



DESIGN AND IMPLEMENTATION OF MECHANICALLY POWERED BATTERY CHARGER

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ABSTRACT

In this paper a simple mechanical power driven battery charging system is introduced. Specifically, a hand driven system has been developed to charge rechargeable batteries for small scale electricity supply. Instead of using any fossil fuel, the system can provide enough electrical energy to charge a battery for domestic applications. The charging unit can be used to provide limited electric supply in the remote and isolated areas where there is no national power grid connection. In addition, the system can be used for mobile charging, indoor lighting and such applications in emergency situation of power failure.

Keywords: battery charger, human powered system, green technology.

INTRODUCTION

The use of mechanically powered devices plays a vital role in our daily life. The energy generated from those devices or machines are used to accomplish many domestic applications to make comfort of our life. For example, manual swing machine, bicycle, hand pump etc. are some of the conventional mechanical devices that are often used for domestic purposes. In addition to these, there are other machines, such as generator, that convert mechanical energy to electrical energy. By using these machines we can get enough electricity to run other electrical and electronic equipment for domestic purposes. However, in the remote and isolated places where fuels are costly, alternative electric power generation is necessary. Also, the residents of a remote and rural areas should have alternative power option during natural disasters like flood, earth quake etc. The small scale power supply during emergency situation is vital especially for mobile charging, indoor lighting and such applications. In those situations, a simple system can be used to convert mechanical energy into electrical form to run different domestic appliances. Note that, the system may supply limited power but should be simple in design and implementation.

Using mechanical energy from natural sources, such as river current and wind flow, few mechanical power driven systems have been used for years. For example, the mini hydroelectric power generation system is one of the power supply systems in hill tracts where national grid connection is not available (S Doolla *et al.*, 2006) (EJ Jeffs, 1979) (NPA Smith, 1994). Similarly, wind turbine based power generation is another alternative process in the coastal areas for supplying limited electric power (TJ Chang *et al.*, 2003) (ASA Shata, 2006). However, both of the above processes are not easy implementable in terms of cost and management. Also, the natural resources like river current and wind flow are not

consistent in all palaces throughout the year. This yields a question of power availability in emergency situation. Using dynamo in bicycle wheel is one of the oldest techniques to provide electrical energy for bicycle lights (E. Schwaller, 1993) (F Ko, 2003). The dynamo can convert the mechanical energy to electrical energy to operate the lights while the bicycle is moving. However, the current supply from the dynamo will be cut as soon as the bicycle stops. In addition, in the recent years, the use of integrated charging system with wheels has become popular for the new generation electric vehicles such as electric cars and electric bicycles (SK Sul *et al.*, 1995). In addition, onboard charging systems for electric vehicles have been proposed to utilize the energy remainder from the motor in the vehicles (N Somchaiwong *et al.*, 2006). However, the above studies focus on the regeneration of the electrical energy that has been evolved from another electrical machine. In addition to the above, there are human powered energy system studied in (A Jansen *et al.*, 2006) and (Mitcheson, P.D. *et al.*, 2008). This type of systems basically scavenges small amount of electrical energy from different active human body parts such as arms, legs, blood vessel etc. However, the energy production by this type of system is limited by the health condition.

Several bio inspired system were developed in (Ahmed, N.U. *et al* 20013) and (Mamun, A. *et al* 2014). These are microcontroller based system and may not be available in rural society. Apart from the above, (Ahmed, N.U. *et al* 20011) and (Ahmed, N.U., K. Sundaraj *et al* 20013) also discussed on the recent development of the sensor based automated systems which are also expensive. There are many electro-mechanical systems that burn fossil fuel to produce electrical energy such as diesel generator, gas generator etc. This type of system not only pollutes the environment, but also appears as a threat to the conservation of natural resources. The green



technologies including biofuels have therefore become very popular in recent years (Midilli Adnan *et al.*, 2006) (K Tom *et al.*, 2007). Recently, biodiesel produced from animal fat and vegetable oil has become a popular candidate of renewable energy (F Ma *et al.*, 1999). The use of methanol and ethanol with biodiesel has also become an emerging research area for green energy production (Nadir Yilmaz, 2012). Nevertheless, although this biodiesel possesses strong stand against carbon emission, the process still depends on the natural resources. The use of mechanical power to produce electrical energy can be a great alternative of the fossil fuel and other natural fuel based systems. However, the use of mechanical power driven electric charging system for the indoor applications has not been given much attention yet. In addition to the above, in the remote and isolated places where electricity is not available, the mechanically powered system is necessary to provide limited electricity supply for emergency mobile phone charging, lighting and other indoor appliances.

In this paper, we introduce a Mechanically Powered Battery Charger (MPBC) system to charge battery that can provide electricity supply for domestic usage. Specifically, we design a mechanically (human) powered battery charging unit that will recharge low voltage batteries used for mobile phone, Light Emitting Diode (LED) lighting, limited power backup to personal computer etc. The system would be very useful and cost effective for charging batteries in the remote areas where national power grid connection is not available. The materials of the charging system are very easy to find and the design of the system is very easy to implement.

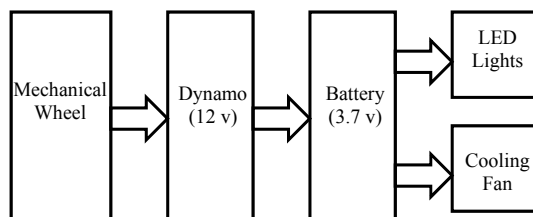


Figure-1. Block diagram of a MPBC system.

SYSTEM MODEL AND IMPLEMENTATION

The block diagram of the MPBC system is shown in Figure-1. As shown in the figure, a dynamo (GP Richardson *et al.*, 1981) is connected to a wheel through a belt. The wheel is rotated by hand with the help of a handle. When the wheel is rotated the dynamo produces an electric current to charge a battery. The proposed design is hand driven but the overall design could be altered to use another source of mechanical power such as the river current or wind to alleviate the need of human effort. According to block diagram there are five parts in this system. Firstly, the mechanical wheel which is driven manually for rotation as shown in Figure-2(a). The wheel is connected to a 12 volts dynamo as shown in Figure-2(b). When the wheel rotates dynamo armature, the

mechanical energy is converted into electrical energy in the form of 12 AC. Next, a bridge rectifier circuit has been used for AC-DC conversion. The configuration of the circuit is shown in Figure-2(c).

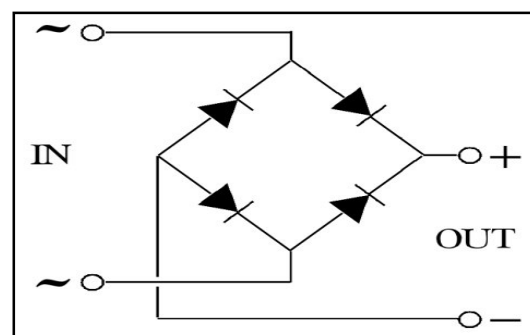
A common 3.7 volt battery is used which is charged directly by the current from the rectifier circuit. In this system a common 3.7 V rechargeable battery (NiCd and NiMH 3.7 V) has been used as shown in Figure-2(d). The battery can be charged at low current rate of 0.1C (mAh/10 = charging time in hours). This is done with a very low charging current to keep the battery constantly alive for long period. Next to the battery, a 8 LED lighting unit is installed as shown in Figure-2(e). In addition to the lighting unit, a common personal computer CPU cooling fan is also used for small scale domestic cooling system.



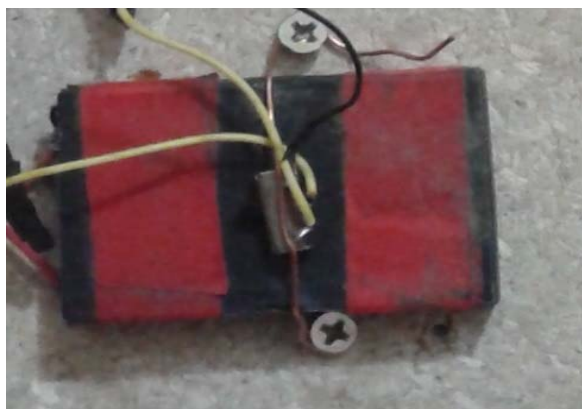
(a)



(b)



(c)



(d)



(e)

Figure-2. (a) wheel, (b) dynamo, (c) rectifier circuit, (d) battery and (e) LED lights.

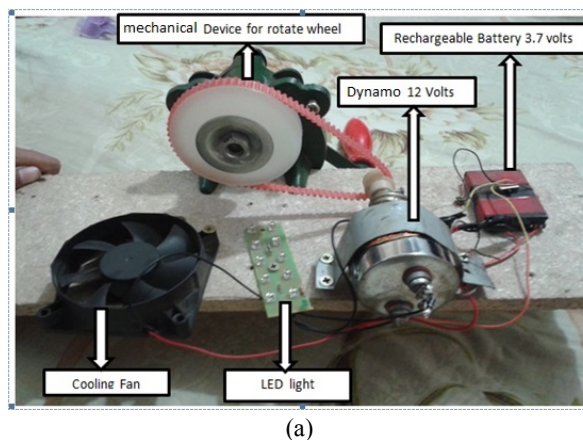
In Figure-3(a) the complete MPBC unit is demonstrated. As shown in the figure, we set all the equipments in a rectangular plywood board having dimension of 18 inch by 10 inch. The wheel together with the handle is screwed in one side of the board while the dynamo is bolted across the board attaching the commutator to the wheel through a belt. The battery is attached in one side of the dynamo and the LED and fan are screwed in another side. Figure-3(b) illustrates the system during operation. Specifically, we charge the battery in maximum and operate the LED and fan with the stored charge.

PERFORMANCE AND DISCUSSIONS

The MPBC unit offers only the most basic features, providing surge protection and battery backup. The system has the following features.

A) The MPBC system can be expanded easily whenever required without any interruption to the working system.

- B) The system is designed to operate critical condition even in the rural environment. An experimental test of the system was carried out. The power consumption of 5 watt energy directly from MPBC and the power consumption of charger circuit were measured by the energy meter. According to the result, a considerable amount of power can be saved by using charger circuit. In addition, the charging unit has a consistent power level maintained throughout the period of use.
- C) This system can recharge low voltage batteries used for mobile phone, LED lighting, cooling fan and such small domestic applications. Note that, LED does not require much voltage which is perfect for emergency situation in remote and isolated areas.
- D) The design of the MPBC system is cost effective by means of charging batteries for those who may not be able to afford electricity and or those who are in areas where electricity is unavailable. Energy savings result from not having to buy candles or kerosene fuel, and can reduce the monthly expenditures.



(a)



(b)

Figure-3. (a) Implemented MPBC system (b) MPBC system in operation



CONCLUSIONS

In this paper a simple mechanical system has been introduced that can supply electrical energy for charging batteries for small scale domestic usage. The charging unit can provide enough electricity to charge a battery for mobile charging, LED lighting and such small domestic appliances. The system has been found to be very effective for the remote and isolated places where there is no power connection from national grid. The charging system is also very useful for the emergency situation like natural disasters when there is often power failure.

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