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DESIGN AND FABRICATION OF PEDAL OPERATED BATTERY CHARGER AND EXERCISER

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Abstract:

In remote areas, hilly regions, strategic location, border areas (army deployment), Islands etc. generation of power is scanty if not nil. In these situations a Small Manual Battery Charging Unit would be of great help to provide power supply to battery chargers or battery operated gadgets like mobile phone, communication devices, radio, lamp, fan, TV etc. This product was conceived while studying various means to charge the batteries of an energy efficient lamp. The present design relates to very compact and easily portable power-generating unit, which besides being used as a power generator can also be used as cycle exerciser. The power-generating unit is pedal operated. It serves dual purpose of power generation and helping the person to maintain physical fitness through exercise of muscles of legs and lower torso. The force applied to the pedals gets transmitted to the rotor unit of power generating device through chain-sprocket and gear train. The sizes of sprockets and gears are so chosen to achieve suitable rotating speed of the rotor for power generation. The shape and size of rotor is chosen to act as a flywheel and impart suitable moment of inertia. The electrical power so produced can be fed to a rectifier unit and plurality of electrical connectors in the rectifier unit provides electrical power to various electrical devices. As per the suitability of individual user the height of the present design can be adjusted. The design enables hands free operation and simultaneously the user can engage himself in other activities like reading, watching TV etc. The user can relax intermittently without stopping the motion of the rotor unit abruptly.

Key Words: Bicycle, Motor, Battery, Drive Belt, Rim, Pulley, Diode

I. INTRODUCTION

The use of fossil fuels and other non-reusable sources of energy must be reduced in order to keep emissions low and alleviate the use of diminishing resources. The idea of human powered generation has been implemented in many different situations. Some examples include hand-crank radios, shaking flashlights, and receiving power from gym equipment (William and Jeffrey, 2012). The use of exercise equipment for a clean source of energy would turn out to be an even more fun experience for participants; it would provide them a means to exercise while indirectly generating power.

The pedal operated power generator utilizes human energy to produce electricity quickly and efficiently. The goal is to provide technological solution to problem in the rural world by using detailed opportunity recognition, evaluation, and development of prototype. The prototypes are then turned over to the developing world for manufacturing, distribution and use. Less commonly, pedal power is used to power agricultural and hand tools and even to generate electricity. Some applications include pedal powered laptops, pedal powered grinders and pedal powered water wells. Some third world development projects currently transform used bicycles into pedal powered tools for sustainable development.

Using human powered generation gives a power source that is not directly derived from natural sources. An example is that a human powered generator can be operated if there is no sun for solar generation, no wind for wind generation, and no water for hydro generation. The power generated from pedal is perfect for remote areas, hilly regions, strategic location, Islands etc., where electricity generation is scanty if not nil. In these situations, a small portable power generating unit would be of great help to provide power supply to charge battery-operated gadgets like mobile phones, lamps, radio, communication devices, etc. It is important to visualize new ways to bring power to the people as population continues to grow and power shortages continue to occur. Much of the power that is provided to people today is done in very un-sustainable ways; new ideas are needed to transit into a post cheap-petroleum era. This design relates to very compact and easily portable power-generating unit, which besides being used as a power generator can also be used as cycle exerciser. It serves dual purpose of power generation and helping the person to maintain physical fitness

through exercise of muscles of legs. It can be pedaled or cranked by hand/foot to charge 12 volt batteries and run small appliances.

II. LITERATURE REVIEW

2.1 Short History on Pedal Powered Machines

Throughout human history, energy has generally been applied through the use of the arms, hands, and back. With minor exceptions, it was only with the invention of the sliding-seat rowing shell, and particularly of the bicycle, that legs also began to be considered as a "normal" means of developing power from human muscles (Wilson, 1986). Over the centuries, the treadle has been the most common method of using the legs to produce power. Treadles are still common in the low-power range, especially for sewing machines. Historically, two treadles were used for some tasks, but even then the maximum output would have been quite small, perhaps only 0-15 percent of what an individual using pedal operated cranks can produce under optimum conditions. However, the combination of pedals and cranks, which today seems an obvious way to produce power, was not used for that purpose until quite recently. It was almost 50 years after Karl von Krais invented the steerable foot-propelled bicycle in 1817 that Pierre Michaud added pedals and cranks, and started the enormous wave of enthusiasm for bicycling that has lasted to the present.

Ever since the arrival of fossil fuels and electricity, human powered tools and machines have been viewed as an obsolete technology. This makes it easy to forget that there has been a great deal of progress in their design, largely improving their productivity. The most efficient mechanism to harvest human energy appeared in the late 19th century: pedaling. Stationary pedal powered machines went through a boom in the turn of the 20th century, but the arrival of cheap electricity and fossil fuel abruptly stopped all further development (Kris, 2011).

Otto Von Guericke is credited with building the first electrical machine in 1660. This form of electricity precedes electromagnetic energy which dominates today. The landscape for today's electricity usage practices bloomed from 1831 to 1846 with theoretical and experimental work from Faraday, Weber and Gauss in the relationship of current, magnetic fields and force. These theories enabled the design modern motors and generators. From 1880 to 1900, there was a period of rapid development in electrical machines. Thus this section reviews the works that has been done on human power generation.

2.2 Early Development

Studies in power generation shows that bicycling is one of the most efficient form of power generation known, in terms of energy expended per person. McCullagh, (1977) gives us an insight into the test conducted by Staurt Wilson using a 24V (at 1800rpm), 20A generator to charge a 12V car battery. A belt-drive was used to connect a 15.5" diameter bike flywheel to a 2.5" diameter pulley that turned the generator. During this test, an average cyclist produced 75W of sustainable electrical power 12V (900rpm) for a period of one hour.

In 1980, Carl Nowiszewski a mechanical student at the Massachusetts Institute of Technology worked with Professor David Gordon Wilson on a design of a human powered generator which when built will serve as an auxiliary control function in a sail boat in an Atlantic crossing. The energy storage was primarily for automatic steering while the pilot sleep and the pedaling was a way of keeping warm and avoid boredom. The overwhelming problem in the design was the cramped quarters which Nowiszewski eventually solved. And then in 1988, George Alexander Holt III designed a human powered generator using recumbent bicycle technology for use in a sail boat using 6061-T6 aluminum; he built a light weight foldable apparatus. The human power requirement was 120watt at 75rpm (George, 1988).

2.3 Recent Development

Mohd and others (2013) discussed charkha device in India, stated that spinning wheel horizontally could be rotated by a cord encircling a large, hand-driven wheel where the fiber is held in the left hand and the wheel slowly turned with the right. Holding the fiber at a slight angle to the spindle produced the necessary twist. Jansen and Slob (2003) improved the power generation system known as "Better Water Maker" (BWM) water disinfection system. The BWM was designed for use where water is unsafe for drinking and electricity is scare. The BWM utilizes a manual hand crank to provide power to its pump. They also studied one hand cranking and found that 50w of power could be sustained for up to 30 minutes, which is more than double the 17w required by the BWM.

As early as 2007, fitness facilities around the world have begun researching applications for converting human power to electricity. The California Fitness facility in Hong Kong was one of the first gym establishments to incorporate human powered machines. Started by French inventor Lucien Gambarota and entrepreneur Doug Woodring, the gym began a program called "Powered by YOU" in which the excess energy generated by members on 13-step cycling and cross training machines is diverted and converted to power lighting fixtures in the gym (Gerard, 2008).

Maha and Kimberly (2010), in the Proceedings of ASME 2010 4th International Conference on Energy Sustainability made us to understand that other gyms in the United States began to harness human power as well. The Dixon Recreation Center at Oregon State University (OSU) is one of the many facilities retrofitted between the years 2008 and 2009 by the Clearwater, Florida based company known as ReRev. The company retrofitted 22 elliptical machines at OSU so that the excess energy generated by patrons was diverted to the electric grid. According to the

company's website, "An elliptical machine in regular use at a gym using ReRev technology will generate one kilowatt-hour of electricity every two days."

Dean (2008) revealed that human legs are up to four (4) times more powerful than human arms. On average, a human can sustain about 100W of power through pedaling for an hour but only hand crank about 30Ww of power in an hour. Wilson (2004) demonstrates that a person's oxygen consumption, and consequently their potential power output, decrease with age, with the peak of potential power output being between 20-40 years of age

According to Jamie and Aaron (2012), Windstream, Convergence Tech and Magnificent Revolution have manufactured stationary pedal powered generators. Typical design included a back-wheel stand that elevates the bicycle and causes the back wheel to come in contact with a smaller wheel that is hooked up to a "bicycle dynamo" and a large battery.

III. PROBLEM DESCRIPITION

The aim of this thesis project is to present a working prototype of a Smartphone charger whose power source is a standard front wheel bicycle dynamo hub. The demographic for this product is the touring cyclist, who may spend weeks to months bicycling on the road, with potentially no access to electricity. Other demographics of bicycle riders, such as commuting cyclists, may have use for this product but the design is tailored to the touring cyclist. Current smart phones offer a variety of utilities to cyclists, including GPS, maps, bicycling apps which display speedometer, odometer, etc., phone, camera and video; these utilities are of value to the cyclist, but of course only if the phone remains charged.

Since this project must result in an actual consumer product and not just a proof of concept, certain design considerations as well as ergonomic and economic factors play important roles in the development of the Smartphone charger. A few products are currently on the market and are designed to power portable electronic devices, smart phones included; however they all exhibit certain limitations, which this design overcomes. The existing products are bulky, they have an excessive amount of cables, and some of them cannot charge devices at speeds under 10 MPH.

The overall theme for this design is a product which is ergonomic and simple to use, is able to charge the smart phone at speeds under 10 MPH, and is priced comparably with the existing products on the market. The design consists of a weather-proof case which houses the Smartphone and charging electronics, with a single cable that connects to the dynamo hub. The case mounts to the handlebars of the bicycle, giving the user easy access to the visual display and touch screen, headphone jack, and cameras. Since the dimensions and charging requirements of smart phones vary from model to model, this project is designed specifically for the Apple iPhone5 due to its popularity; all other Smartphone models are outside the scope of this project.

IV. CAD/CAM

Computer Aided Design (CAD) is the use of wide range of computer based tools that assist engineering, architects and other design professionals in their design activities. It is the main geometry authoring tool within the product life cycle management process and involves both software and sometimes special purpose hardware. Current packages range from 2D vector based drafting systems to 3D parametric surface and solid design models

4.1 Introduction:

CAD is used to design and develop products, which can be goods used by end consumers or intermediate goods used in other products. Cadis also extensively used in the design of tools and machinery used in the manufacturer of components. Cadis also used in the drafting and design of all types of buildings, from small residential types (house) to the largest commercial and industrial types. CAD is used thought the engineering process from the conceptual design and layout, through detailed engineering and analysis of components to definition of manufacturing methods.

4.2 Introduction to Pro/E:

PRO/E is the industry's de facto standard 3D mechanical design suit. It is the world's leading **CAD/CAM /CAE** software, gives a broad range of integrated solutions to cover all aspects of product design and manufacturing. Much of its success can be attributed to its technology which spurs its customer's to more quickly and consistently innovate a new robust, parametric, feature based model. Because that ***PRO/E*** is unmatched in this field, in all processes, in all countries, in all kind of companies along the supply chains.***PRO/E*** is also the perfect solution for the manufacturing enterprise, with associative applications, robust responsiveness and web connectivity that make it the ideal flexible engineering solution to accelerate innovations. ***PRO/E*** provides easy to use solution tailored to the needs of small medium sized enterprises as well as large industrial corporations in all industries, consumer goods, fabrications and assembly. Electrical and electronics goods, automotive, aerospace, shipbuilding and plant design. It is user friendly solid and surface modeling can be done easily.

4.3 Advantages of *PRO/E:*

1. It is much faster and more accurate.
2. Once a design is completed. 2D and 3D views are readily obtainable.
3. The ability to changes in late design process is possible.
4. It provides a very accurate representation of model specifying all other dimensions hidden geometry etc.

5. It is user friendly both solid and surface modeling can be done.
6. It provides a greater flexibility for change. For example if we like to change the dimensions of our model, all the related dimensions in design assembly, manufacturing etc. will automatically change.
7. It provides clear 3D models, which are easy to visualize and understand.
8. ***PRO/E*** provides easy assembly of the individual parts or models created it also decreases the time required for the assembly to a large extent.

V METHODOLOGY AND BLOCK DIAGRAM

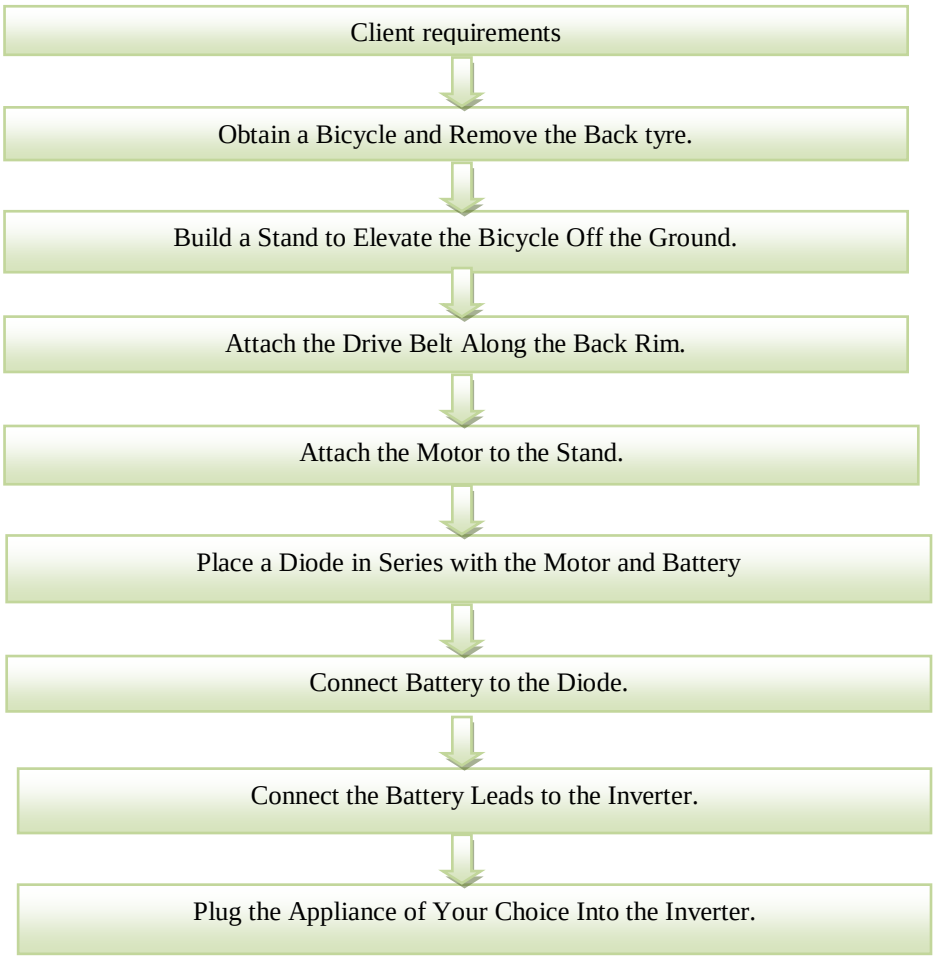

Figure 5.1 Methodology of Fabrication

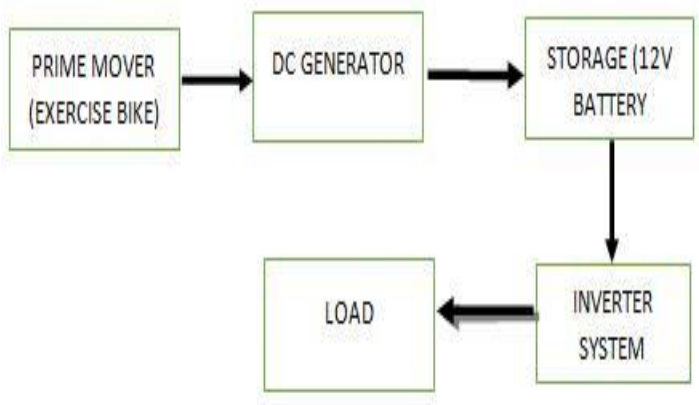

Figure 5.2 Block Diagram

VI. DESIGN AND SPECIFICATIONS

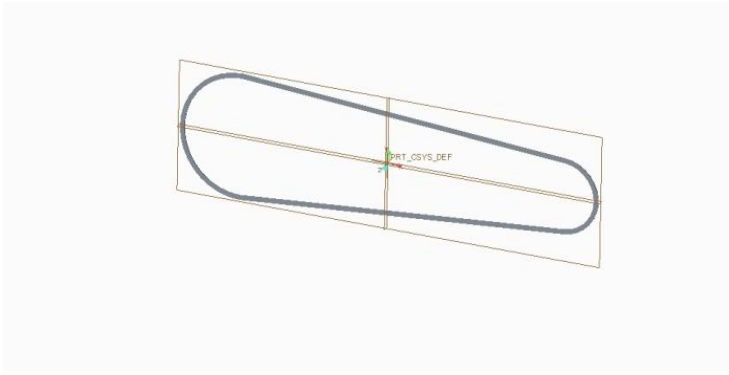

Figure 6.1 Design of Belt drive

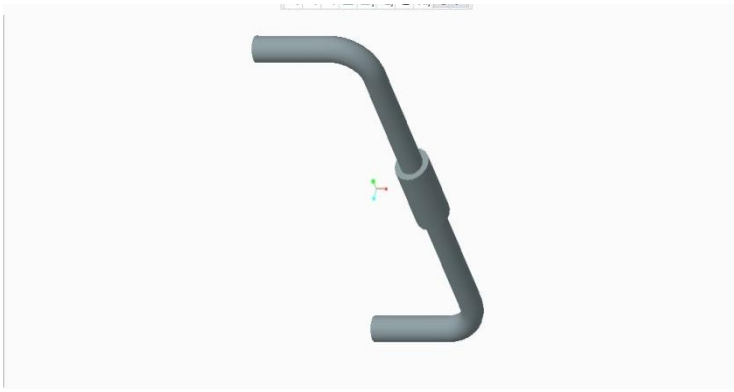

Figure 6.2 Design of Handle

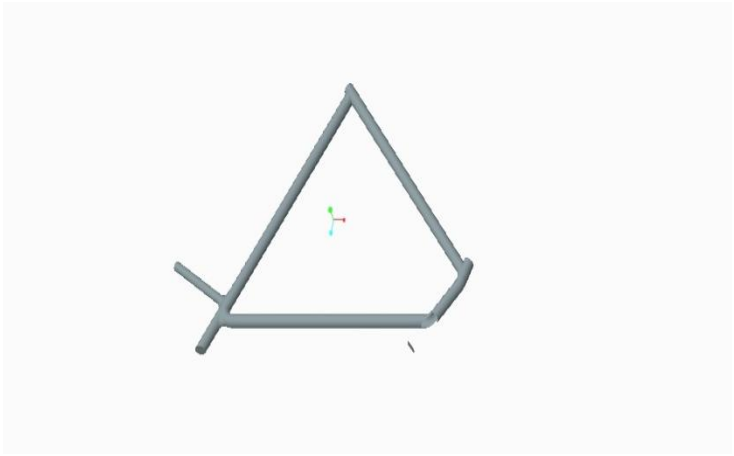

Figure 6.3 Design of Frame

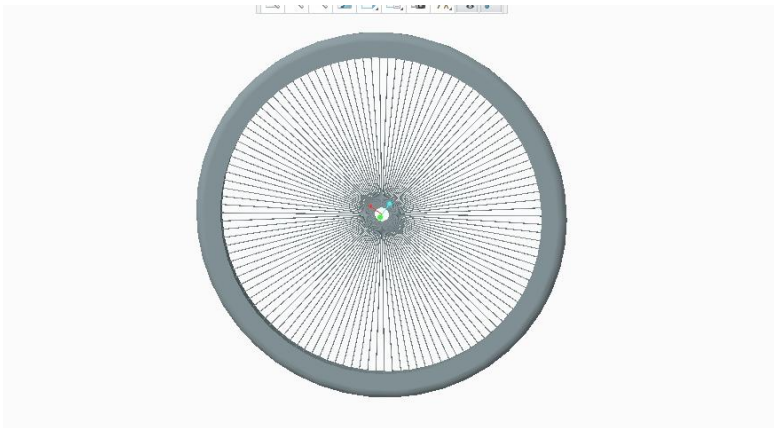

Figure 6.4 Design of Back rim

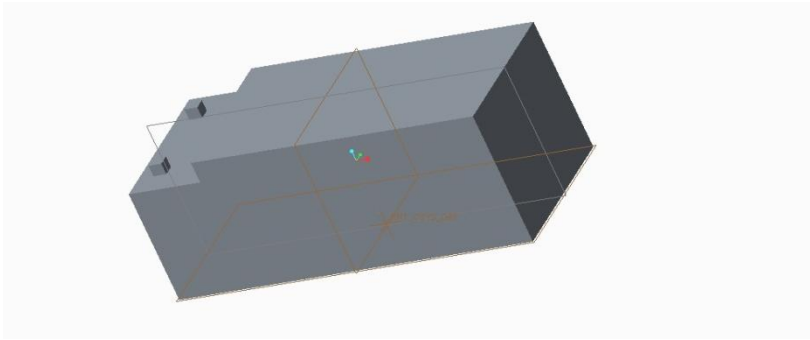

Figure 6.5 Design of Battery

Figure 6.6 Design of Motor

Figure 6.7 Design of Bicycle

Figure 6.8 Final Product

SPECIFICATIONS

- **Motor cum generator :**
  Voltage: 12V
  Speed : 3600 -7200 rpm
- **Battery:**
  Voltage : 12V
  Current : 7.5 Amp
- **Rim:** 36 inches
- **Pulley Size :** 1 inch

VII. CONCLUSION

In the view of current rural electrification program of government, a consideration to fabricate and develop pedal operated multi-operational machine will perform various operation without use of electricity. This multi-operational machine can perform operations simultaneously or individually like machining operation cutting, grinding, electricity generation and water lifting for agriculture and domestic purpose. This machine is durable, portable, easy to maintain and can be used in remote or rural places. This machine is cost efficient. This machine also promotes physical fitness of human body.

We can see that all the production based industries wanted low production cost and high work rate which is possible through the utilization of multi-function operating machine. It requires less power as well as less time, since this machine provides working at different center it really reduced the time consumption up to appreciable limit. In an industry a considerable portion of investment is being made for machinery installation. Its working can be done in less floor space. Unskilled labour can also handle it, efficiently because of this we can reduce the cost of production which is the most important factor in production industry. The system described above is being developed with these problems in mind. it is being designed with specific goals to make the greatest impact possible with multi tasks. low cost, portability, reliability, and ease of use are all essential to the success of the system.

In this way we have concluded that the power is generated and which can be used to operate small power devices such as mobile, laptops, LED lights, charging units. Hacksaw assembly is used to cut the MS bar up to 20 mm diameter, PVC pipes, plywood etc. Grinding operation can be done with good finish. The centrifugal pump assembly is applicable where we want to lift the water at required height.

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