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Experimental Study of Small Scale Industry of Human Powered Mechanical Device for Battery Charging

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Abstract—*In this paper authors, fabricated, cost estimated and experimentally studied the human powered mechanical device to establish small scale industry for electric generation to charge the dc batteries for home lighting at rural areas where grid power is not available and population rely on kerosene for light. It has unique features of using human power as prime mover for electric generator. Human energy in form of high-torque low-speed can be converted into low-torque high-speed through speed increaser to energize the electric generator. The electricity generated is stored in the batteries of different capacity and used when required. This equipment is emission free, low cost and has long life. Also this equipment needs less maintenance and any person can run either skilled or unskilled.*

Keywords*: Muscle energy, human powered mechanical device, electric generation, small scale industry..*

1. INTRODUCTION

Over 1.5 billion people rely on kerosene for light. Lack of suitable home lighting is directly linked to illiteracy, poverty and health problems. The current widespread burning of kerosene also results in environmental pollution. It is very difficult and very costly to available grid power everywhere specially at remote isolated communities in developing countries. There are many renewable power sources like solar power, wind power, hydropower, bio-energy, geo-thermal power, tidal energy etc, but all have their limitations. Although from beginning of mankind human have been doing for domestic works, but the electricity generation by muscle power is a novel technology.

Human power is a work or energy that is produced from the human body. It can also refer to the power (rate of work per time) of a human. Power comes primarily from muscles, but body heat is also used to do work like warming shelters, food, or other humans. A trained cyclist can produce about 400 watts of mechanical power for an hour or more, but adults of good average fitness average between 50 and 150 watts for an hour of vigorous exercise. A healthy well-fed laborer over the course of an 8-hour work shift can sustain an average output of about 75 watts. The yield of electric power is decreased by the efficiency of the human-powered generator [1-9]

2. FABFRICATION DETAILS

(i) Human Power: The authors' main object is to use the Human muscle power for generating electricity for domestic use. The two person of 53 kg and 56 kg of age 22 year were worked alternate as an energy source.

(ii) Human powered mechanical device: There are two step gear transmission system and two step pulley & belt system. The first gear of 68 teeth is mounted on first shaft at 20 mm from the collar which meshes with the second gear having 15 teeth mounted on second shaft at 20 mm above from the collar. The third having 68 teeth is mounted on second shaft 50 mm above the second gear and meshes with the fourth gear having 15 teeth which is mounted on third shaft at the same height. The first pulley of 9 inch is mounted on third shaft 50 mm above the fourth gear and drive the second pulley of 3 inch which is mounted on the fourth shaft at the same height. The third pulley of 18 inch is mounted on fourth shaft 50 mm above the second pulley which drive the another pulley of 3 inch mounted on alternator and alternator is fabricated on the frame.

(iii) Belt and Pulley transmission unit: According to Indian Standard Code (IS: 2494-1974), the A type of belts are selected which has power ranges 0.7kW – 3.5 KW[10]. The first pulley of 9 inch is mounted on third shaft 50 mm above the fourth gear and drive the second pulley of 3 inch which is mounted on the fourth shaft at the same height. The third pulley of 18 inch is mounted on fourth shaft 50 mm above the second pulley which drive the another pulley of 3 inch mounted on alternator and alternator is fabricated on the frame

Fig. 1: Human powered mechanical device.

(iv) Generator: In this experimental study authors select the car alternator to generate electricity. Lucas-TVS car alternator of 12V and 40 AH is used. Car alternator needs high rpm to work efficiently. It produces constant voltage but current depends on rpm and produce high as rpm is high. The direction in which the alternator is oriented to spin does not affect its output power. The alternators rotor can be rotated either clockwise or counter clockwise and achieve the same output values.

(v) Storage system: In this experiment a typical 12V, 40AH Lead-acid automotive battery is used. An automotive battery is a type of rechargeable battery that supplies electric energy to an automobile. Charging time depends on the capacity of that battery and the resting voltage of that battery when you begin to charge it.

3. FABRICATION AND PROCEDURE

The fabrication of speed increaser is done very carefully because there are five vertical shafts which are supported by taper roller bearing. The bearing covers are fitted with the help of nut and bolt on the mild steel ties, which are welded on the frame at top and bottom. Collars are provided at bottoms of shaft to support the load on bearings. Gears are fitted by means of nuts by drilling two holes on the shafts and on gear hubs. There are two step gear transmission system and two step pulley & belt system. The first gear of 68 teeth is mounted on first shaft at 20 mm from the collar which meshes with the second gear having 15 teeth mounted on second shaft at 20mm above from the collar. The third having 68 teeth is mounted on second shaft 50 mm above the second gear and meshes with the fourth gear having 15 teeth which is mounted on third shaft at the same height. The first pulley of 9 inch is mounted on third shaft 50 mm above the fourth gear and drive the second pulley of 3 inch which is mounted on the fourth shaft at the same height. The third pulley of 18 inch is mounted on fourth shaft 50 mm above the second pulley which drive the another pulley of 3 inch mounted on alternator and alternator is fabricated on the frame with the help of mechanical linkage.

Authors select the car alternator for generating electricity. Human has very low speed (v = 4km/h= 1.11m/s)[1]. If human moves at radial distance (r) of 2.5 m from the main shaft (first gear) then the distance covered at one revolution is 15.7 m ($2\times \pi \times 2.5$). And the distance cover in one minute by human is $1.11 \times 60 = 66.66$ m. Hence the initial rpm is 4.24 (= 66.66/15.7). Due to compatibility and resources available author select the gears used in sugarcane juice machine of speed ratio 4.5. Two stage gear system is used. Output rpm is increased by using pulley and belt which has speed ratio 1: 3 and 1: 6. So that the output rpm of alternator if speed of human is 1.11 m/s.

$(N_f)_{alt} = 4.24*4.5*4.5*4*6 \approx 2060$ rpm.

Fig. 2: Human powered mechanical device for battery charging.

The system is tested by means of human power for many times and it is recognized that the initial force (torque) to rotate alternator at idle speed is very low, it can easily operated. Before staring the experiment the alternator is connected with battery and ampere meter is jointed in series. The mechanical link 2500 mm is fitted with the first gear of hand winnowing fan by means of nut-bolt at one end and another end is free to applied force. When human applied force through arm at handle the first gears start rotate and drive the meshing gears as well as pulley one. The pulley one transmits power to counter pulley and so on. At the starting the rpm is very low hence the alternator was not responding but as well as speed is increasing the alternator start to generating power. Human were need to applied force to maintain average speed. The rpm and generated volt & current were taken after every minute. First time the battery was 50% discharge and it took approximate 1.5 hours to charge fully (multimeter indicate 12.6V). Second time battery was 25% discharge and it took 2.5 hours. Parallel the time required to discharge the battery at different percentage when 120 watt AC load (two 60W bulb) is subjected to battery through inverter had taken. The experiment had done 9 times.

4. RESULT AND DISCUSSION

The humans' effort and speed depend on the load subjected. Human speeds are change very quickly and abruptly. Experimental result shows that human take very little time to get working speed of 1500 rpm. Alternator generates constant voltage of 12V as specified after reaching ideal speed. The readings are taken after every minute. Speed vs. Current shows that at low rpm at starting motion it is not generating current by alternator, but as well as rpm is increasing and reaches to ideal working rang alternators producing high value of currents. First time the battery was 50% discharge and it took approximate 1.5 hours to charge fully (multimeter indicate 12.6V). Second time battery was 25% discharge and it took 2.5 hours. Parallel the time required to discharge the battery at different percentage when 120 watt AC load (two 60W bulb) is subjected to battery through inverter had taken. The experiment had done 9 times.

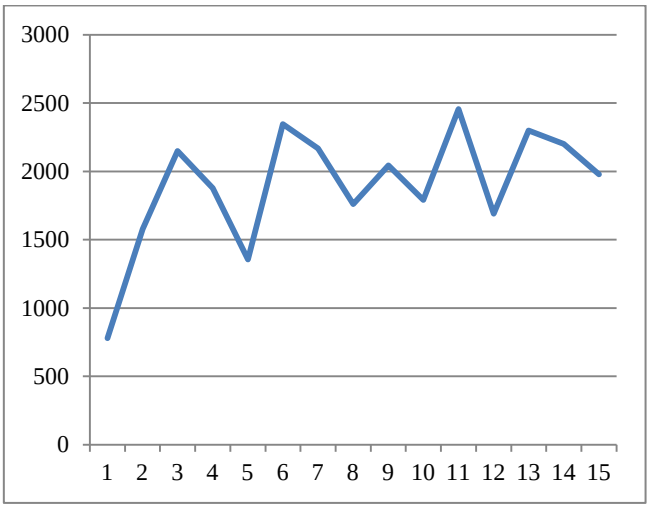

Fig. 3: Time (in minutes) vs. RPM of alternator.

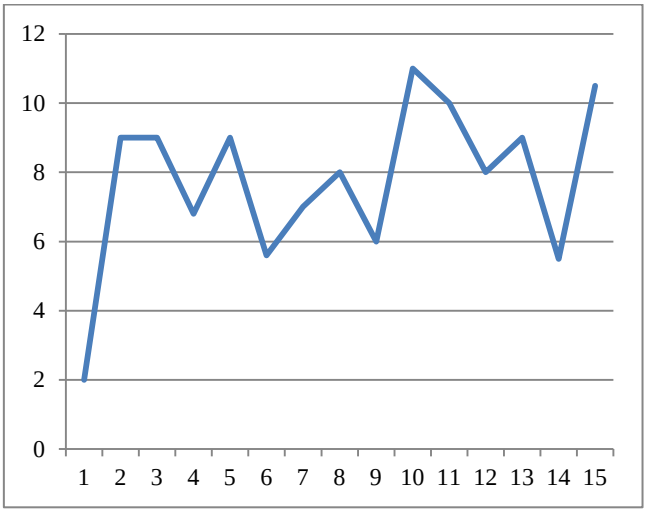

Fig. 4: Time (in minutes) vs. Current in AH.

5. COST ESTIMATED

Human powered mechanical device requires cost iron gears, steel pipe, GI pipe, bearings, mild steel angle, steel tie bar, nut & bolt, pulley, belt car alternator etc. requirements are easily available in market. The cost of different parts are tabulated below

items	size	Total cost (Rs)
Cost iron gear	68 & 15 teeth	3400
Steel pipe	50 mm	175
GI pipe	37 mm	750
Steel angle	35×35×5	200
bearing	50 mm	2000
pulley	3, 9 & 18 inch	1700
belt	A sise	45
Alternator	12V 40AH	4200
Amps meter	40 Amp	100

6. CONCLUSIONS

The present work provides a mechanical device for producing electricity for home lighting using the biological energy of the muscles of human. The project goal was to design, fabricate and experimentally studied of mechanical device to charge a battery with a 12 volt DC output for 1.5 billion people who rely on kerosene for light. This goal had to be met within the constraints of a low production cost and high safety. The project has to offer a durable product with relatively good efficiency. This is also concluded that fabricated mechanical device is itself a very small scale industry for charging batteries at rural and isolated areas.

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REFERENCES

[1] Fuller R. J., Aye LU,2012, "Human and animal power – The forgotten renewables" Renewable Energy 48 (2012) 326-332.

[2] Draught animals. From (http://www2.sjsu.edu/faculty/watkins/animalpower.htm) Metric conversion by Tim Lovett.

[3] Nagendra Pathak, Pushpito Kumar Ghosh, Sohan Lal Daga, Virendra J ayantilal Shah, Sanat Natubhai Patel "Animal powered mechanical device for water destination" US 7,387,728 B2. July 17, 2008.

[4] Maximo Gomez-Nacer, "Animal powered electricity generator" Patent no - US 2005/0161289 A1, July 28, 2005.

[5] Udayasankar Devanaboyina, "System for driving an animal powered vehicle" Pub. No: US 2011/0308868 A1, Des 22, 2011.

[6] FAO. Draught animal power – an owerview. UN Food and Agriculture Organisation; 2010.

[7] Wilson RT. The environmental ecology of oxen used for draught ower. Agriculture,ecosystems and environment 2003;97:211-37.

[8] FAOSTAT. Production; live animals. Available from http://faostat.fao.org/;2011 [accessed 13.12.11].

[9] Pearson A. Animal power: matching beast and burden. Appropriate Technology 1991 ; 18 (3): 11-4.

[10] Bhandari, V. B., 1994, "Design of Machine Elements," Tata McGraw-Hill.

[11] Ratan S S., "Theory of Machines," Tata McGraw-Hill.