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Power Generating by using a Speed Breaker

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Abstract: *As our world continues to grapple with the challenges posed by climate change, the need for sustainable and renewable sources of energy has become increasingly urgent. Fossil fuels, which have long been the backbone of our energy system, are fast depleting, and their combustion by-products are causing serious environmental problems. Therefore, it is essential that we shift towards the use of renewable energy resources, which can help reduce pollution and save fossil fuels. One area where we can explore the potential of renewable energy is in capturing the kinetic energy from moving vehicles. While this concept is not new, it has not been widely implemented due to the need for specialized mechanisms to effectively capture and convert the kinetic energy into electrical power. However, by using an innovative arrangement of Rack and Pinion with Ratchet Mechanism, it is possible to efficiently harness the kinetic energy from moving vehicles and convert it into usable electrical power. This generated power can be used for various low-power applications such as streetlights and traffic signals. Implementing such a system in urban areas has the potential to utilize the energy from millions of passing vehicles to generate power for public use. This can significantly reduce the dependence on fossil fuels and promote the use of renewable energy sources. Moreover, it can also help reduce the overall carbon footprint of the transportation sector and mitigate the effects of climate change. However, the implementation of such a system requires careful planning, significant investment, and proper infrastructure. It is also important to ensure that the installation of these systems does not obstruct traffic or pose any safety hazards to motorists or pedestrians. Therefore, proper coordination with local authorities and stakeholders is essential for the successful implementation of such projects..*

Keywords: Rachet Mechanism, Kinetic Energy, renewable energy resources

I. INTRODUCTION

The demand for power has increased significantly in modern times, and energy is a crucial input in all sectors of the economy. With the growing population and dwindling conventional sources of energy, it is necessary to explore alternative energy resources. This project focuses on the fixed speed-breakers on streets, where a significant amount of kinetic energy from vehicles is wasted. Thousands of crowded cities with heavy traffic flow present an abundant source of energy, which can be viewed as an urban energy resource. Harnessing this energy can eliminate the need for a transmission system between remote and urban areas for lighting purposes.

The aim of this paper is to conserve the kinetic energy wasted by vehicles passing over speed breakers. As the production of vehicles has surged in recent years, they pass over speed breakers, generating electricity. Underneath the speed breaker, a Rack and Pinion arrangement converts reciprocating motion into rotary motion, which rotates in both directions. A ratchet arrangement is then used to change this bidirectional motion to unidirectional motion, thus conserving the energy generated for power generation. The electricity produced can be stored using various electrical devices and supplied to street lights, traffic lights, and nearby areas, thereby contributing to the country's economy.

This design ensures that the system does not impede the movement of any vehicle, from bicycles to heavy vehicles.

II. SCOPLE OF THE PROJECT

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III. MECHANISM INVOLVED

The demand for power has increased significantly in modern times, and energy is a crucial input in all sectors of the economy. With the growing population and dwindling conventional sources of energy, it is necessary to explore alternative energy resources. This project focuses on the fixed speed-breakers on streets, where a significant amount of kinetic energy from vehicles is wasted. Thousands of crowded cities with heavy traffic flow present an abundant source of energy, which can be viewed as an urban energy resource. Harnessing this energy can eliminate the need for a transmission system between remote and urban areas for lighting purposes.

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IV. MATERIAL DESCRIPTION

4.1 RACK AND PINION

The rack and pinion mechanism is a type of mechanical device that is used to convert linear motion into rotational motion. The mechanism comprises of two gears- a circular gear called the pinion and a linear gear bar referred to as the rack. When linear motion is applied to the rack, the pinion is rotated, which in turn translates the linear motion into rotational motion. This mechanism is commonly used in steering systems and other applications where precise control over movement is required.

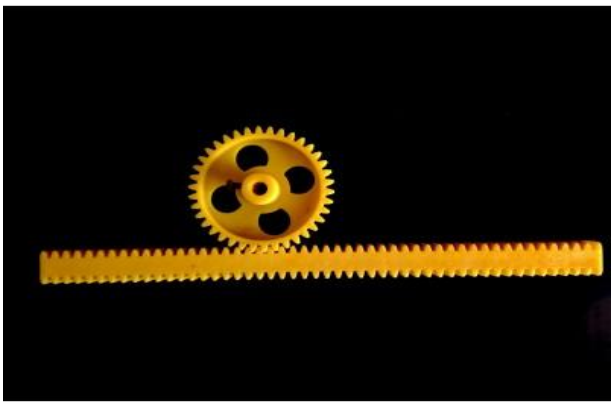

Figure 1: Rack and Pinion

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4.2 EXTENSION SPRINGS

Extension springs are a kind of mechanical spring that can elongate when a force is applied and then return to their original length when the force is removed. These springs are widely used in different applications, such as garage doors, toys, and trampolines. They are often used in situations where they need to provide a return force to components that are actuated, such as hinges or levers. Extension springs are designed to be attached to other components at both ends and can absorb and store energy, in addition to providing resistance to pulling forces. They can be customized with different end types and tensions to meet the specific needs of various applications.

Figure 2: Extension Springs

4.3 SHAFT

A shaft is a mechanical element that has a significant function in transmitting torque and rotation between various components of a drive train. These components are unable to be directly connected because of the gap between them or the necessity to enable for relative motion. Drive shafts are considered torque carriers and are subjected to torsion and shear stress which is proportional to the variance between the input torque and the load. Hence, they must possess enough strength to endure the stress while avoiding too much weight which would cause their inertia to increase.

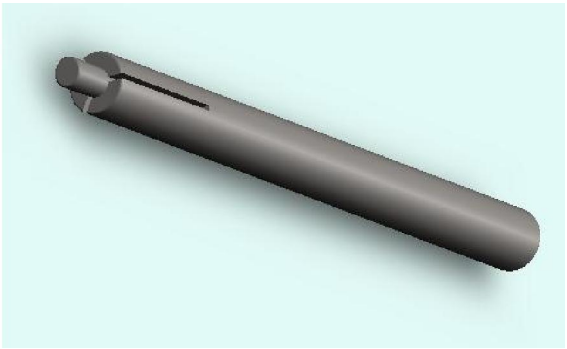

Figure 3:Shaft

4.4 RATCHET

A ratchet is a mechanical device that is commonly used in various applications to allow motion in one direction while preventing it in the opposite direction. It typically consists of a round gear or linear rack with teeth and a pawl, which is a spring-loaded pivoting finger that engages with the teeth. The teeth have a symmetrical but asymmetrical design, with one side having a moderate slope and the other side a steeper slope.

In the forward direction, the pawl moves up and over the gently sloped edges of the teeth, while the spring forces it into the depression between the teeth as it passes the tip of each tooth. On the other hand, in the backward direction, the pawl catches against the steeply sloped edge of the first tooth it encounters, locking it against the tooth and preventing

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further motion in that direction. The ratchet can only stop backward motion at specific points, or tooth boundaries, resulting in a limited amount of backward motion called backlash.

To minimize backlash, a toothless ratchet with a high-friction surface, such as rubber, is used. The pawl is positioned against the surface at an angle such that any backward motion will cause the pawl to jam against the surface and prevent further backward motion. This mechanism can significantly reduce backlash since the backward travel distance depends primarily on the compressibility of the high-friction surface.

Figure 4: Ratchet

4.5 FLYWHEEL

The flywheel has a large moment of inertia, so it resists changes in rotational speed. The energy stored in the flywheel is proportional to the square of its rotational speed. The energy is transferred to the flywheel by applying pressure, the rotation speed and thus the energy is stored. Instead, the flywheel releases stored energy by applying energy to the motor, thereby reducing the speed of the flywheel. The flywheel has a large moment of inertia and therefore resists changes in speed. The energy is transferred to the flywheel by applying pressure, the rotation speed and thus the energy is stored. The provides continuous power when power is not continuous. For example, reciprocating engines use flywheels because the engine's energy sources and torque are intermittent. provides energy that exceeds the capacity of the renewable energy source. This is done by accumulating energy in the flywheel over time and then rapidly releasing it at a rate that exceeds the engine's capacity. flywheels are usually made of steel and rotate in normal bearings; they are usually limited to speeds of a few thousand cycles.

Figure 5: Flywheel

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4.6 DYNAMO

A generator is an electrical machine that uses an electric motor to generate direct current. Generators are the primary power generators of the electrical industry and form the basis of many other electronic devices such as electric motors, alternators and changeovers. Currently, alternators easily dominate large-scale power plants due to their efficiency, reliability and cost effectiveness. However, generators have the disadvantage of using conventional generators. The generator has a fixed structure called a stator that provides a constant magnetic field and a rotating system called an armature that rotates in this field. Generators use rotating coils and magnetic fields to convert any rotation into pulsating direct current via Faraday's law of induction. As the metal moves in the magnetic field, the field repels electrons in the metal, creating an electric current in the metal. Small machines use one or more permanent magnets to provide a constant magnetic field, while large machines use one or more electromagnets (often called field coils) to provide a constant field.

Figure 6: Dynamo

V. LITERARY STUDIES

Literary studies Literary studies are writings written by an individual that takes into account important points of existing knowledge, including important discoveries, and views and contributions to a context. The literature review is secondary, so there are no new publications or primary study trials. In addition, a literature review can be defined as a review of incomplete results. Therefore, we conducted a study on various end-effectors in the power generation of gear units. A brief summary of our study materials is as follows: STUDY The energy crisis is an important factor in economic strength.Research to solve electrical problems gave rise to the idea of using gearboxes to generate electricity. First, the electricity crisis in South Africa prompted them to set up a small village on the highway using this method. The idea is mainly physics, converting kinetic energy into electrical energy, which is wasted when the car passes through the retarder. Since then, a lot of work has been done in this area. Guwahati-based amateur innovator Kanak Gogol has developed a similar device that generates energy when a car passes by at high speed. The idea caught the attention of IIT-Guwahati, who funded experimental work on power generation with reducers. They evaluated the machine and recommended it to the Assamese government. It gives the need to think about this alternative way of generating electricity, as their work has proven beneficial for the country's economy. The output power can be increased by adjusting the speeds in series. The electricity produced can be stored using different energy sources. We can provide this energy to lights, lights, and communities so we can help the country's economy. We can increase efficiency with solar panels that provide the energy the vehicle needs while it is in motion.

VI. CALCULATION

OBSERVATIONS:

Material of the spring used: carbon steel
Modulus of rigidity (G) = 77GPa
Mean coil diameter =14mm

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Load Applied (P)= 200N
Number of turns (n)= 52
Length of the spring = 160mm

SNO.	LOAD (N)	DEFLECTION (mm)			STIFFNESS (N/mm)
		INITIAL	FINAL	(FINAL-INITIAL)	
1	0	160	160	0	-
2	100	160	196	36	2.778
3	200	244	284	40	5

CALCULATION:

Spring index(C):

Formula:

C=D/d

= 14/5

Spring index (C) = 2.8

Wahl's stress factor:

Formula:

Ks = ((4C-1)/ (4C-4)) + (0.615/C)

= (((4*2.8)-1)/ ((4*2.8)-4)) + (0.615/2.8)

= 1.6

Shear stress (ꚍ):

Formula:

ꚍ = (8 ks P D/π d^3)

= (8 x 200x 14x1.21 / 3.14 x 5^2)

= 352.27 N/mm^2 ~ 353N/mm^2

Deflection (y):

Formula:

y = (8 C^3 P n/ G d) (G= 77x10^3 N/mm^2)

= (8 x 200 x 52x 2.8^3 / 5 x 77x10^3)

= 39.8mm ~ 40mm

Stiffness:

Formula:

q = (P / y)= 200/40

= 5 N/mm

RACK AND PINION CALCULATIONS

MATERIAL PROPERTIES

Material selection- both rack and pinion are made out of CI35

Young's modulus E=1x 10^5N/mm^2

Ultimate stress σ_u =530n/mm^2

Bending stress $[\sigma_B]$ =1.4xK_{BL}x σ_{-1}/n.K_σ [K_{BL} =0.7 for H>350

=1.4x0.7x160/1x1.5 σ_{-1} =160N/mm^2

=104.5N/mm^2 n=1 for steel

Wear strength $[\sigma_C]$ =600N/mm^2 K_σ =1.5 these values are Referred from P.S.G.D.D.B]

MODULE CALCULATION

Number of teeth on rack z_2= i x z_1 = 3 x 20 = 60

Module m = 2x ax cosβ/(z_1+z_2)

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= 2x96x cos20/(20+60)
~2.25
=3mm

TORQUE TRANSMITTED BY THE GEAR

Tangential force acting on the gear at the pitch line
f_t=1000n
Torque to be transmitted
$m_t=f_t$ x d/2 [d=m x z_1
m_t=1000x0.06/2 =3 x 20
m_t =30nm =60mm]
Design torque
$[m_t]=k.k_d.\ m_t$ [$k.k_d$ =1.3 ref p.s.g d.d.b]
=1.3x30
=39nm
Center distance calculation
Center distance $a \geq (i+1)\sqrt[3]{((0.7/\sigma_c)^2 \text{ x } e_{eq}\ [m_t]/i\psi)}$
Where ψ=0.3 [ref p.s.g d.d.b]
$a \geq (i+1)\sqrt[3]{((0.7/600)^2 \text{ x } 1x10^5 \text{ x } 39 \text{ x } 10^3/3 \text{ x } 0.3)}$
$a \geq 72.27$
a= 73mm

REVISION OF CENTER DISTANCE

CENTER DISTANCE $a=m(z_1+z_2)/2\cos\beta$
=3(20+60)/2x cos20
= 128mm
THEREFORE, THE DESIGN IS SAFE

CALCULATION OF b,d_1,v and ψ_p

FACE WIDTH b= ψ x a
= 0.3 x 73
= 21.9mm
PITCH DIAMETER OF PINION $d_1 = m.z_1/\cos\beta$
= 3 x 20/cos20
= 64mm
$\Psi_p=b/d_1=0.342$

CALCULATION OF THE BASIC REQUIREMENTS FOR PINION AND RACK

Module m=3mm
Face width b=21.9mm
Height factor f_0=1
Bottom clearance c=2.25x m=2.25 x3=6.75mm
Tooth depth h=2.25x m=2.25x 3= 6.75mm
Pitch circle diameter $d_1=m.z_1$=3x20=60mm
$d_2=m.z_2$=3x60=180mm (considering the rack as a spur gear)
Tip diameter $d_{a1}= (z_1/\cos\beta+2f_0)$ m
= (20/cos20+2x1) x3 =70mm
$d_{a2}= (z_2/\cos\beta+2f_0)$ m

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= (60/cos20+2x1) x3 =198mm
Root diameter d_{f1}= (z_1/cosβ-2f_0) m-2c
= (20/cos-2x1) x3-2x0.75
=57mm
d_{f2}= (z_2/cosβ-2f_0) m-2c
= (60/cos20-2x1) x3-2x0.75
=184mm
Rack cross section =29x35mm

Circular pitch = (CIRCUMFRENCE OF PCD/NO. OF TEETH)
= (188.4/20)
= 9.42mm
Pitch diameter = (NO. OF TEETH/PCD)
= (20/60)
= 0.333mm
Addendum = (1/DP)
= 1/.333
= 3.00mm
Addendum circle = pitch dia + (2 x ADDENDUM)
= .333+ (2x3)
= 6.333mm
(or)
Addendum circle = Ra - R = 36.333-30 = 6.333mm
Clearance = (0.157/PD)
= (0.157/0.333)
= 0.471mm
Clearance = DEDENDUM – ADDENDUM
Dedendum = CLEARANCE + ADDENDUM
= 0.471 + 6.333
= 6.804mm

VII. FABRICATION

During our project, many parts are produced separately and then put together. We use various processes such as cutting, grinding and welding to manufacture these products. Cut to verify that the item is the correct size. We use a variety of commercially available knives for this, such as Dewalt and Black Decor. For softer metal parts such as stainless steel, use a hacksaw. Drilling is a convenient method that uses a drill to cut or enlarge the hole in the material. A drill is a multi-point insert cutting tool that applies pressure and rotation to the workpiece to create chips on the cutting edge. Welding is used to join different materials, including metals and alloys. The process involves applying heat from electricity or light to bring the materials together. Heat and pressure are important for the welding we use arc welding.

VIII. ASSEMBLY

Subframe The subframe is made of 1.5 mm thick hollow carbon steel. Rack and Pinion The rack and pinion used in this model are from a Maruti 800 stepper purchased at a local store. The 30 mm hollow tube is welded to the rack and pinion housing in the direction of the rack's axis of motion. This configuration is then welded together with the subframe. Ratchet The other end of the pinion shaft with the coil is welded to the ratchet. The frame is welded to the inside edge of the latch. The ratchet only allows rotation in one direction. The VOLAN cassette is 205 mm in diameter and 3 mm thick. The generator is supported bychassis brackets. After all the parts are welded together, the assembly is coated with red oxide to prevent corrosion.

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Figure 7:Fabrication Power Generating by using speed breaker

IX. APPLICATIONS

Reduced power generation can be used in many places, for example:

- All highways near toll stations.
- All reduction methods.
- Near traffic lights.
- Special areas such as apartments, multi-purpose, and universities This generator can be placed at a shorter distance from the road. Electricity is produced when cars pass. This electronic device can be used in many places after using a generator that raises the voltage from 12 volts to 230 volts. This energy can be used for:
- Street lights.
- Manual.
- Road maps.
- Lighting at bus stops.
- Lighting of highway control points, etc.

X. ADVANTAGES

- This is a cheaper electric model.
- Renewable Energy.
- Since it is renewable, it helps shorten the life of non-renewable energy.
- Since it is produced by itself, there is no need for another place.
- Everyone can easily access it.
- They generate high voltages for low stress.
- Simple structure, advanced equipment, and easy maintenance.
- Do not consume non-renewable sources of fossil fuels.
- No need for fuel.
- Power generation must be independent of external power.
- Strong energy every year

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XI. CONCLUSION

Energy is an important strategy to support economic growth and a country's standard of living is directly related to energy consumption. Fossil fuels such as coal, oil, and uranium were running out fast, and at the turn of the century, people had to rely on fossil fuels to generate electricity. In a world where electricity is scarce, the project will help solve some problems. The advantages of electric generators are that they are non-polluting energy sources; have a simple structure, easy equipment, and easy maintenance; no need to work during production; energy is available during the year; no transportation problems; no - Renewable fuel consumption; no external connection required for power generation; small footprint; easy to install; does not affect traffic. Low energy generation and low start-up and capital costs, so the project is economical. Electricity generation is simple, we can use batteries to store electricity. No fuel is required for entry. Today's machines have some disadvantages, such as the difficulty of choosing the right generator. Striking the right balance between speed and power is difficult. We need to control the time process, so the treatment costs are high. It may not work well at traffic lights. It will rust in the rainy season. These machines have many uses. Electricity generation using electricity can be used in many places such as all highways, and all road reducers, you can charge the batteries and use them for lighting, lighting, lighting, road signs. The electricity produced can be used in parking lots, stores, stores, schools and universities, airports, bus stations, cinemas, and shopping malls. This project can also be modified by using camshafts, pulleys, and gears instead of the couplings we used in the research, which will reduce the complexity and problems in the project. There is a lot of traffic in big cities nowadays, which causes problems for people. It has the advantage of not outsourcing. Now is the time to strengthen these new ideas and research should be done to increase their importance. The stored electricity can meet the daily electricity demand. Electrical transmission is not as expensive to install as it is easier to prepare. So, electricity can spread easily. The project is the first step in exploring the potential of many vulnerable areas.

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