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Design And Fabrication Of Electricity Generation System Using Railway Tracks

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Abstrac

Forecasting of electricity demand has assumed a lot of importance to provide sustainable solutions to the electricity problems. In the present situation power is the basic need for human life. Energy is responsible for major developments of any country's economy. Use of Conventional energy sources are polluting the environment and causes global warming. In this project we are generating electrical power as non-conventional method by simply running train on the railway track. This study aims to harvest the electrical energy from railway tracks. The power is produced by the semicircular section when the train moves over proposed track , the semicircular plate gets pushed down due to the train and causes the rotation of rack and pinion arrangement which produces the electricity using a dynamometer. The energy generated will be stored in the battery and also showing the output by glowing a 5V LED.

Keywords*— Sustainable, Conventional, Non-Conventional, Rack and Pinion, Dynamometer***.**

I. INTRODUCTION

World is growing at the faster rate with regards to consumption of fuel and so the scarcity of energy as the sources producing them are depletable in nature. Around the world, there were 8,06,000 cars and light trucks on the road consuming 260 billion US gallons 980000 liters of gasoline yearly. Railways were first introduced to India in 1853. By 1947, the year of India's independence, there were forty-two rail systems. In 1951 the systems were nationalized as one unit, becoming one of the largest networks in the world. IR operates both long distance and suburban rail systems. Indian railways operate about 9000 passenger trains and transports 17 million passengers daily across twenty-eight states and three union territories. IR owned about 225,000 wagons, 45,000 coaches and 8300 locomotives and ran more than 18,000 trains daily. We are looking forward to conserve the kinetic energy that gone wasted, while trains move. The number of trains passing over the system fixed on the railway track is increasing day by day.[1] We proposed a non-conventional power generating system based on railway track mechanism which generate electricity without using any commercial fossil fuels, which is not producing any polluting products. In this paper, our aim is to conserve the kinetic energy which convert into electricity that gone wasted, while train move on track. [2] Unfortunately, a substantial portion of railroad tracks exist in remote areas or certain underground regions in which there is little electrical infrastructure. In these regions, instalment of equipment such as warning signal lights, wireless sensors for railway track monitoring, bridge monitoring and train positioning have limited practical deployment due to the lack of a reliable power supply or low-maintenance battery. Therefore it is necessary to design a cost-effective and reliable power supply to track-side sensors and equipment. [3] This project work includes simple rack and pinion arrangement with increased gear ratio which then moves a dynamometer to generate the electricity.

Problem Statement:

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In our country due to increased paying capacity, advanced lifestyle and rapidly growing industrialization, the need & demand of transportation is increasing day- by- day. The number of train rolling on the track is increasing daily. Hence we, the group of our class found the need of designing and manufacturing such a system, which will make the track somewhat flexible, soft which will not damage the more also the impact energy being absorbed by the generation system will be utilized to convert it in to electricity rather than this hard impact transferring to damage the suspension.

II. OBJECTIVES OF PRESENT WORK

The main objective is to build a power generation system such that it can contribute to the present power generation system as the need of energy is growing day by day. The generated power is ecofriendly as well as inexhaustible means the power can be generated as long as the railways are in function.
This can be achieved by utilizing the energy resources along the railway tracks i.e., by utilizing the mechanical energy supplied by both wind gust from train as well as mechanical energy supplied by the train when it is in motion. The proposed technique relates generally to generating electricity and, more particularly, to a method and a system for generating electricity along a railroad track. Many known railroad systems employ a variety of wayside equipment alongside the railroad tracks. Within a network, railroad tracks often span rural and unpopulated areas, and as such, providing power to wayside equipment in remote locations may be a challenging and costly task. At least some known railroad systems run power lines into remote areas to power wayside equipment. However, depending on the location, such power systems may be expensive to install and to maintain.

III. COMPONENTS

From our survey we identified the suitable material for all the above parts. Such mechanism is to be mounted on frame. The entire frame such as Railway track, supports, C Channel is made from mild steel. All the assembly is done through welding

- STEEL FRAME

It is constructed from mild steel and by applying MIG welding. The frame dimensions are such that it can incorporate a rack and pinion arrangement as well as two shaft and a spur gear pinion arrangement. The dynamometer is used to produce the electricity.

- HELICAL SPRING

A spring is an elastic body whose function is to distort when loaded and to recover its original shape when the load is removed. It cushions, absorbs or controls energy either due to shocks or due to vibrations.

- RACK AND PINION

Rack and pinion can convert rotary to linear of from linear to rotary motion. Rack is a linear gear and pinion is a circular gear. Applied force on rack is converted to rotation by pinion. The mechanical force is converted into rotational force.

- SHAFT

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The various members such as gears are mounted on it. In our project we use two shafts one is connected with dynamo and another one is connected with rack and pinion arrangement.

- BEARING

A bearing is a machine element that constrains relative motion to only the desired motion, reduces friction between moving parts.

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- SPUR GEAR AND PINION

It is rotating disc type structure having several teeth cut's on it. Here two gears are used made from Cast Iron. Big gear is mounted on main shaft and other pinion is mounted on counter shaft which continuously meshes.[1]

- DYNAMOMETER

The device which converts mechanical energy into electrical energy is called generator. An AC generator is used for producing alternating current which contains an assembly of stationary (stator) and moving parts (rotor). The rotor is connected with the gear. The torque which generated by gear rotates the rotor of the generator. The rotor creates a moving magnetic field around the stator, which induces a voltage difference between windings of stator and produce the alternating current (AC) output of the generator.

IV. METHODOLOGY

Power can be produced from conventional and nonconventional energy sources. In this paper we show energy conversion from kinetic energy to rotational energy and rotational energy to electrical energy respectively. This project explains the mechanism of electricity generation from railway tracks. It is a simple but optimum process to generate energy from railway tracks arrangements. We want to add our proposed railway tracks with traditional railway tracks. It is an Electro-Mechanical unit. This system utilizes both mechanical technologies and electrical techniques for the power generation and its storage. The generation will be proportional to the number of railway bogies passing over the railway tracks as shown in Fig 1.

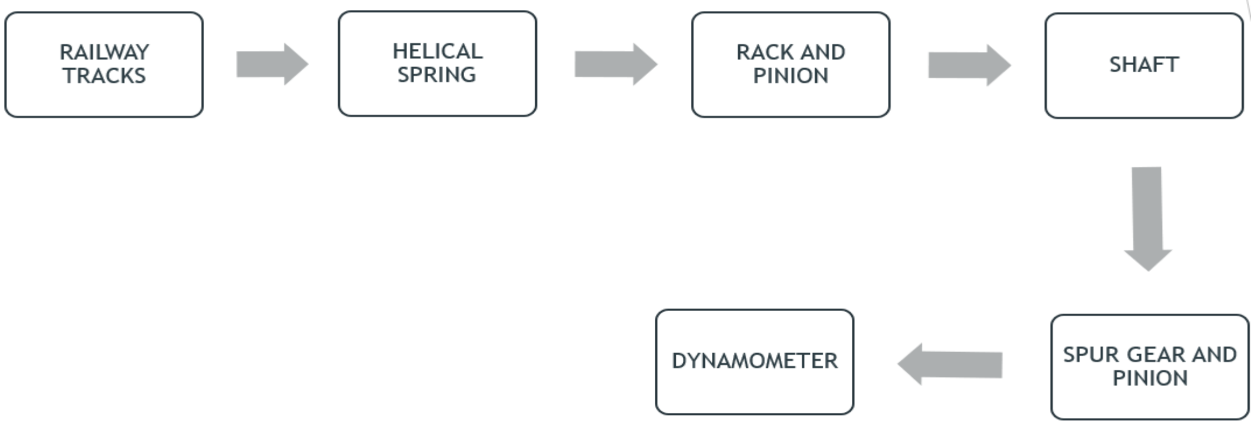

Fig 1 A line diagram of power generation using railway tracks

V. EXPERIMENTAL WORKING

This project model includes a simple gear pair arrangement for generation of electricity using deflection of semicircular plate which is situated between the railway tracks. Whenever the railway bogies move over our proposed railway tracks, the deflection of plate causes the spring to deflect and passes the linear motion to the rack and pinion arrangement, which converts the linear motion into rotary motion of shaft on which rack and pinion are mounted. Hence, the gear mounted on one side of main shaft also rotates. Small pinion is provided which is mounted on countershaft which continuously meshes with big gear. Hence, countershaft also starts to rotates.

On one end of countershaft a 12Vdc dynamometer is fixed. As the shaft of Dynamo rotates mechanical energy of the shaft get converted into electrical energy. Instead of using chain and sprocket arrangement which is noisy and expensive a simple gear and pinion arrangement is used which is more efficient as compared to the chain and sprocket arrangement as shown in Fig 2.

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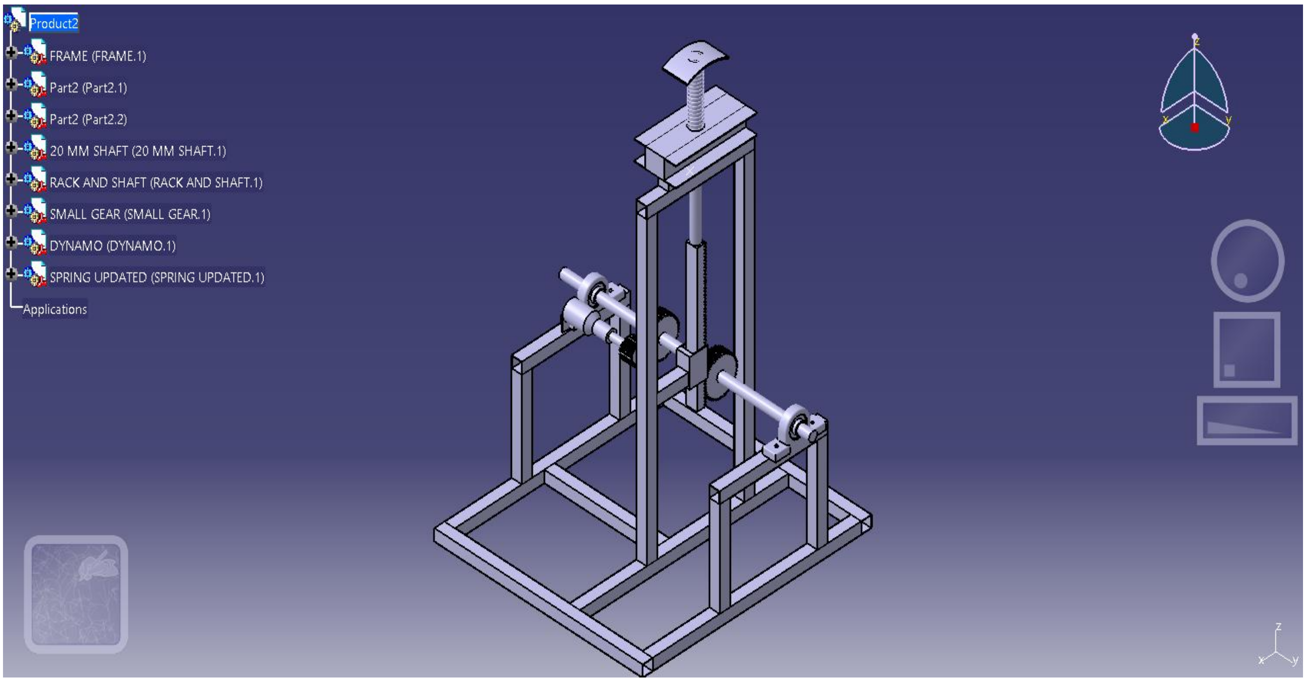

Fig 2. CAD model

VI. CALCULATIONS

1.Design of frame

Frame design for safety for 25×25×3mm square hollow mild steel channel
b=25mm, d=25mm, t=3mm
Consider maximum load on the frame to be W=50 kg
Force = W× g = 490.5N
Maximum bending moment=Force × perpendicular distance of square bar length= 220725 N mm
We know, M / I = σ_b / y

Where, M=Bending moment
I= Moment of inertia about axis of bending i.e.I_{xx}
y= Distance of the layer at which the bending stress is consider
E = Modulus of elasticity of beam material

I = $\frac{b\times d^3}{12}$ = 32552.08 mm^4
σ_b = $\frac{m\times y}{I}$ == 84.76N/mm^2
The allowable shear stress for material is σ_{allow} = $\frac{S_{yt}}{F.O.S.}$
Where S_{yt}= yield stress =210 N/mm^2
So σ_{allow}= 105 N/mm^2
Comparing above we get,
$\sigma_b < \sigma_{allow}$
i.e. 84.76 <105 N/mm^2
So, design is safe.

2.Design of spring

Force =F=20kg =196.2 N
Diameter of wire(d)=10 mm

Mean diameter of wire(D)=85 mm
C=D/d=8.5

Assuming carbon steel material of spring
Modulus of rigidity(G)=77 GPa
Modulus of elasticity(E)=210 GPa

For severe service condition, maximum allowable shear stress is τ=350 MPa
Depending upon above said limit, it is possible to calculate maximum load that spring can handle before failure by,

$$\tau = \frac{Ks \times 8 \times F_{max} \times D}{\pi d^3}$$

Where,
Ks=1.05882

$$350 = \frac{Ks \times 8 \times F_{max} \times D}{\pi d^3}$$

F_{max}=1527.16 N
Deflection in the spring is given by,

$$\delta = \frac{8FnD^3}{Gd^4}$$

δ = 21.28 mm

3.Design of Shaft

Power = $\frac{Force\ \times Deflection}{Time} = 4.175\ W$
For finding torque of shaft,
Torque = $\frac{P \times 60}{2\pi N} = 2.657\ Nm$
For calculating diameter of shaft:
Torsional shear stress,

$$\tau = \frac{16 \times K_t \times T}{\pi \times d^3}$$

d = 6.911 mm
Taking, factor of safety=3
d = 6.911$\times 3 = 20.73\ mm$
Diameter of shaft is 20 mm.

4.Design of Spur gear and pinion

n_p =40 rpm
G =2.3:1
Minimum no. of teeth on pinion to avoid interference, Z_p=18 for $\varphi = 20°$,$\sigma_g = \frac{410}{3} = 136.67$ N/mm^2
$\sigma_g = \frac{200}{3}$ = 66.67 N/mm^2

No. of teeth of gear =Z_g=$G \times Z_p$=41.4
Z_g= 42

Diameter of pinion = $d_p = m \times Z_p$ =36 mm
Diameter of gear =$d_g = m \times Z_g$=84 mm
Lewis form factor for pinion Y_p = 0.3245
Lewis form factor for gear Y_g = 0.4156

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$\sigma_p \times Y_p$= 44.3483 N/mm^2
$\sigma_g \times Y_g$ = 27.7083 N/mm^2
Here, $\sigma_g \times Y_g < \sigma_p \times Y_p$ therefore, design for weaker component i.e. gear
Peripheral speed will be same for gear and pinion
Peripheral speed,

$$V=\frac{\pi d_p n_p}{60\times10^3}=0.07539 \text{ m/s}$$

$F_t = \frac{P}{V}$ = 55.372 N
$F_{t\,max} = C_s \times C_m \times F_t$ =107.976 N
C_v = 0.9754
$P_{eff.} = \frac{F_{t\,max}}{C_V}$ = 110.689 N
Beam strength,

$$F_b = \sigma_g \times Y_g \times b \times m = 1108.15 \text{ N}$$

Wear strength,

$$F_w = d_p \times b \times Q \times K$$

Where, b = 10m = 20mm
Q =1.4
K=1.44

$$F_W = 36 \times 20 \times 1.4 \times 1.44 = 1451.52\ N$$

Factor of safety = $\frac{F_b}{F_{eff.}}$ =10.01
So, Design is safe.

Fig 3. Working model

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VII. RESULTS

In this project, our main aim was to solve problem related to the energy crisis. For this purpose we have been able to store the electricity in a battery, which can be used later for different purposes. The load is allowed to act as sudden but not impact or gradual. A fixed load is released on the mechanism and the peak of the voltage reading is noted. Also we have used a 5V led which glow as soon as the 20kg load is applied on the plate.

VIII. CONCLUSION

This, generated electricity can be stored in batteries and can be used for various purposes for example illuminating street lights. Now, train traffic is increasing, we can utilize this for power generation by means of train track power generation. It has advantage that it does not utilize any external source. As the conventional sources are depleting very fast, then it's time to think of alternatives. 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.

A properly designed mechanical based electrical generation system has the potential to power major railroad equipment and infrastructure, representing a safety benefit to areas lacking electrical infrastructure. The listed system is non-conventional and the way of power generation technique is also eco friendly. It has advantage that it does not utilize any external source.

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