

Electrical Power Generation Using Bicycle Generator

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Abstract – This paper shows design, implementation and operation of bicycle power generation. We know that the supply of fossil fuel is limited and their utilization as energy source causes environmental degradation. The use of renewable energy sources has been increased to reduce the environmental degradation. This goal will be accomplished by designing safe and sturdy human powered stationary bicycle. The power generated can be stored via batteries and used by the local population for lightening and other utilities that many take for granted on daily basis. The human population is an increasing entity and if we can use this entity as an asset we can reduce the energy gap to some extent. Using human energy as a source of power generation we can trap the mechanical energy of pedaling cycle and convert it into electrical energy.

Keywords— Pedal Power; Power Generation; Storage of Electrical Energy; Renewable Energy

1. INTRODUCTION

India has about 18% of total population of the world and the rate of growth of population is also high. Most of the people live in rural area. India is an agrarian country. Most of the villages have limited access to electricity or have access for very few hours. The demand of electricity for industrial purposes is also increasing. Therefore, to fulfil the large energy demands we have to generate more electricity and utilize effectively [1]. In India about 235 million people have no electricity even after 69 years of independence. The deficiency of energy affects badly on aspects like social, health, economy, education etc. [7]. According to law of energy conservation 'energy can neither be created nor destroyed, it can only be transformed from one form to other if we could understand this concept and could properly apply, we can solve the problem of energy deficiency.

Today we are living in the era of modernization, where we want everything to be automatic, which in turn is reducing human efforts. This is badly affecting human health. So to maintain health there is a need to exercise. If we are able to harness this human power to generate electric power using the stationary bicycles in the gym then we can fulfil the energy demand to some extent and side by side we can solve the health issues [5].

The electricity generated using stationary or gym bicycles can be used effectively for residential purposes. So the generating demand on the utilities

will reduce to some extent and the problem of energy deficiency will be solved

2. ELECTRIFIED COUNTRY

The survey report of electrified in India by IIFL reveals that even after 69 years of independence 15.5 percent of India is still in dark during nights. All of the 5161 cities in India are electrified i.e. cent percent in the case of cities. However, in India villages are more than cities and development of India is possible when there is development of villages. 17 percent villages are not electrified. Delhi, Andhra Pradesh, Goa, Kerala, Punjab, Tamilnadu and Haryana are a few of the states that are about 99 percent electrified. Arunachal Pradesh, Bihar, Jharkhand, Orissa, Meghalaya and Tripura are the states where less than 65 percent of the villages are electrified. The worst situation is in Jharkhand where only 33.6 percent villages are electrified. The consumption of electricity in the country is increasing at the rate of 13 percent per year. The energy usage has been increasing through years, but there has been no sufficient increase in the production. This leads to load shedding and increase in prices.

3. CONCEPT

The field of energy conservation is becoming an increasingly notable subject of research among the scientific community. Therefore, the concept of this project is to design a renewable energy source which would be available to everyone, everywhere. The energy expended in a typical workout at the gym is

usually wasted in the mechanics of the equipment. To avoid this wastage of energy, this project is designed. This project harnesses the mechanical energy of the machine and converts it to electrical energy using a generator based system. The exercise equipment is attached to the shaft of the generator. Thus produced electrical energy is used in powering a piece of equipment such as lamps, blenders, laptops and other small appliances. In this way we can fulfil the electricity demand of domestic appliances.

4. DESIGN

The design and construction of pedal power generation is developed using economical engineering processes and the system does not require any tools or complex circuit for generation of electricity and storage of electrical power. The pedal of bicycle acts as a prime mover of alternator. The rear wheel of bicycle is mechanically coupled to the alternator. The output of alternator is proportional to speed of pedalling. As speed of pedalling may vary, thereby electrical output is not constant. Hence additional circuit is provided to get constant electrical output to the load [6]. Fig.1 shows block diagram of generation of power using bicycle. There are two cases, first is the output of generator is applied to load through stabilizers. Second is the output of generator is stored in battery by converting to DC. And then the stored energy is supplied to DC load directly or to AC load through inverter

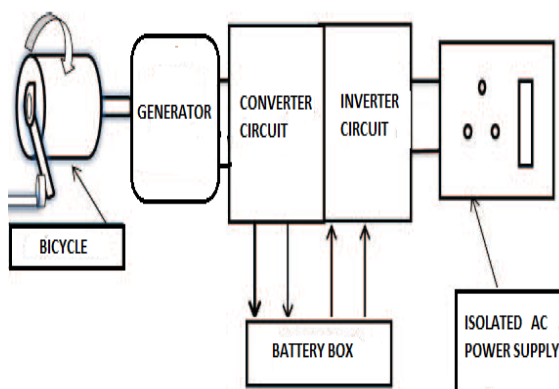


Fig.1.1 Block diagram of concept of electric generation

A. Bicycle

Power generation using bicycle is cheap and eco-friendly. Pedalling drives the rear tire of the bicycle and the rear tire are mechanically coupled to shaft of the alternator. The diameter of this wheel is calculated with base on speed and diameter of the flywheel and nominal alternator speed. A minimum speed of generation was established to ensure a DC voltage of at least 12V in the output of the alternator, which is 70% of average speed.

B. Dynamo

Bicycle Dynamos are nothing but alternators equipped with permanent magnets, which produce ac current. There are two types of dynamos available which are the hub dynamo and the bottle dynamo. Hub dynamo is built into the hub of a bicycle wheel. Therefore generation of electricity is done by using the rotation of the bicycle wheel. A bottle dynamo is also small electric generator like hub dynamo. It is generally placed to the rear wheel of the bicycle. It acts like a small alternator.

• Why dynamo?

The main function of dynamo is to convert mechanical energy to electrical energy. Alternating current can be produced normally using the dynamo. This current can power devices, which work on ac directly and can be converted and used for devices working on dc. The amount of power generated from a dynamo by pedalling is sufficient to power the devices, which require low power. Most of the electronic gadgets including mobile phones and iPods can be powered using this. These devices can be charged while either riding the bicycle or by keeping the bicycle stationary and pedalling. Dynamo is small, lightweight, and is therefore best to use in bicycles.

C. Alternator

The practical option to implement for the bicycle system is to use a standard car alternator. An alternator is an electrical generator that converts mechanical energy to electrical energy in the form of alternating current. For reasons of cost and simplicity, most alternators use a rotating magnetic field with a stationary armature. An alternator that uses a permanent magnet for its magnetic field is called a magneto. The alternator consists of two main parts, rotor and stator.

D. Rectifier

The AC power generated by the alternator is given to rectifier for converting it to DC power. This DC power is either stored in battery or directly supplied to the DC load.

Basically the thyristor based fully controlled bridge rectifier with LC filter is used.

E. Charger Circuit

The output of the generator is unregulated dc voltage; we need to regulate this voltage for storage or for conversion purpose. Most of the batteries and inverters work with 12v regulated dc, so we need to convert generator output to a proper 12v dc. For this purpose LM317 charger circuit is used in this system.

It is a dc to dc converter circuit with variable input and fixed output.

LM317 is a step down converter meaning that it can take a range of input voltages and convert that into a stable output dc voltage that is lower than the input voltage. The chip can handle an input voltage between 15 volts to 40 volts dc and will output to 12V DC. (See fig.1.2 below)

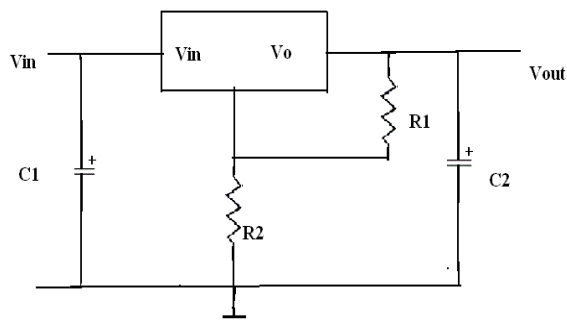


Fig 1.2 Circuit diagram of controller

In this circuit R1 is a variable resistor by adjusting R1 to a proper value we can get required output.

$$V_{out} = 1.25(1 + R1 \cdot V_{in} / R2) + I \cdot R2$$

F. Battery

Rechargeable battery is used to store the energy produced by pedalling. Rechargeable batteries are made up of one or more electrochemical cells and it stores the electrical energy in the form of chemical energy. Mostly nickel cadmium or nickel metal hydride battery is used.

G. Inverter

The DC power from battery is given to inverter for converting it to AC form and then given to AC loads.

Table 1.1 shows comparison of properties of alternator and dynamo

Characteristics	Alternator	Dynamo
Weight	Comparatively more(>0.5kg)	Comparatively less(>270gms)
Output power	100W – 300W can be generated	Normal:3W (6V, 500mAh)
Current	60amps and more at max RPM	22amps at max RPM
Efficiency	55%-70%	≈40%
Size	Comparatively big	Small
Loss	As heat, friction, noise, vibration	As heat, friction, noise

	Copper loss: series field & shunt field Iron loss: Hysteresis loss and eddy current loss Other losses: Armature loss and mechanical loss	
Applications	High power and low power devices including portable TV, DVD players, iPod etc. Alternator is preferred, if more power with less effort is needed	Low power devices such as mobile phones, LED lamps, CFL etc. Dynamo is preferred, only for powering small power devices, like lighting purpose
Rpm	High(1000rpm)	130rpm – 170rpm

Table 1.1 Comparison of dynamo and alternator

5. APPLICATIONS

1. Charging mobile phones

For charging mobile phone, we need a mobile charging circuit which would give the appropriate voltage and current. Here, the difference will be the input to charging circuit. In normal chargers, the input is from ac main 230V. However, in our case the voltage will be of lower value. Correspondingly, some changes are required to be made in the mobile charging circuit. Here two types of chargers are possible:

- 1) The first, in which the mobile phone battery is charged by connecting the charger output to mobile phone directly.
- 2) The second in which battery of the mobile phone is charged separately.

In the case of connecting charger to the mobile directly, the battery level indicator is not required, as the battery level will be shown on the mobile screen itself. However, if we are charging the battery separately then a battery level indicator will be

required. Battery level indicator is necessary as it avoids overcharging of the batteries, which may lead to battery damage. Even if there a village is un-electrified, people there use mobile phones. At such places, our design will be of great use.

2. Pedal powered laptops

Laptops powered using solar energy is available, but everyone cannot afford to buy it. A simpler way will be to pedal and charge it. This already exists in Afghanistan and they claim that even a third grader will be able to use it without any difficulty. Here the pedal is fitted to the laptop table so that while using the laptop one could charge it.

3. Pedal powered washing machine

Pedal power can be used to operate washing machine. It agitates, cleans and rinses the clothes. Already existing models use pedal power in two different ways. In one of the model, plastic barrel filled with water, soap powder and clothes are put and lid is closed. This plastic barrel itself is rotated by pedalling. In the other model also plastic barrel is used. But one person can sit on that barrel and pedal the foot pedal provided at the bottom of the plastic barrel.

4. Pedal powered refrigerators

To keep the food fresh and cool without being spoiled during a bicycle tour, pedal power refrigerators are used. In villages, particularly in India there are many street vendors for selling vegetables and fruits. Many of these vendors use bicycle or tricycle for this purpose. Pedal powered refrigerators would be of great use to them. In addition, it can keep vaccines and medicines safe without getting spoiled. According to World Health Organization, about 50 percent of vaccines go waste in developing countries. Because of this, both lives and money are lost. The human powered refrigerator uses a manual turning device which turns a small generator and it charges a battery. In turn it powers the thermoelectric cooling

5. Pedal powered water pump

There are places where wells and bore wells are very deep and to fetch water manually is cumbersome and strenuous. At such places, pedal powered pump can be used. Also at a higher level it can be used for irrigation and drinking water purposes. For pumping more water, electric pump is needed, but where electricity is not there pedal-powered water pump can be of great use.

6. Pedal powered lawnmowers

Lawnmowers are used to cut the grass at an even height. There is a blade rotating in a vertical axis which cuts the lawn. This blade can be rotated using pedal power. For small area like gardens in houses, instead

of human driven, the lawnmower can be driven by pedal power.

7. Blenders

Drive coupling of the blender is connected to the bicycle tire, which would rotate the blades of the blender. Electric blenders are high-powered devices, which work at about 500 watts power. If blenders are operated mechanically it would save electricity as well as money.

6. CONCLUSIONS

The population of the world is increasing tremendously, to fulfil the energy demands, it is necessary to search new ideas of renewable energy sources. One such innovative power generation technique using bicycle is presented in this paper. We have developed an efficient system which is reliable and cheap for domestic purpose in order to meet the power requirements. The usage of this equipment can be modified according to the utilization requirements and it has a wide scope in future to be used with other vehicles such as car and other transport vehicles to produce power for domestic purposes.

7. REFERENCES

Government of India, Ministry Of Power Central Electricity Authority, New-Delhi, Executive Summary Power Sector February- 14

Chetan Khemraj, Jitendra Kumar, Sumit Kumar and Vibhav Kaushik, "Energy Generation and storage Using Bicycle Pedal system", Special Issue of International Journal of Sustainable Development And Green Economics (IJSDDGE) ISSN No: 2315-4721

R.Podmore, R.Larsen, H. Louie, P. Dauenhauer, W.Gutschow, P.Lacourciere, R. Parigoris, S. Sabzyla, " Affordable energy solutions for developing communities", April show Issue 2012.

T. GIBSON, «Turning sweat into watts» IEEE SPECTRUM, pp. 50-55, Julio 2011.

L. GAMBAROTA, «Exercisers & Equipments, » Motor Gym, [online]. Available: <http://www.motorwavegroup.com/Motorgym/>. [Last access: 05 April 2015].

Michael Mazgaonkar, Ronnie Sabavalla, Ravi Kuchimanchi, "Pedal Powered electricity generator", PP-2-7, July 2010

Rajesh Kannan Megalingam, Lekshmi M Nair, Meera

Viswanath, Sreeja Sugathan, "Pedalite: Lighting up lives in unelectrified villages", 2012 [IEEE Global

Humanitarian Technology Conference, 978-07695-4849-4/12, 2012 IEEE DOI 10.1109/ GHTC.2012.61

Núñez, Carlos. Flórez, Julián. Diseño de un sistema de generación de energía eléctrica a partir de bicicletas estáticas, universidad industrial de Santander Colombia. Tesis de pregrado. 2011

D. Fodorean, L. Idoumghar, L. Szabo, "Motorization for an Electric Scooter by Using Permanent-Magnet Machines Optimized Based on a Hybrid Metaheuristic Algorithm", IEEE trans. on vehicular technology, vol. 62, no. 1, January 2013.

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