

A Detailed Study on Power Generation using Speed Breakers

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Abstract: *Today we see many vehicles on road creating pollution and using its mechanical energy only for transportation purpose, but if we use that kinetic energy of vehicles to convert into some useful electrical energy then we can use that energy for street lights and can save at least some amount of electrical energy. In this article various methods of generating power using the speed breaker are listed and studied carefully. Many authors conducted many experiments on each type of power generation method, and the results are noted down here. The methods listed here are rack and pinion method, roller speed breaker, crankshaft and piston mechanism, hydraulic speed breaker.*

Keywords: Power Generation, Speed Breakers

I. INTRODUCTION

The energy crisis is one of the major problems in our country. The pollution caused by generating power is enormously high. Even though we have many kinds of renewable energy sources we are affording the normal conventional methods in generating power. In addition to this pollution, we are having many vehicles on road creating more pollution. So, we are hurting our environment in many methods. So, this project can help the environment to escape from the pollution, not totally but a little bit. Since we see many vehicles on road, we can use the energy from those vehicles to generate electrical energy. All the vehicles use their kinetic energy in order to move from one place to another. In this process, it is wasting more energy. We can use that kinetic energy and convert it into electrical energy. We can provide the speed bumps on roads with specialized mechanisms under them. So, whenever a vehicle moves over the speed bump, the speed bump takes the kinetic energy of the vehicle and converts it into mechanical energy and which further converted into electrical energy. The process of generating electrical energy by this method is of different kinds. They are:

- Rack and pinion mechanism
- Roller speed breaker
- Crankshaft and piston mechanism
- Hydraulic speed breaker.

1.1 Rack and Pinion Mechanism

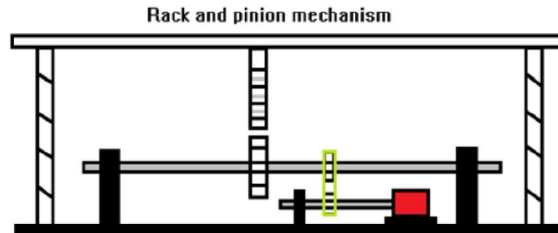
The process of generating power using the rack and pinion method is efficient and many authors conducted the experimental studies on this process. This method has a rack which creates linear motion and a pinion which converts that linear motion into rotatory motions. That rotary motions are transferred to the generator. In between a gear train or transmission system is built in order to transfer the energy efficiently. At the end of transmission system there is a generator connected. We all know the purpose of the generator that is to convert the mechanical energy to electrical energy. The power generated will depend upon the efficiency of rack and pinion mechanism and the transmission system.

A. Working

So, we see many vehicles on roads and as well as speed bumps for controlling the speed of the vehicles indicating speed limit on roads. The design of the speed bump is of special kind that is the speed bump is designed as a kind of suspension system. The speed bump is spring supported at both ends. So, whenever a vehicle or weight passes over the speed breaker the springs under the speed breaker takes the energy and gets compressed. During this process the speed breaker is able to

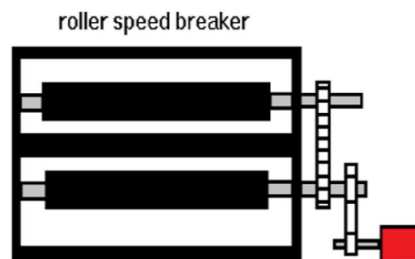


generate the linear motion. As the rack and pinion mechanism is connected to the speed breaker the linear motions created by the speed breaker is taken by the rack and pinion mechanism. So that rack and pinion mechanism converts the linear motion to the circular motion. That circular motions are transferred to the generator by using the transmission system. The transmission system is may be of different kinds i.e., gear train, belt drive, chain sprocket mechanism.



1.2 Roller Speed Breakers

In this type of process the circular motions are directly generated by the speed breakers. Many authors conducted experimental on this process by using the different kinds of friction material as a speed bump covering material. But in this method the efficiency of the system totally depends on the speed of the vehicle. The speed of the vehicle is directly proportional to the efficiency of the system. So, in many commercial areas the role of the speed bump is to reduce the speed of a vehicle. Keeping that factor in mind the speed breakers are designed with good friction material so that the speed bump can take more energy from the vehicle. Remaining mechanism is same to every process that is the rotational energy from speed breaker is transferred to generator by using transmission system and it may be of any kind i.e., gear train, chain sprocket, belt drive.



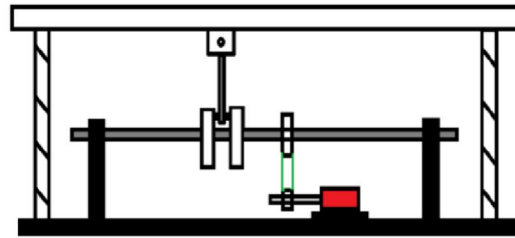
A. Working

As the speed breaker is a roller both the ends of the speed breaker are bearing supported. The speed breaker is covered or wrapped in a friction material. So, whenever a vehicle passes over the speed breaker, due to the friction between the wheels and the speed breaker, and the bearing support makes the roller speed breaker to generate circular motions. So, the speed bump itself creates the circular motions here. That circular motions are transferred to generator by using the transmission system. Since here the speed breaker itself creates circular motion there no need of mechanical energy conversion, which means there is no lot of energy losses or may have less losses compared with other process. And the efficiency of the system depends on the type of the friction material using to wrap around the speed bump, and as usual the transmission system.

1.3 Crank Shaft Mechanism

As we all know the use of crank shaft i.e., converting of the linear motion to the circular or rotary motion. The use of this method for generating power good but as it has many moving parts there will be a lot of heat generated and vibrations in the system. So, the system should be designed carefully while selecting such type of systems. As the specialized speed breaker can afford linear motion the piston and crank shaft mechanism can generate circular motions. As our main motto is to generate electrical energy these circular motions can be transferred to generator by using an efficient transmission system.

piston and crank shaft method



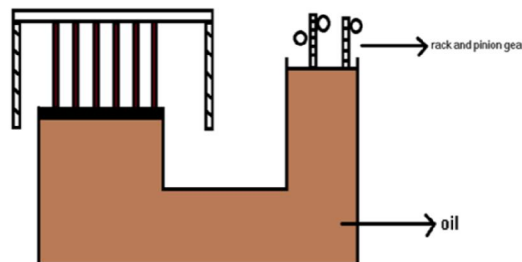
A. Working

The use of piston in automobile engineering is to convert the thermal energy to mechanical linear motion. That mechanical linear motion is converted into circular or rotary motions using the crank shaft mechanism. That rotary motions generated by the crank shaft is sent to the differential using power transmission system. Here in the process of power generation by using the crank shaft mechanism uses kinetic energy instead of thermal energy to push the piston down or to generate the linear motion. So, whenever a vehicle passes over the speed breaker the speed breaker pushes down the piston due to the kinetic energy applied on the speed breaker. So, the piston makes the crank shaft to complete half revolution. As crank is designed on basis of inertia the crank itself makes the other half of the revolution in order to push the piston up. So, the piston comes to its original position by bringing the speed breaker to its original position. In such a way the crank shaft mechanism is able to create the circular motion. That circular motions are transferred to the generator by using the transmission system.

1.4 Hydraulic Speed Breaker

The hydraulic speed breaker mechanism shown better results while compared to crank shaft mechanism. This process uses pistons in order to compress the oil. So that the power is supplied to the system. All the equipment may be costlier here.

hydraulic speed breaker



A. Working

Here also the speed breaker is a spring supported at both the ends so that the speed breaker can create linear motion. And pistons are provided under the speed breaker such that the speed breaker pushes down the pistons whenever a vehicle passes over it. Such that piston can compress the oil provided under the piston. The compressed oil travels to the accumulator. The accumulator is further connected to the motor which generates torque. That torque is used to generate the electrical energy.

II. LITERATURE REVIEW

The speed breaker is connected to the U-shaped shaft with help of the connecting rod, and springs are used in order to provide the return motion of the speed breaker after the vehicle passes over it. the U-shaped shaft is connected to the sprocket and using a chain drive mechanism the power from U shaped shaft is transferred to the small sprocket which is transferred to the DC motor using gear drives, which in result generates power. The specifications of the equipment used in this particular arrangement are as follows, permanent magnet

D.C. generator, the voltage generated is 12 Volt D.C. This D.C. voltage is stored in the lead 12-volt battery. The battery and inverter are connected. The inverter is used to convert 12 volts D.C. to 230 volts A.C. [1].

The speed breaker used is a roller type that rotates as the vehicle moves on it then the kinetic energy is converted into mechanical energy which is then converted into electrical energy. which means when a vehicle moves over a roller, the rollers are arranged in a way of free rotation and mounted on bearings on each side so the moving vehicle makes the roller rotate. The roller speed breaker is connected to a sprocket which is mounted on bearings. The chain drive is used to transfer the motion from a sprocket to gear which is used to drive the motor to generate electricity. As a result, we can see that if the speed of the car increases, then the speed of the roller also increases which helps in increasing the efficiency. [2]. The number of rollers used is 3 which are connected by a chain sprocket mechanism, to achieve uniform motion when a vehicle is passed over the speed breaker. the total mechanism is the same as explained before in roller type speed breaker as the kinetic energy is converted into mechanical energy which after is converted into electrical energy. but here it is mentioned the efficiency given by this speed breaker power generator is very low as the test is done by a two-wheeler and also mentioned that for a day the average number of vehicles passed on a speed breaker is more which automatically gives more efficiency. the fine advantage of this process is that the moving parts are less compared to other processes and also the maintenance cost is also less .in this process we are able to reduce the maintenance cost by replacing the chain mechanism with a V-belt mechanism which will reduce the lubricating cost. And The amount of friction can be increased by providing the texture on the roller in order to make the fine rotational motions of the roller when a vehicle passes over it.[3].

The power generated by the speed breaker process uses the rack and pinion mechanism to generate the power. The kinetic energy of the car is converted to linear motion when the car is passed on the speed breaker and the linear motion of the speed breaker is converted to the rotational motion using the rack and pinion mechanism. since the moving parts are less its maintenance cost is less. The circular motion created by the rack and pinion mechanism is transferred to the chain sprocket mechanism and transferred to the DC motor which in result generates the electricity. here a flywheel is used in order to maintain a uniform speed of rotation.[4] Ammar Ahmed explained about the designing of movable-speed bump-based mechanism is used to store kinetic energy which is dissipated when automobiles run on bumps. The system is designed as follows consists of Integrated double-sided rack which has two racks on either ends parallel to each other attached to each pinion and these pinions are connected to two separated gears. The pinion is placed between two gears to increase velocity further this pinion is attached to Flywheel for conservation of angular momentum so as to increase efficiently store rotational energy which occurs during motion of rack and pinion. This flywheel is attached to generator for conversion of Mechanical into Electrical energy. The motion analysis of system is performed on cad model which is designed in Solid works. Different levels of frequencies are applied and analysed using Autodesk Inventor. The force sensors are placed for noting the amount of force applied by different automobiles. To find an accuracy of measured results the uncertainty calculations are performed for finding Errors further developed an Equation. Selection of Generator is based on less Electrical damping and resistive load for higher Efficiency. On basis of obtained results the overall Efficiency of mechanical energy harvester (MEH) is calculated as 57.5%. It is concluded by the both practical and simulation results are compared which results by 5.7% in difference of efficiency.[5] Aniket Mishra conducted an experiment with the load of 300kg, and Power developed for 60 minutes (1 hr) is 441.45 watts. The power generated by this can be more sufficient to run four street lights in the night time [6]. Mohammad Ramadan conducted the experimental studies and the results were roughly 26.2 to 44.7 W by the masses of 65 kg and 80 kg. if the masses increases then the output power also increases linearly. it is believed that the power generated can be supplied to the street lights, cameras, and the radars on the roads [7]. Sanket S. Khodke eliminated use of chain, sprocket and flywheel to make the model simple and installation easy. The rectifier is used to convert the AC power to pure DC power at the end of the circuit. The rectifier used is bridge rectifier which consists of 4 rectifier diodes [8]. The process of power generation by rack and pinion method is conducted and the power generation by using roller mechanism is also used. As we all know whenever a rolling motion transfers on the roller arrangement the rollers in the arrangement also get rolled. So, by using this simple process power can be generated. When a vehicle passes through this roller arrangement speed braker the rollers get rotated. The rotations of the roller are transferred to the gear arrangement and then the maximum amount of the rotations is transferred to the generator or motor and thus electricity is generated and that generator is connected to the battery. By using this power road street lights can glow. The differences between roller, rack, and pinion method are mentioned here such as the roller method is less efficient and rack and pinion method are more

efficient, the maintenance required for roller method is high compared to rack and pinion method, designing of roller method is easy as compared to rack and pinion method. [9]

2.1 Crank Mechanism

As we all know the crank mechanism is used to convert the linear motion to circular motion here also it is used to perform the same function. All this equipment is placed under a specialized speed breaker. When the vehicle passes over the speed breaker as the head of the piston is in contact with the speed breaker, the piston makes the linear motion and the crank at the end of the connecting rod converts the linear motion to the circular motion and using gear mechanism the speed of the rotations is increased and transferred to the generator. For a single crank mechanism when a vehicle passed on a speed breaker the piston makes a total of 4 strokes and for a double crank mechanism is 8 strokes. As this method consists of a large number of moving parts as compared to other methods so it needs a lot of maintenance and it also has more losses due to vibrations during motion.[10] M. Prasanth conducted the experiment with 250 kg (approximately) and the output power developed is 2.35 KW in 24 hours. The generator used is also a dynamo type electric generator, the gear used is spur gear. The output power increases with increase in load. The electric power generated can be used to burn four street lights in the night time.[11]

The power generation by using the kinetic energy of the vehicles on the road by using various processes like crank mechanism, roller mechanism, and rack and pinion mechanism is discussed and experiments are conducted on the rack and pinion mechanism.[12]

A pressure lever is placed under the specialized speed breaker. When the vehicle passes over the speed breaker the pressure is applied on the pressure lever which in result rotates the flywheel and the rotations are then transferred to the generator and are converted to electrical energy. when the pressure is applied on the pressure lever then by using a chain sprocket mechanism the rotations are transferred to the flywheel and then a DC motor [13].

S. No	Weight in kg	Current in watt	Author
1	70	52.49	Prashanth Narote et.al
2	71	35	Mohamad Ramadan et.al
3	605	6.675	M.Prasath et.al
4	30	353.16	Jyoti Maurya
5	7	2	Md.Saiful Islam
6	300	7.3575	Aniket Mishra and D. Venkata RaoAet.al

In this paper, Chung-Cheng Hsiao discussed about Developing a mechanical roadway system for waste energy capture of vehicles and electric generation. In automobiles the complete fuel is not consumed to run vehicles whereas only 15% is used and all other exhausts as wastage. It is whole about developing a compressive system for capturing energy during braking by using hydraulic system. In downhill roadways the piston arrangement is placed and vehicles will decelerate during this energy is captured. These piston plates are pressed by vehicles and the fluid results in transporting in to potential energy for storage. These storage system drives a generator through hydraulic device by uplifted weight. This hydraulic drive consists of 136 pistons which is composed of piston plates. The energy is stored and connected to Generator for conversion of energy in to Electrical. The reservoir consists of oil is arranged to save hydraulic fluid. The overall efficiency depends on factors are plates of piston, potential storage and transmission of hydraulic results as 90.38 %,95.09 % and 57.52 %.It is concluded that by using this mechanical roadway system results in overall efficiency is 41.03%.[14]

In this paper Mohamed A. Hassan has explained about Energy harvesting sensitivity analysis and assessment of the potential power and full car dynamics for different road modes. In a MATLAB Environment the model of complete car suspension is implemented by giving different inputs of road irregularities. During complex situations of inputs given results the realistic views when compared to assumed results of vehicle dynamics on roads by using more input modes. On basis of different analysis, the vehicles which are loaded heavy is good for harvesting of energy per unit regarding cost. It is a completely comprehensive analysis considering the knowledge of vehicle dynamics. When a roll mode input is considered there is a reach of damper to 420 W of mean potential power for given driving cycles. During harvesting regarding tire

parameters there is surely no effect on damping factor of tire due to its very minimum value which is completely different from impact of tire stiffness. The sensitivity considering to energy harvesting completely depends upon characteristics of tire, environment of road and driving velocity. By increasing Body of mass results in fluctuation of mean potential power in minimum range can be observed. The strong movement from power of wheelbody is relative movement for collection of vibration energy. It is concluded during steady-state velocity there is collection in more amount of energy at high speeds when compared to transient speed.[15]

III. CONCLUSION

All the types of power generation using speed breaker are listed and studied carefully. Many authors conducted various experiments on each type of mechanism and the results are noted here. All the advantages and disadvantages of the all types of mechanisms are described here.

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