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Pedal Powered Generator for Remote Villages

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ABSTRACT

Access to power has been a major concern in the remote areas even after few decades of independence. It needs attention of researchers to find an economically viable alternative for harnessing energy with the help of available resources to improve the quality of life in such remote areas. This paper proposes a pedal powered generator with energy storage that can be utilized to light a bulb and a small fan even during non-pedaling period. The same can be extended to charge other devices such as mobile phones, laptop, iPods etc. The improvement in health index of one's life may be another benefit to reduce weight and prevention against the chronic diseases.

Keywords: Exercise, Alternator, Super Capacitor, DC-to-DC Booster.

I. INTRODUCTION

The installed capacity of power generation has shown a significant achievement over last six to seven decades in India. The per capita electricity consumption in India as of now is 1000 kWh compared to 8000 – 10000 kWh in the developed nations. The Government initiatives to provide power to all through various schemes have been implemented effectively. Meanwhile, the researchers attempted to find the newer methods of green power generation and avoid environmental changes such as solar, wind, piezo-electric etc. There has been tremendous improvements and cost reduction in solar and wind power generation but the output of these technologies are intermittent. The daily average wind velocity in a typical meteorological station has been found to vary between 20 – 70 kmph. On the other hand, the average solar radiation largely depends upon the number of peak sun hours roughly estimated to be 8 kWh/m^2. The reliability of both the system can be improved if it is accompanied with the battery energy storage system in order to be effectively implemented on the mainstream. Approximately, 15% of remote villages yet have poor access or no access to electricity. The rural electrification is given the utmost importance as it is the underprivileged area and needs immediate attention. The remote villages need small amount of power in the range of 1 kW to 1.5 kW. It is believed that the human is a source of energy. If it is properly utilized in remote villages, it may fulfill the energy requirement and improve the standard of living. An average human can produce 120 watts of power by pedaling for 40 minutes. Though the power produced by pedaling will not be sufficient to power large devices but the proposed method may be able to illuminate a small LED bulb and a small fan. The method has potential to be utilized in an area where it has poor access to electricity such as rural area, hilly area and deep forests. Benefits of Pedal Power Generation: (i) Producing our own electricity by pedaling an exercise cycle. (ii) Generates electrical energy which is used for charging the storage batteries. (iii) The proposed idea is economically viable where transmission of power proves uneconomical. (iv)Improvement in human health index of the community.

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Pedal Powered Water Pumps

A bicycle may pump 8 to 10 gallon per minute from well, provide irrigation and drinking water [2]. Historically, the humans apply energy by the use of arms, back, feets. It is believed that the legs can generate four times more than pedaling by hand crank.

Handcrank, Capstan and Treadwheels

The cranks and pedals were popular during ancient times which transformed human power to the useable devices. They were used as hand generator, juicers, blenders, drills etc. Capstan has a vertical axis tied with a rope to hold the ships on river bank. Tradewheels were the human powered crane used for lifting goods and moving it to the other area.

Human Powered Cranes and Lifting Devices

It is a matter of fact to believe, how human power was used to make Alexandria Lighthouse and Egyptian Pyramids. Human power was mostly used in construction projects, loading and unloading, hoisting sails on ships, mining purpose etc.

Based on the historical applications of human power, if the pedal power technology is explored in right direction, it may contribute to the society offering comforts and improve quality of life and human health index.

II. BASIC SCHEME

The proposed idea of pedal power generation is suitable for a location where there is no access to electricity such as deep rural area, hilly area, deep forest etc. The scheme has a generator that receives mechanical energy from human pedal power. The system has a gear mechanism coupled with exercise bicycle giving an rpm of 1500 to 3000 with least human effort. The output of the generator may be used for charging the batteries of super capacitor so that the electricity so generated may be used even during off pedaling period. The super capacitor has less charging time and more discharging time. Since the load requirement is minimal, it can be implemented even at lower voltage. This may help in improving the quality of life in rural area. The total ON period of various loads is estimated first and the required farad of super capacitor is calculated.

III. PERFORMANCE EVALUATION

The bicycle has a support system and a gear system. The support system is extended for improving stability while pedaling. It is required to rotate the generator at high speed of 3000 rpm. A gear box of 1:10 has been

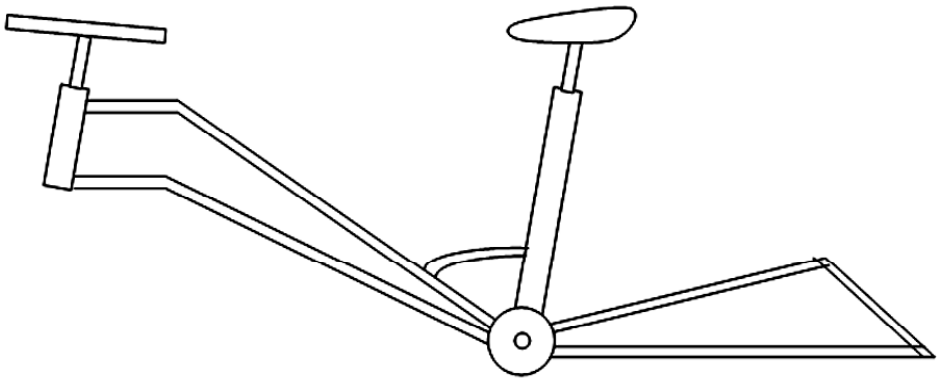

Figure 1: Bicycle Frame

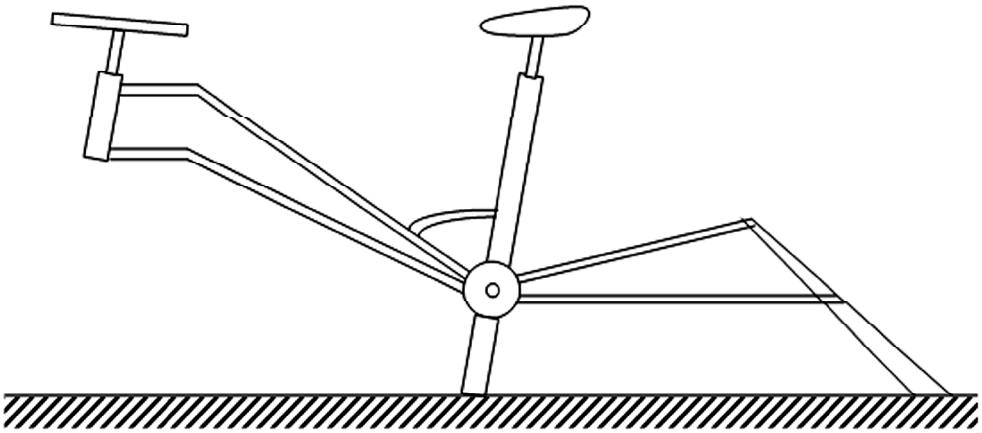

Figure 2: Bicycle Frame

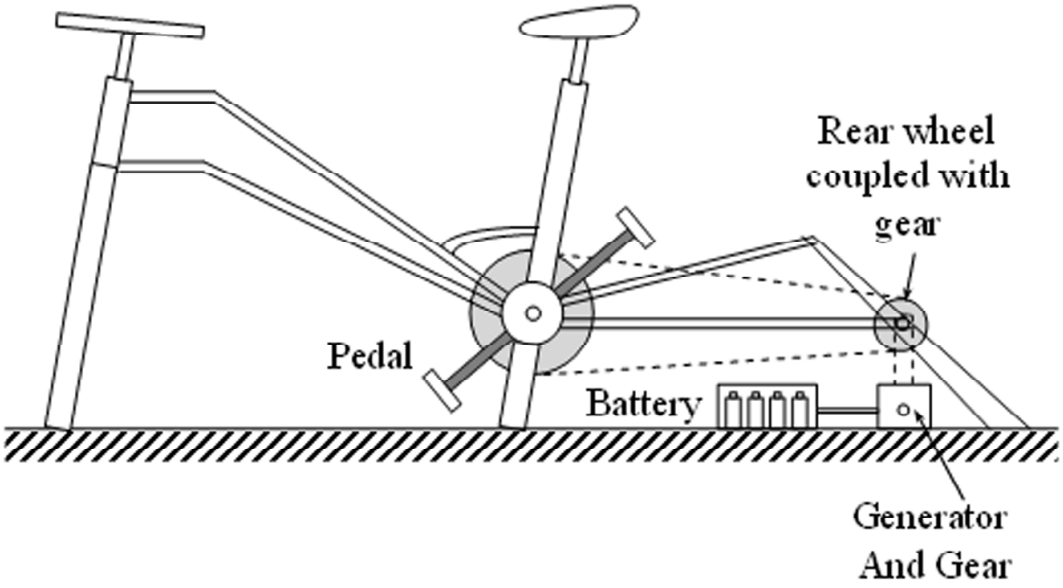

Figure 3: Battery and Gear Arrangement

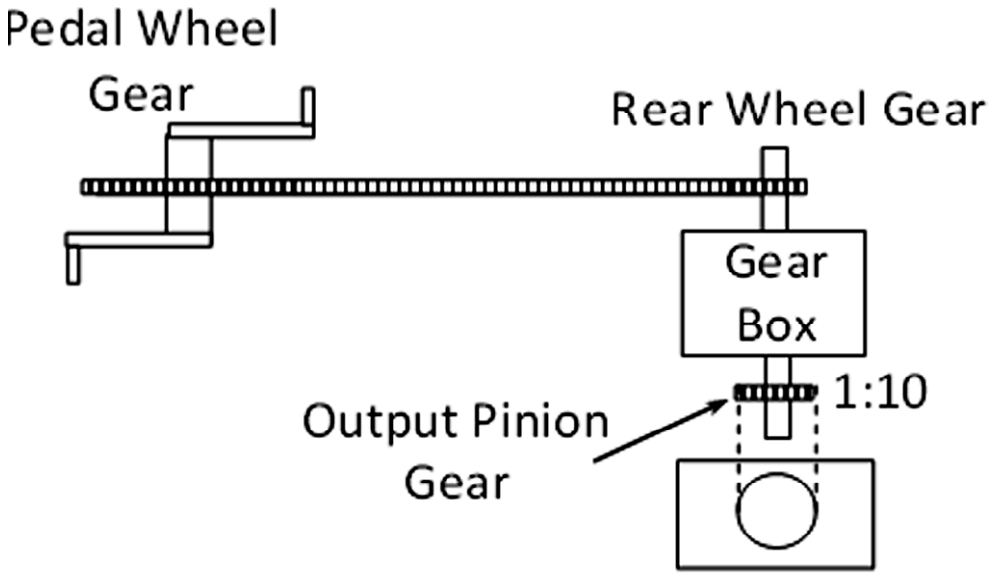

Figure 4: Top View of Gear Arrangement

procured. The speed of generator largely depends upon the pedaling speed and effective gear ratio. The term effective gear ratio takes into account the pedaling gear, rear wheel gear, and gear box together.

Pedal wheel axle = 42 teeth
Real wheel left axle = 18 teeth
Real wheel right axle = 32 teeth
Gear box ratio = 1:10
Alternator gear = 18 teeth
Alternator voltage = 14.8 volts
Field current = 0.15 to 2 Amp

Table 1
Calculation of Speed

Sr	*Gear's*	*RPM*	*Radiuscm*	*Circumference*	*SpeedKm/hr*
1.	F.G.	60	8	0.05	1.80
2.	R.G.L	139.8	2.5	0.018	2.196
3.	R.G.R	78.6	3	0.019	1.48
4.	G.B. I/P	139.8	2.5	0.016	2.196
5.	G.B. O/P	1398	9	0.056	79.1
6.	Alternator gear	3257	2.5	0.016	52.12

Circumference =
Radius of Flywheel = 0.298m
Circumference of Flywheel = 2 x 3.14 x 0.29 = 1.8221 m
Speed in Km/Hr= {(1.8221 x 1.39)/1000} x 60 = 15.28377 Km/Hr

From the above discussion, it is calculated that at 60 rpm of pedaling bicycle alternator run's at 3257 rpm i.e. at speed of 52.12 km/hr. Though the pedaling is required for power generation, but the voltage so induced may not be constant and depends upon the fatigue. Hence, it is recommended to store the energy in super-capacitors. There are several methods for measurement of super-capacitors. The required charging time constant of a capacitor yields its capacitance if resistance through which it is charging is known.

$$t = RC \quad or \quad C = \frac{t}{R}$$

$t = 0.632\ V_o$, where V_o is the initial applied voltage.

The other method of C measurement is similar but instead, the C is calculated during discharging cycle. Thus

$$t = C\frac{(V_o - V_1)}{I}$$

Where t = discharge time, V_o= initial voltage, V_1= ending voltage, I = current.

Thus, it can be estimated that a super capacitor of 250 farads when charged fully to 12 volts. If is allowed to discharge till 8 volts on the lower side assuming the current to be 0.5 Amps, the time for which it could deliver energy to the load will be

$$t = \frac{250\,(12-8)}{0.5} = 2000 \ \text{sec} = 33 \ \textit{minutes}$$

Figure 5: Base Frame

Figure 6: Gear Box

Figure 7: Freewheel

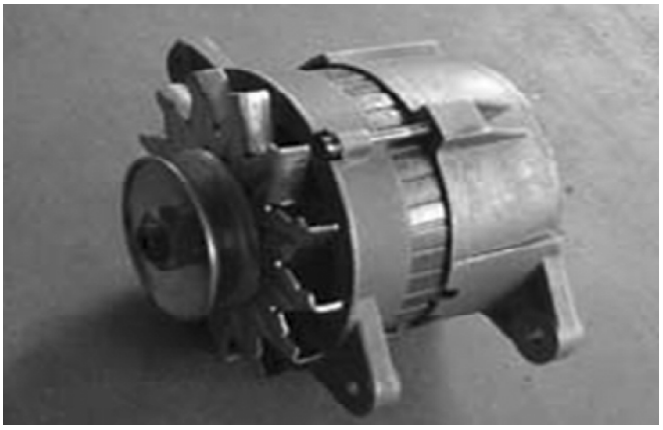

Figure 8: Generator

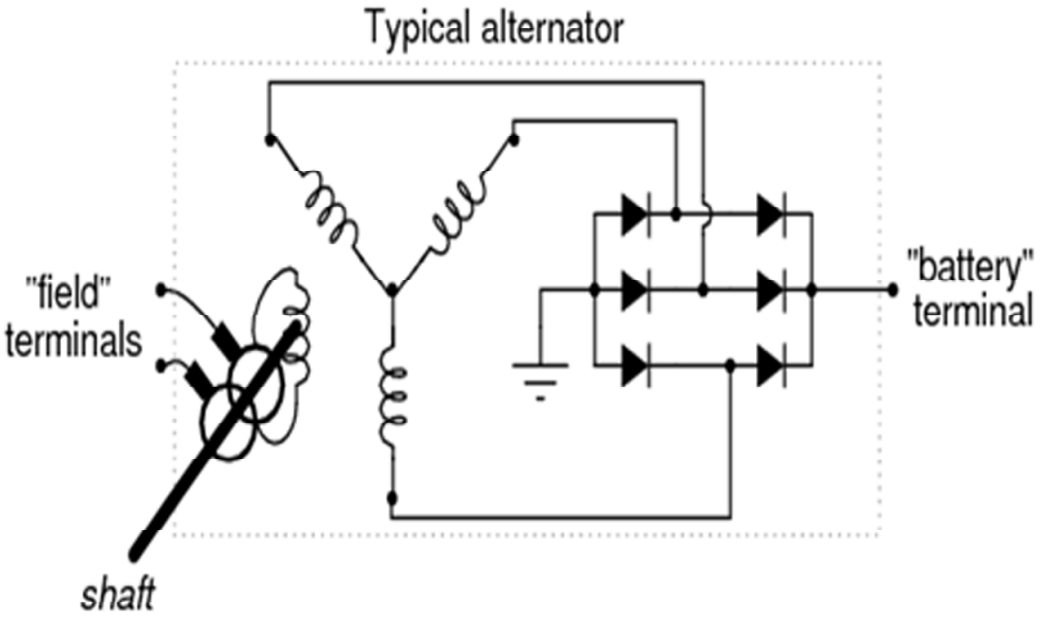

Figure 9: Internal Circuit of Generator

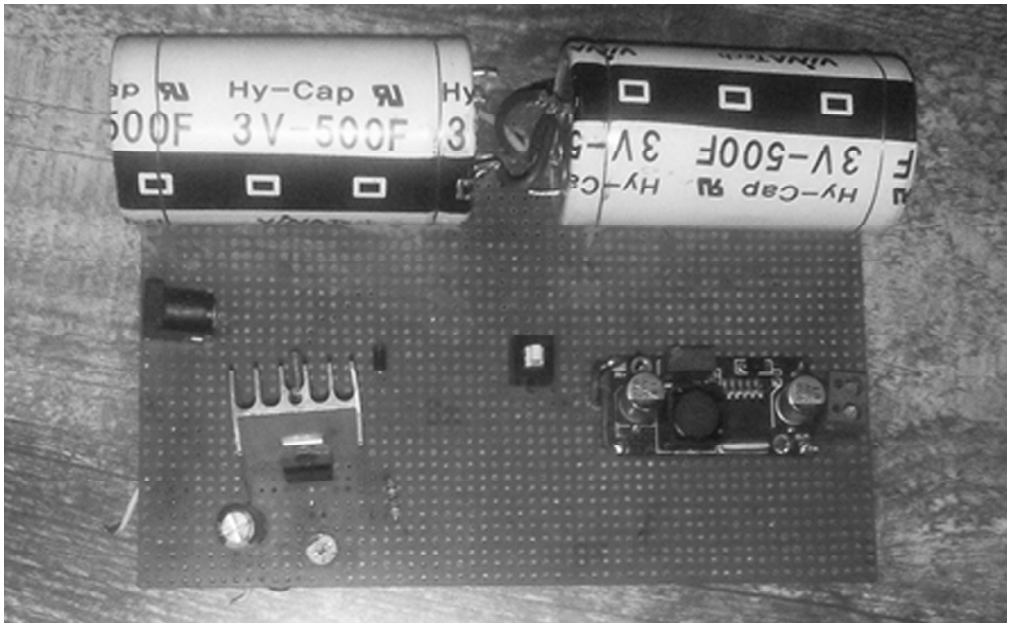

Figure 10: Super Capacitor for Energy Storage

Figure 11: Pedal Powered Generator

IV. DISCUSSION

For generator, the alternator of Maruti 800 has been chosen and driven at approximate speed of 3200 rpm which requires the pedaling at the rate of 60 rpm. This makes it possible for a human being to pedal for a long time without being exhausted. The appropriate values of gear box and other mechanical arrangement has been shown in Table 1. The excitation winding of the alternator needs to be supplied initially. Once the alternator starts its operation, the external supply to the field winding is removed as it is internally supplied. The major concern was the generator output which completely depends upon the human who is pedaling. Hence a boost converter was connected. In order to increase the reliability of the system, the supercapacitors were connected with the alternators that could provide power even during off-pedaling period.

V. CONCLUSION

The pedal powered generator has been designed with the objective of providing an alternative source of electricity as well as an effective mode of physical exercise. It is believed that, if effectively used may be considered as an innovative idea and a good solution for the energy crisis as far as a developing nation like India is concerned.

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