.
- Pollution free power generation.
- Less floor area required and no obstruction to traffic.
- No need of manpower during power generation.

7.2 DISADVANTAGES:

- We have to check mechanism from time to time.
- It can get rusted in rainy season so frequent maintenance is required.

7.3 APPLICATIONS:

1. Street Lights

A Street light which is turned on or lit at a certain time every night. Modern lamps may also have light-sensitive photocells to turn them on at dusk, off at dawn, or activate automatically in dark weather.

2. Traffic Lights

Traffic lights are signaling devices positioned at road intersections, pedestrian crossings and other locations to control competing flows of traffic

3. Toll Plaza

At the toll plaza huge amount of electricity generated from speed breaker by vehicles. This electricity is used for the lighting purpose, signaling, and in various systems.

4. Housing area

In housing area we can used for lighting, and low power application like door bell, mobile charger etc.

5. School area

In school areas generated energy is used for the Lighting purpose and for various systems used in school like personal computers, ringing bell, bio metric machine etc.

8. COMPARISON BETWEEN DIFFERENT MECHANISMS:

Table no.8 comparison between different mechanism

9. CONCLUSION

In this paper we discover technology to generate electricity from speed breakers in which the system used is reliable and this technique will help conserve our natural resources. Due to population explosion, the current power generation has become insufficient to fulfill our requirements. From this hardware model we generate the electric power of 3watt in 60 sec by applying 90 kg weight on 20 cm height of speed breaker and the power developed for 60 minutes (1 hr) is 176.58 watt. Power developed for 24 hours is 10.594 kw for same weight and height of speed breaker. As the conventional sources are depleting very fast, it's high time to think of alternative resources. We got to save the power gained from the conventional sources for efficient use. So this idea not only provides alternative but also adds to the economy of the country.

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