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DESIGN AND MANUFACTURING OF VIBRATION ENERGY HARVESTER

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ABSTRACT

Energy is the main concern of day to day life. The creation of electric charge in greater amount is essential for today's world. There are various methods used for the creation of energy like renewable and non- renewable methods. Here we will represent the non-conventional source for the production of electric current. This non-conventional method is "Vibration Energy Harvester" the main objective is to generate maximum energy from bicycle using different methods. here the energy will be produce by riding the bicycle on a road in which rack and pinion gear are used to convert the mechanical energy into electrical energy and further we will store this energy into battery this entire process is carried out by using generator. Similarly at rare wheel a hub is attached on which chain and sprocket assembly is mounted. By using this method, we will produced the energy to light the bulb and charge electric devices. By the results it's manifested that we will produce the more than 20volt power in hour. This project is cost effective and easy to install in a populated area like cycle, moped bikes and in two wheeler.

Keywords: Vibration Energy, Full Wave Bridge Rectifier, Step Down Regulator.

I. INTRODUCTION

The consumption of nonrenewable fuel is rapidly increasing. The drastic growth is manifested in cost of fuel used. So somebody has to work on saving of the fuel consumption. Our aim is to illustrate how the kinetic energy from the suspension of a bicycle can be utilized to achieve our goal of obtaining maximum energy that would otherwise have gone waste .With the increasing number of vehicles custody and tremendous hike in consumption, natural fuels which are scanty are on limit of the extinction. So conservation of energy and saving energy have sustain great attention from automatic manufacture and government of all over the world. So here usually the vibration energy caused by road roughness can be detected and converted to other form of energy, the aim of environmentally safe energy and its storing is reached for this we have decided to work on implementation of differed mass of vehicle through regeneration system with the help of a suspension pot. The purpose of this project is to develop the system which would harvest the energy from the spring of suspension system and also be simple for fabrication and maintenance. Man has used tremendous amount of energy for his daily needs. Therefore, huge amount of energy has been drained and wasted. Whether we fetch it or not, energy is an important part of daily life. The amount of life and even its nourishment, depends on the availability of energy. Therefore, it is crucial to have a good knowledge of the sources of energy, the conversion of energy from one form to another and the consequence of these conversion. This new technique work on the law of conservation of energy "energy neither created or nor destroyed its can changed its form". It has moreover gained interest for established researchers to look into the energy change devices and to grow new approach to more willingly use the current restricted benefit. Therefore, here we will explain a new technique for vibration energy harvesting.

II. METHODOLOGY

The development of front wheel mechanism was done on the measurement of cycle structure which include cutting of hollow pipes for suspension. The two pipes of different diameter were cut with help of cut saw machine in appropriate size. The manufacturing of spring was later procedure, which had diameter of 4 mm where a long wirewas cutted at certain length with cutter machine and then the wire was coiled on CNC spring coiler machine which is placed in suspension pot for damping process. After construction of suspension pot the cutting of bicycle front folk was carried out. The cutting was done by taking certain measurement and dimension. The machine used was hand cutting machine. A simple structure was developed to assemble the suspension pot on wheel. As per the selection of rack and pinion the component they were added in development process, where rack was cutted at length 100mm and was welded on suspension pot. Finally the

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motor was mounted on the free arm by welding and proper meshing was took under consideration of rack and pinion. Grinding operation was carried out with the help of a Cheston Angle Grinder for Grinding, Cutting, Polishing (4 inch/100mm), and 850W Yellow Grinder Machine with Auxiliary Handle. Here Angle grinders is used for removing excess material from a piece. Finally after the entire construction the voltage output on compressing the spring was almost2-4 voltage maximum which was shown in positive and negative poles so to convert and obtain proper positive output the implementation of full wave bridge rectifier was done. Hencethe constant positive output of 5 volt on one complete compression was observed. The second part of project was to build entire assembly of rare wheel consist of chain sprocket and generator assembly. The mounting of sprocket on generator was the firststep where the job was structured on lath machine consist of different material removing steps then the job is mounted on generator shaft on then on which the sprocket is mounted by hammering or press process. The sprockets having 18 teeth on body was mounted on the leftside of cycle hub which was similar to sprocket mounted on generator having 1:1 ratio. Twoplates were cutted in square shape and then machined on grinder to obtain flat surface and then 4 drills were drilled with help of drilling machine. The plates of square size were weldedat right angle and attached at the wheel carriage. Then the generator is bolted to plate and then it is attached to sprockets with help of chain to obtain accurate drive after the entire assembly the voltage obtain on 40RPM is 8 voltage.

Figure 1. Isometric view of energy vibration harvester

Figure 2. Energy Vibration Harvester

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III. RESULTS AND DISCUSSION

Design of pinion

Considering module for pinion

Module M = 1.5

No of teeth on Pinion=14

Gear angle=20 deg

Diameter of pinion=30mm

Taking face width = 10 x Module of gear

= 10 x 1.5

= 15mm

Mass consideration of pinion

M =V x D

D = 7.870/cm^3

M = 228.8 g

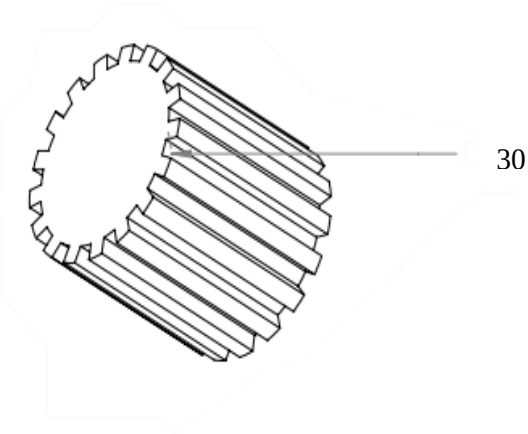

Figure 3

Number of teeth on rack

We know the module of rack and pinion gear

M = 1.5 mm

Rack length = 3inch (75mm)

Width = 20mm

No of teeth on rack= 14 teeth

Mass consideration of rack

M = V x D

D = 7.870g/cm^3

M = 356g

Rack pinion ratio = 1:1

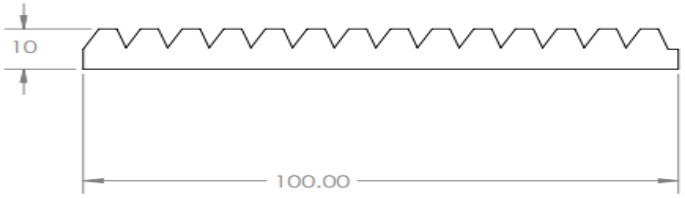

Figure 4. Rack

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Design of spring

We used helical spring for front wheel suspension

Considering mass acting on suspension is 30Kg

To calculate force

F = M x G

= 20 x 9.81

= 196.2 N

To calculate K we should know spring index

In practical application spring index varies from 4 to 12 where 8 is considerGood value

Assuming value of spring index c = 8

Wahl factor = k = 4c – 1/4c-4 + 0.615/8

= 4(8-1)/4(8-4) + 0.615/8

k =1.184

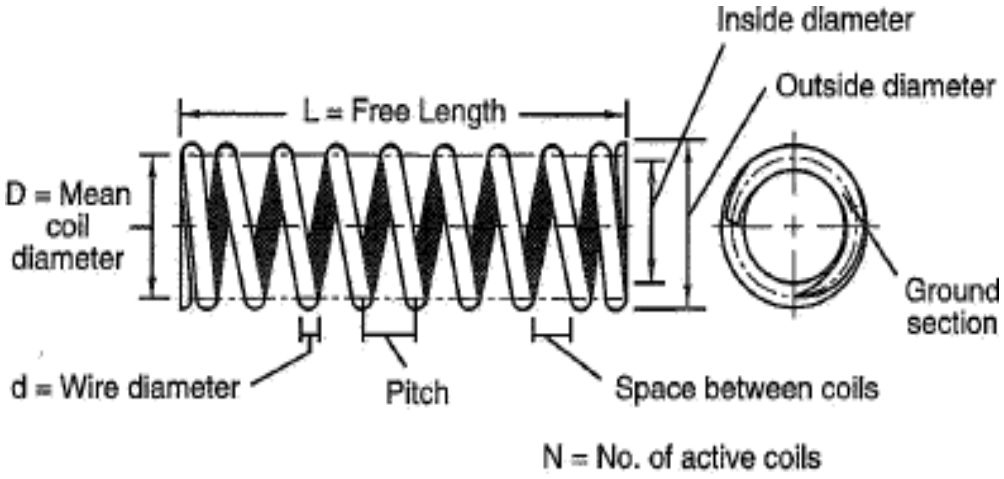

Figure 5. Spring specification

To calculate wire diameter

Ultimate tensile stress (Sut) of stainless steel is 505 MPA

The Indian standard 4454-1981 has recommended much higher value

For permissible shear stress

According to standard

T = 0.5 sut = 0.5 x 505

T = 253 mpa

τ = k 8 Pc / π d^2

253= 1.184 (8 x 196 x 8/3.14 x d^2)

d= 4.2 = 4 mm

To calculate mean coil diameter

D= cd

D= 8 x 4.2

D= 33.6mm

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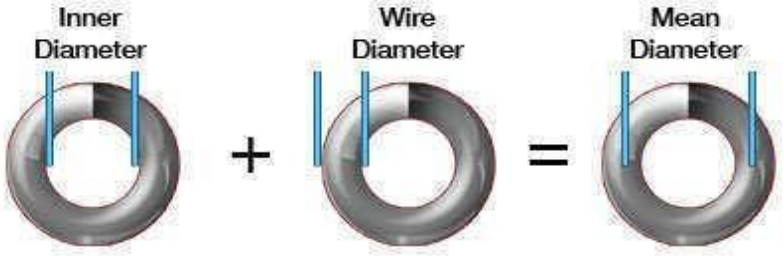

Figure 6. Mean diameter

To calculate the no of active coils

$\delta = 8PD^3N / Gd^4$

Here the modulus of rigidity G= 84 kn/mm^2

And assume deflection δ = 40 mm

$40 = 8 \times 196 \times 33.6^3 \times N / 84 \times 10^3 \times 4.2^4$

N= 17

To calculate solid length of spring

= Nt x d

= 17 x 4.2

= 71.4 mm

To calculate actual deflection of spring

$\delta = 8PD^3N / Gd^4$

$\delta = 8 \times 196 \times 33.6^3 \times 17 / 84 \times 10^3 \times 4.2^4$

δ = 38.68mm

Free length of spring

$= n'd + \delta + 0.15\ \delta$

$= (n + 2)\ d + \delta + 0.15\ \delta$

$= (17 + 2)\ d + 38.68 + 0.15 \times 38.68$

$= 19d + 38.68 + 0.15 \times 38.68$

= 266.2

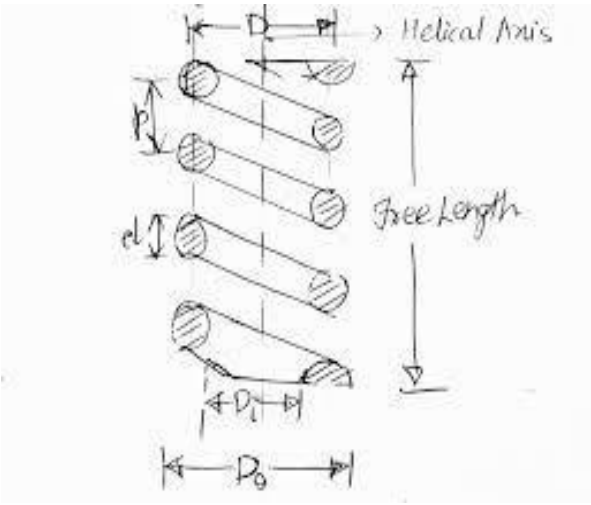

Figure 7. Free length

Calculate pitch of coil

Free length/ n'-1 = 266.2/17- 1

= 16.6 mm

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To calculate stiffness of spring

k = f / δ

= 196 / 0.033

= 5.9 x 10^3

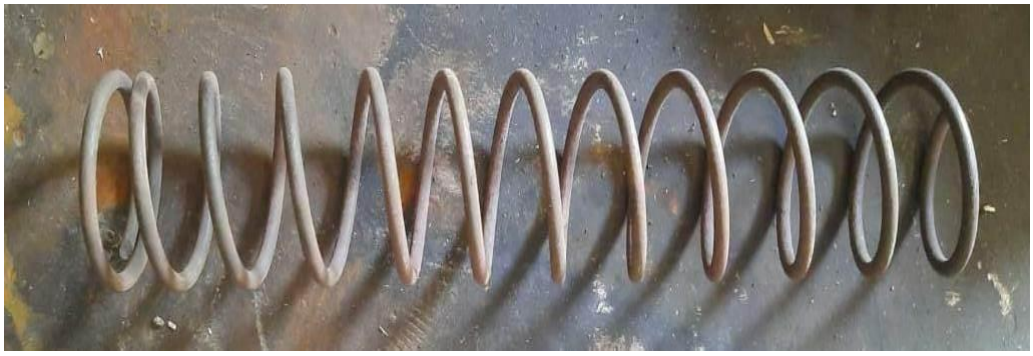

Figure 8. Helical spring

Chain sprocket

The sprocket ratio is simply the number of teeth on the driving sprocket (T1)divided by the number of teeth on driven sprocket (T2)

T1 = 16, T2=16

Sprocket ratio=T1/T2 = 16/16 =1

i.e. T1=1T2

Thus one complete rotation of driving sprocket is equal to the two complete rotationof driven sprocket.

Relative revolutions per minute Sprocket ratioT1/T2 = V2/V1 =1

V2 =1V1

For V1= 400rpm V2=40 rpm

Vehicle speed = circumference×40 rpm assuming V1= 40rpm circumference = 2π r =2×π×35 Circumference=220cm

Vehicle speed= 220 × 10 =2200cm/min = 22m/min

Power generated in one minute under no load condition

= 2 x π x N x T / 60

= 2 x 3.14 x 40 x 2 / 60

= 0.83 watt

Average power generated in one minute at 40 RPM is 0.83 watt

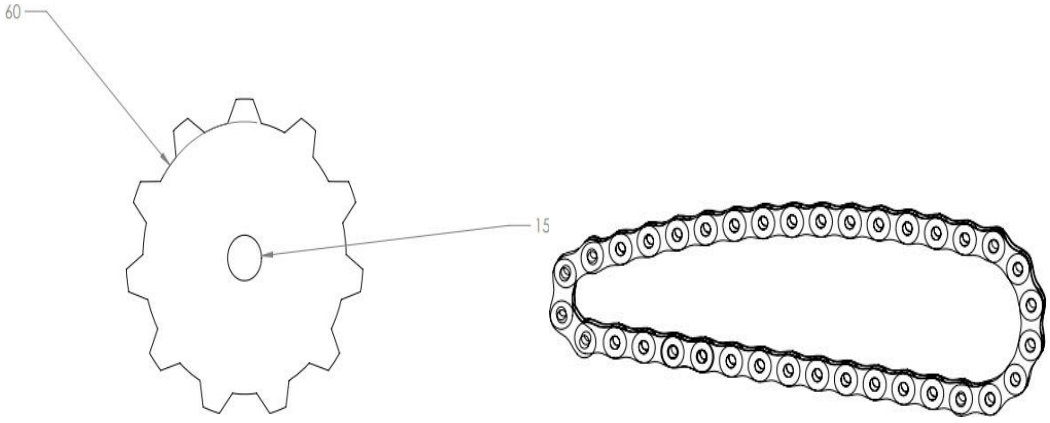

Figure 9. Chain sprocket

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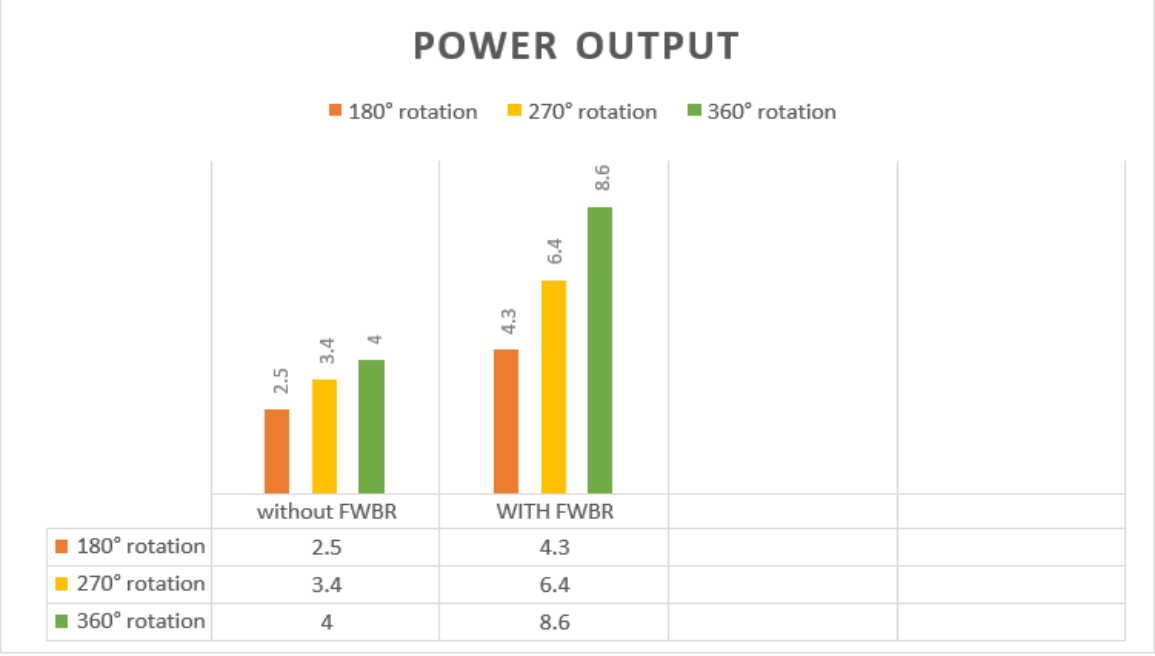
Testing

After manufacturing we took few trials for energy output. After successful sorting the finishing touches were done. From this study, vehicle suspension system is used to generate the diverse power due to movement of rack and pinion. Movement of rack and pinion is directly proportional to power produced. The power increases linearly as time increases withrespect to large movement of rack and pinion as shown in figure It was observed that the suspension system had marginally produced the energy compared to adaptive suspension The power generation Bar graph is shown below at first the difference between power output with using full wave bridge rectifier and without using full wave bridge rectifier is shown, here we can clearly see that after using full wave bridge rectifier power output is increased exponentially. When rack and pinion movement position is zero, there is an absorption in energy and a decrease in voltage.

Another power output testing is done on the rear wheel where we have chain and sprocket arrangement for driving output from the rear wheel also here in testing the power output is increased by keeping the sprocket ratio of 1:2 and further use of step up regulator is done for amplifying the output. The below bar graph shows power output in volt with using full wave bridge rectifier and without using a full wave bridge rectifier. For measuring power output voltmeter was used. The testing was done on 180°, 270°, 360° Rotation of pinion and how much power output is obtain through generator. Output without full wave bridge rectifier was obtained in positive and negative. But after implementation of full wave bridge rectifier the output was only in positive.

Power output through full wave bridge rectifier.



GRAPH 1. Power output

The below bar graph shows the power output for 20 rpm, 40 rpm and 60 rpm of rotating rearwheel of a bicycle when using a 1:1 and 1:2 ratio of sprocket. The power output is in volt, max power output obtained at 60 rpm of wheel using 1:2 ratio of sprocket is 12.3volt whereas in case of 1:1 sprocket ratio the max power output at 60rpm is 8.1 volt

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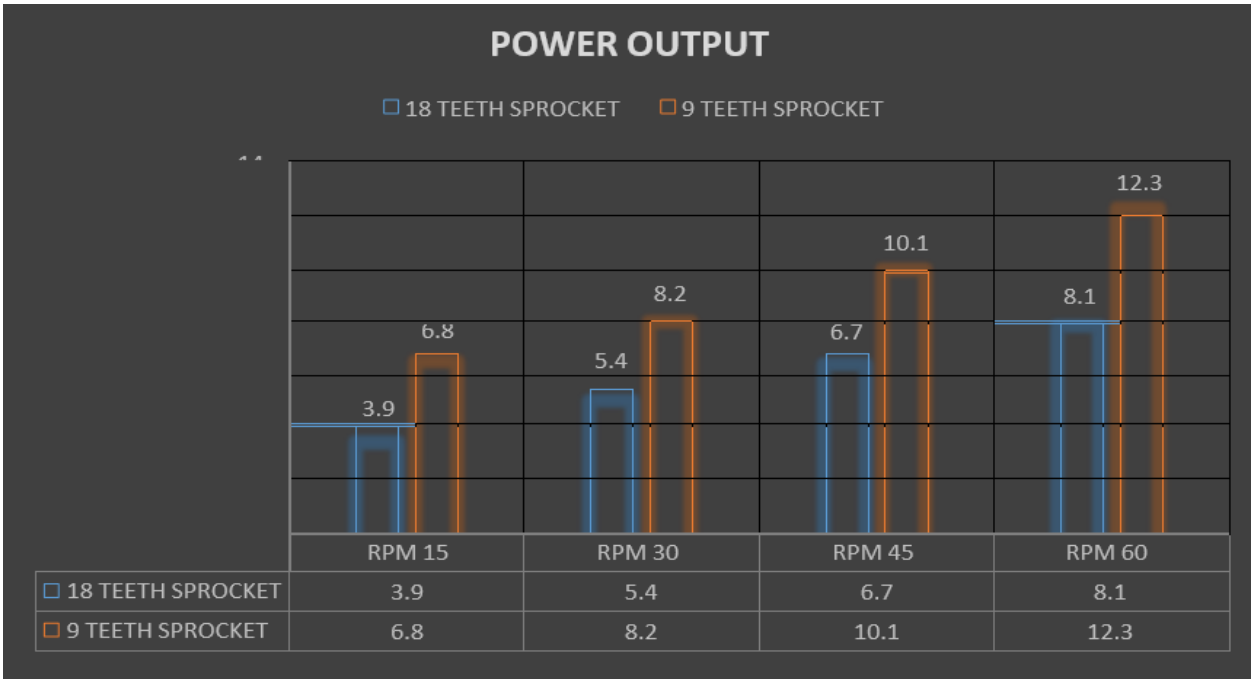
Rare wheel generator



GRAPH 2. Power output

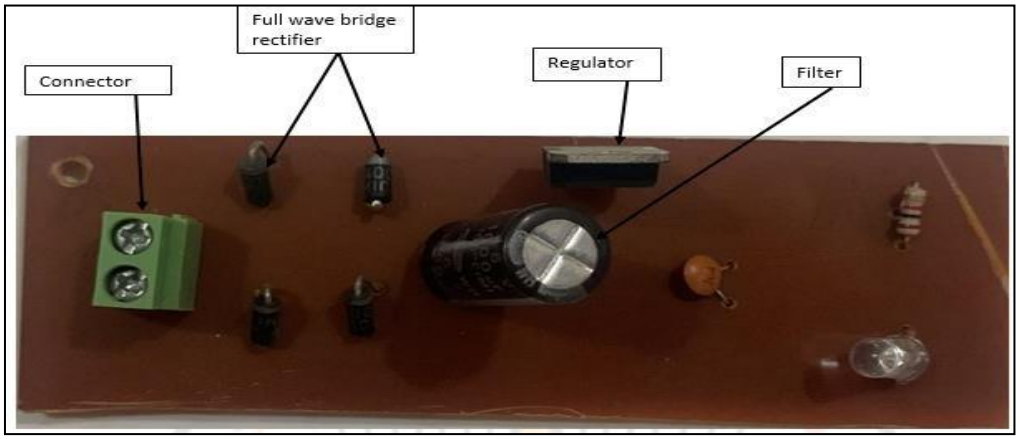


Figure 10. Full wave bridge rectifier

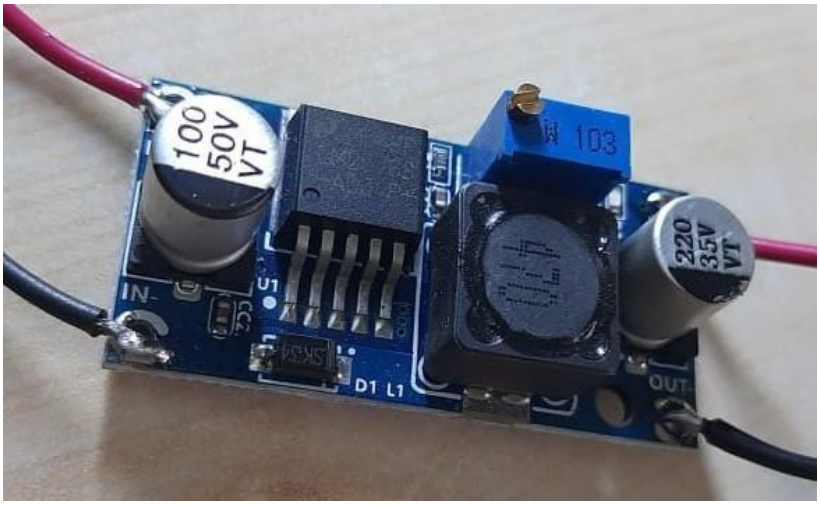


Figure 11. Step down regulator

IV. CONCLUSION

The various component used in project are easily available in stores. The main aim of project is to generate the maximum energy which was not under consideration, by using suspension pot, full wave bridge rectifier, chain sprocket and step down regulator this aim was fulfilled. This project is mostly useful in India because of geographical conditions and various types of roads like even, rough, uneven, smooth etc. by implementing this concept we can store and generate maximum energy while driving the vehicle. A reduction in fuel consumption will be manifested and control in pollution due to exhaust gases is done. Some amount of fuel is also saved. Apart from this a vehicle is capable of charging its own battery and using this charge to run various application.

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