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ENERGY HARVESTATION FROM RAIL TRACK

[1]Er: Tom Mathew, [2]Kevin Varghese George, [3]Tarun Thomas, [4]Nithin V, [5]Lijin George

***Abstract* — In this project we are generating electrical power as non-conventional method by simply utilizing energy from the rail track. Non-conventional energy system is very essential at this time to our nation. Non-conventional energy using railway track needs no fuel input power to generate the output of the electrical power. This project uses simple drive mechanism such as rack and pinion assemble and Sprocket and chain drive mechanism.**

This project uses the conversion of the force energy into electrical energy. The control mechanism carries the rack & pinion, sprocket and chain drive, D.C generator, battery and inverter control. Rack and pinion gear system is used to produce rotary motion from linear motion. Sprocket and chain drive mechanism is used to increase the rotation of the shaft in the ratio 1:3 and this shaft transmit the motion to a generator in the 1:4. We have discussed the various applications and further extension also. So this project is implemented to all railway track, the power generation is very high.

***Index Terms* — energy harvestation, generating electrical power.**

I. INTRODUCTION

Man has needed and used energy at an increasing rate for his sustenance and well-being ever since he came on the earth a few million years ago. Primitive man required energy primarily in the form of food. He derived this by eating plants or animals, which he hunted. Subsequently he discovered fire and his energy needs increased as he started to make use of wood and other bio mass to supply the energy needs for cooking as well as for keeping himself warm.

With the passage of time, man started to cultivate land for agriculture. He added a new dimension to the use of energy by domesticating and training animals to work for him.

With further demand for energy, man began to use the wind for sailing ships and for driving windmills, and the force of falling water to turn water for sailing ships and for driving windmills, and the force of falling water to turn water wheels. Till this time, it would not be wrong to say that the sun was supplying all the energy needs of man either directly or indirectly and that man was using only renewable sources of energy.

II. COMPONENTS AND DESCRIPTION

The block diagram of the Railway track power generation is shown in figure. The main components of this project are,

- Railway track arrangement
- Rack and pinion arrangement
- Sprocket and chain Drive
- Fly wheel
- D.C generator
- Battery
- Inverter Circuit and
- Light Arrangement

A. RAILWAY TRACK ARRANGEMENT:

This is made up of mild steel. The complete set up is fixed in this model railway track. The two L-shapes frame is fixed in the above two ends of the track. Bellow this l-shapes window, the actual power generation arrangement is constructed. This L-shapes window pushes the rack when the time of train wheel moving on these arrangements.

BLOCK DIAGRAM

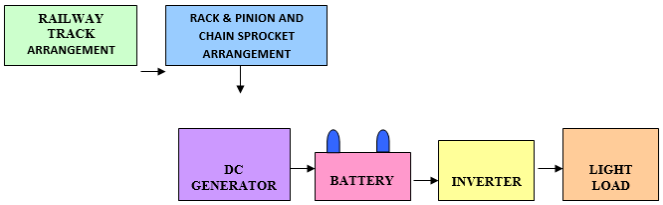

Fig 2.1 Block diagram of railway harvesting system

B. RACK AND PINIAN ARRANGEMENT:

The block is the important part of the unit as it houses the rack and pinion. This rack and pinion attachment gives the rotary motion to the chain sprocket. This block converts linear motion into rotary motion.

Rack and pinion gear system is used to transmit rotary motion into linear motion. The rack is a portion of a gear having an infinite pitch diameter and the line of action is tangent to the pinion.

1) Pinion:

This is a gear wheel which is provided to get mesh with rack to convert the linear motion into rotary motion. They are made up of Cast iron.

2.2.2 Rack:

Rack teeth are cut horizontally about the required length. This is made up of Cast iron.

C. SPROCKET AND CHAIN DRIVE:

This is a cycle chain sprocket. The chain sprocket is coupled with another generator shaft. The chain converts rotational power to pulling power, or pulling power to rotational power, by engaging with the sprocket.

The sprocket looks like a gear but differs in three important ways:

1. Sprockets have many engaging teeth; gears usually have only one or two.
2. The teeth of a gear touch and slip against each other; there is basically no slippage in a sprocket.
3. The shape of the teeth is different in gears and sprockets.

Fig 2.2 Different sprockets

D. FLY WHEEL:

Fly wheel is used to increase the rpm of the system. The generator is coupled with this shaft, so that increase the RPM of the generator.

E. PERMANENT MAGNET D.C. GENERATOR:

Voltage Production

DC Circuits, that there are three conditions necessary to induce a voltage into a conductor.

1. A magnetic field
2. A conductor
3. Relative motion between the two.

A DC generator provides these three conditions to produce a DC voltage output.

1) Theory of Operation

A basic DC generator has four basic parts:

(1) A magnetic field;
(2) A single conductor, or loop;
(3) A commutator; and
(4) Brushes

The magnetic field may be supplied by either a permanent magnet or an electromagnet. For now, we will use a permanent magnet to describe a basic DC generator.

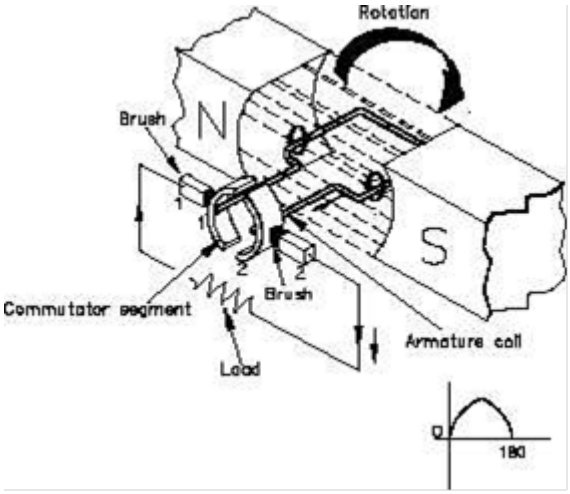

Fig 2.3 DC shunt generator

Basic Operation of a DC Generator A single conductor, shaped in the form of a loop, is positioned between the magnetic poles. As long as the loop is stationary, the magnetic field has no effect (no relative motion). If we rotate the loop, the loop cuts through the magnetic field, and an EMF (voltage) is induced into the loop.

When we have relative motion between a magnetic field and a conductor in that magnetic field, and the direction of rotation is such that the conductor cuts the lines of flux, an EMF is induced into the conductor. The magnitude of the induced EMF depends on the field strength and the rate at which the flux lines are cut.

The stronger the field or the more flux lines cut for a given period of time, the larger the induced EMF.

$Eg = KFN$
where Eg = generated voltage
K = fixed constant
F = magnetic flux strength
N = speed in RPM

The direction of the induced current flow can be determined using the “left-hand rule” for generators. This rule states that if you point the index finger of your left hand in the direction of the magnetic field (from North to South) and point the thumb in the direction of motion of the conductor, the middle finger will point in the direction of current flow.

For example, the conductor closest to the N pole is traveling upward across the field; therefore, the current flow is to the right, lower corner. Applying the left-hand rule to both sides of the loop will show that current flows in a counter-clockwise direction in the loop.

F. LEAD-ACID WET CELL:

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an auto mobile, for

example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery.

The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents short ends the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.

1) CONSTRUCTION:

Inside a lead-acid battery, the positive and negative electrodes consist of a group of plates welded to a connecting strap. The plates are immersed in the electrolyte, consisting of 8 parts of water to 3 parts of concentrated sulfuric acid. Each plate is a grid or framework, made of a lead-antimony alloy.

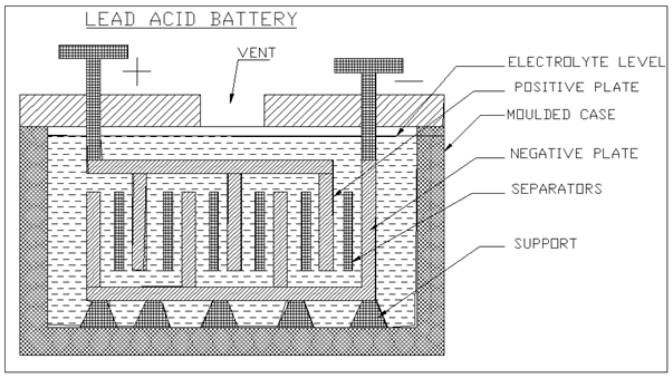

Fig 2.4 Schematic Diagram of Lead acid battery

This construction enables the active material, which is lead oxide, to be pasted into the grid. In manufacture of the cell, a forming charge produces the positive and negative electrodes. In the forming process, the active material in the positive plate is changed to lead peroxide (pbo_2). The negative electrode is spongy lead (pb).

Automobile batteries are usually shipped dry from the manufacturer. The electrolyte is put in at the time of installation, and then the battery is charged to from the plates. With maintenance-free batteries, little or no water need be added in normal service.

G. INVERTER

1) INTRODUCTION:

The process of converting D.C. into A.C. is known as INVERSION. In other words, we may define it as the reverse process of rectification. The device, which performs this process, is known as an INVERTOR. Inversion is, by no means, a recent process. In olden days' gas-filled tubes and vacuum tubes were used to develop inverters. Thyratron inverter is popularly used as a large power device. Vacuum tube inverters were generally used for high-frequency applications. Some of the main disadvantages of the tube as well as the mercury pool type inverters are:

1. They are very costly
2. They are very big in size and heavy in weight
3. They have very poor efficiency
4. The voltage drop across these devices is very high
5. They are less accurate
6. They are very slow in response, etc.

The basic principle of an inverter can be explained with the help of a simple circuit, as shown in figure. If switch S is connected alternately to position 1 and 2 at a rapid speed and if S is not kept closed to any of the two positions (1 and 2) for too long, and then an alternating voltage will appear across the primary winding. This can be explained by the direction of the current flow in the primary winding.

Although the voltage applied is D.C. in nature, the direction of current flow in the primary winding when S is connected to position 1 is from top to bottom whereas when S is connected at position 2, the current flows from bottom to top. This change in the direction of current flow in the primary winding gives rise to an alternating voltage in it. The frequencies of this alternating voltage will depend on how rapidly the switch (S) positions are interchanged. This alternating voltage in the primary winding will induce an alternating emf in the secondary winding, which will act as the A.C. output.

With the development of semi-conductor devices, a lot of improvements to took place in the design of inverter circuits. Transistor being a fast-switching device was used as a switch for developing low and medium power inverters.

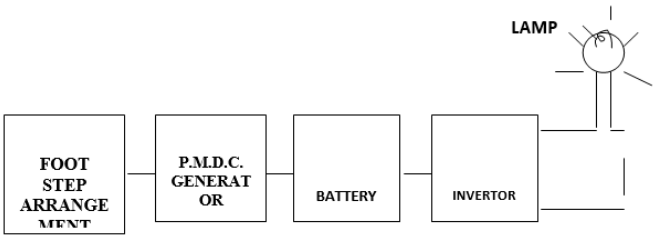

Fig 2.5 Block Diagram Of Inverter

H. LIGHT AND ITS FITINGS:

1) FLUORESCENT TUBES

This type of lamps is a low-pressure mercury vapor discharge lamp. Fluorescent lighting has a great advantage over other light source in many applications.

It is possible to achieve quite high lighting intensities without excessive temperature rises. The efficiency of fluorescent lamp is about 40 lumens per watt, about three times the efficiency of an equivalent tungsten lamp. The average life of a fluorescent lamp is about 4,000 working hours.

2) CONSTRUCTION:

The fluorescent tube consists of a glass tube and 0.6 meter, 1.2 meters and 1.5 meters in length. The inside surface of the tube is coated with a thin layer of fluorescent material in the form of a powder. Various fluorescent materials give different color light. By mixing the various powders light of any desired color including daylight can be obtained.

The glass tube of the fluorescent lamp is provided at both ends with bipin caps and oxide coated tungsten filaments. The tube contains organ gas with a small quantity of mercury under low pressure. Even with organ gas the discharge will not start at ordinary main voltage. A choke and a starter switch are therefore incorporated in the circuit of the tube lamp to give a momentary high voltage across the tube to start the discharge. The choke is connected in series with the tube the starter is connected across tube.

The circuit is suddenly opened at the starter, the flux around the choke collapse causing a kick of about 1000V. This voltage is applied across the two electrodes and sufficient to start the discharge of the tube. During the steady operation of this lamp the voltage across the tube drops to about 150 volts. This voltage is sufficient to maintain the discharge of the tube.

During the steady operation of this lamp, the voltage across the tube drops to about 150 volts. This voltage is sufficient to maintain the discharge. The choke in series with the tube now acts as a stabilizer. A capacitor is connected across the circuit it improves the power factor.

III. DESIGN AND DRAWINGS

A. Specification Of Pinion

Material	: cast-iron
Outside diameter	: 75mm
Circular pitch	: 4.7mm
Tooth depth	: 3.375mm
Module	: 1.5mm
Pressure angle	: 21 degree
Pitch circle diameter	: 72mm
Addendum	: 1.5mm
Dedendum	: 1.875mm
Circular tooth Thickness	: 2.355mm
Fillet radius	: 0.45mm
Clearance	: 0.375mm

Design of rack

Pitch circle diameter of the gear is = 72mm

Circumference of the gear is $= \prod \times$ pitch circle diameter

$= \prod \times 72$

= 226mm

The dimension is for 360 degree rotation

For 180 degree rotation the rack length is 113 mm

1) Specification Of Rack

Material	: cast iron
Module	: 1.5mm
Cross-section	:75x25mm

Teeth on the rack is adjusted for 113mm

OUTPUT POWER CALCULATION:

Let us consider,

The mass of a body (Approximately)	=	60 Kg
Height of speed brake	=	10 cm
∴Work done	=	Force x Distance
Here,		
Force	=	Weight of the Body
	=	1000 Kg x 9.81
	=	9810 N
Distance travelled by the body	=	Height of the flaps
	=	10 cm = 0.10 m
∴Output power	=	Work done/Sec
	=	(9810 x 0.10)/60
	=	16.35 Watts (For One pushing force)

However, this much power produced, it cannot be tapped fully. From the above purpose we have select to generate electricity by permanent magnet type D.C generator and store it by 12V lead-acid battery cell.

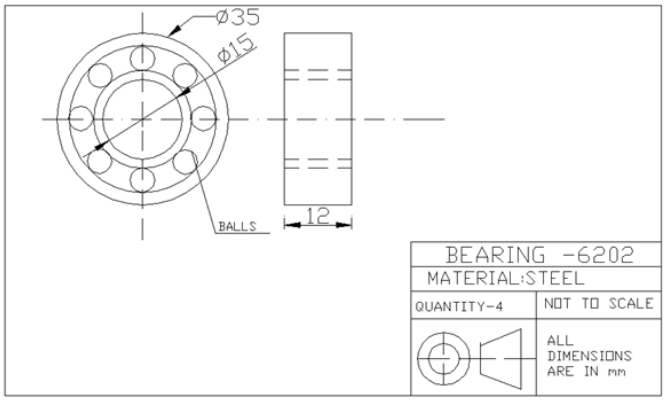

Fig 3.1 Schematic Diagram Of a Bearing

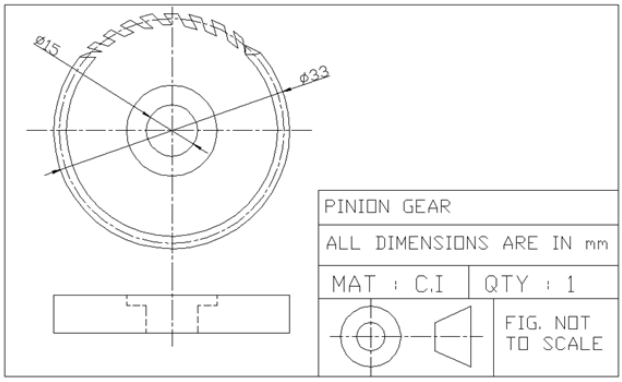

Fig 3.2 Schematic Diagram Of a Pinion gear

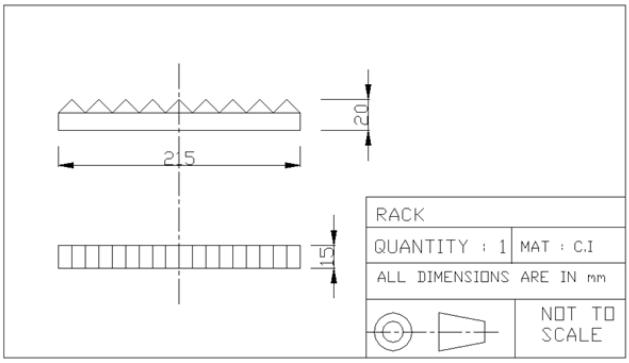

Fig 3.3 Schematic Diagram Of a Rack

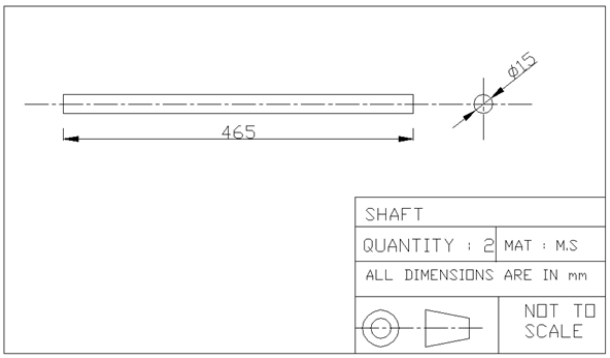

Fig 3.4 Schematic Diagram of a Shaft

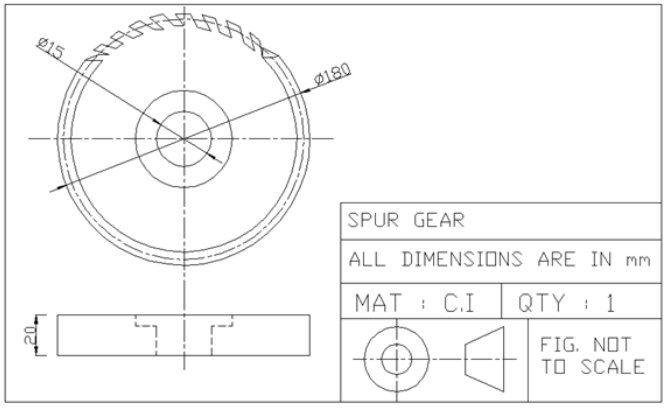

Fig 3.5 Schematic Diagram of a Spur gear

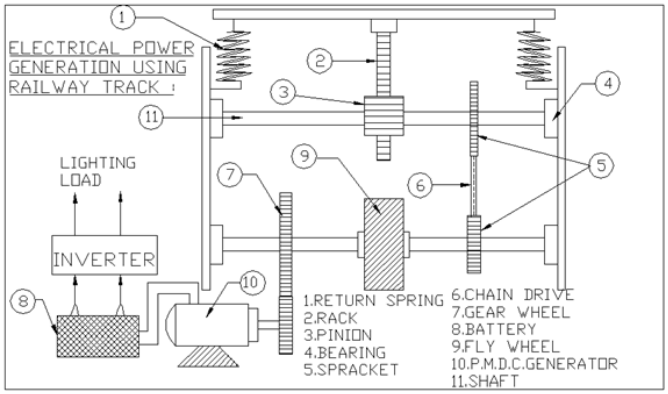

Fig 3.6 2D Figure of our Proposed Design

IV. WORKING PRINCIPLE

The complete diagram of the power generation using railway track is given below. L-shapes window is inclined in certain small angle which is used to generate the power. The pushing power is converted into electrical energy by proper driving arrangement.

The rack & pinion, spring arrangement is fixed at the railway track which is mounded bellow the L-shapes window. The spring is used to return the inclined L-shapes window in same position by releasing the load. The pinion shaft is connected to the supporter by end bearings as shown in fig. The larger sprocket also coupled with the pinion shaft, so that it is running the same speed of pinion. The larger sprocket is coupled to the small cycle sprocket with the help of chain (cycle).

This larger sprocket is used to transfer the rotation force to the smaller sprocket. The smaller sprocket is running same direction for the forward and reverse direction of rotational movement of the larger sprocket. This action locks like a cycle pedalling action.

The fly wheel and gear wheel is also coupled to the smaller sprocket shaft. The flywheel is used to increase the rpm of the smaller sprocket shaft. The gear wheel is coupled to the generator shaft with the help of another gear wheel.

V. ADVANTAGES

- Power generation is simply running the train on this arrangement
- Power also generated by running or exercising on the track.
- By small modification, this system can be used in the speed breaker arrangement
- No need fuel input
- This is a Non-conventional system
- Battery is used to store the generated power

DISADVANTAGES

- Slight inclination is required in the Railway Track
- Mechanical moving parts is high
- Initial cost of this arrangement is high.

- Care should be taken for batteries

VI. LIST OF MATERIALS

SL. NO.	NAME OF THE PARTS	MATERIAL	QUANTITY
1	Model Railway Track arrangement	Mild Steel	1
2	Spring	Steel	2
3	Bearing	Steel	4
4	Sprocket	C.I	2
5	Fly wheel	C.I	1
6	Gear wheel	C.I	2
7	Generator (D.C 12 V)	Aluminium	1
8	Battery (12 V)	Lead-acid	1
9	Inverter	Electronic PCB	5 meter
10	Chain	Steel	1
11	Rack	M.S	1
12	Pinion	M.S	1
13	Connecting Wire	Cu	2 meter

CONCLUSION

In concluding the words of our project, since the power generation using Railway Track get its energy requirements from the Non-renewable source of energy. There is no need of power from the mains and there is less pollution in this source of energy. It is very useful to the places all roads.

It is able to extend this project by using same arrangement and construct in the foot steps/speed breaker so that increase the power production rate by fixing school and colleges, highways etc..

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