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

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Abstract—*In this paper authors, fabricated, cost estimated and experimentally studied the muscle 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 muscle power as prime mover for electric generator. Muscle energy in the 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, speed increaser, electric generation, dc battery, 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.

Muscle 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) Muscle Power: The authors' main object is to use the muscle power for generating electricity for domestic use. The two person of 54 kg and 57 kg of age 23 year were worked as energy source.

(ii) Speed Increaser: There are two step gear transmission system and one step pulley and belt transmission system. The first two identical gears of 68 teeth is mounted on first shaft which mesh with the second two identical gears having 18 teeth mounted on second shaft. The third gear having 68 teeth is mounted on mid of the second shaft and meshes with the fourth gear having 18 teeth which is mounted on mid of third. The first pulley of 18 inch is mounted on end of third shaft which drives another pulley of 3 inch mounted on alternator and alternator is fabricated on the frame.

Fig. 1: Speed Increaser.

(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] There is one set of pulley and belt system. The first pulley of 18 inch is mounted on end of third shaft which drives another pulley of 3 inch mounted on alternator and alternator is fabricated on the frame.

(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 was done very carefully because there are three shafts which are supported by bearings. The bearing covers were fitted with the help of nut and bolt on the mild steel frame. 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 one step pulley and belt transmission system. The first two identical gears of 68 teeth are mounted on first shaft which mesh with the second two identical gears having 18 teeth mounted on second shaft. The third gear having 68 teeth is mounted on mid of the second shaft and meshes with the fourth gear having 18 teeth which is mounted on mid of third. The first pulley of 18 inch is mounted on end of third shaft which drives another pulley of 3 inch mounted on alternator and alternator is fabricated on the frame.

Authors select the car alternator for generating electricity. Car alternator starts to work about 1500 rpm. If human rotates the starting gear having 68 teeth with average 30 rpm then the meshing gear having 18 teeth rotates with 30*3.78 rpm. Since gear of 68 teeth is fabricated in same shaft hence it also rotates at 30*3.78 rpm which rotates the fourth gear having 18 teeth with rpm of 30*3.78*3.78. The first pulley of 18 inch is mounted on same shaft; it has the same speed of 30*3.78*3.78 rpm. The counter pulley of 3 inch mounted on car alternator thereby stepping up the speed in the ratio 1:6; hence the car alternator rotates at 30*3.78*3.78*6 rpm [11].

30*3.78*3.78*6 = 2571 rpm

The system is tested by means of human power for many times. Before staring the experiment the alternator is connected with battery and ampere meter is jointed in series. Two mechanical link handle is fitted with the first gear of first shaft 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 gear start rotate and drive the meshing gear as well as pulley one. The pulley one transmits power to counter pulley. 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 (millimeters 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 10 times.

Fig. 2: muscle powered mechanical system.

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.

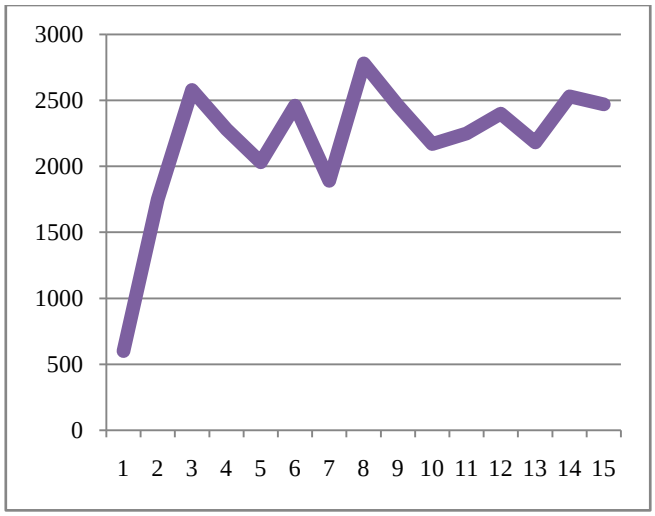

Fig. 3: Time (in minutes) vs. RPM of alternator.

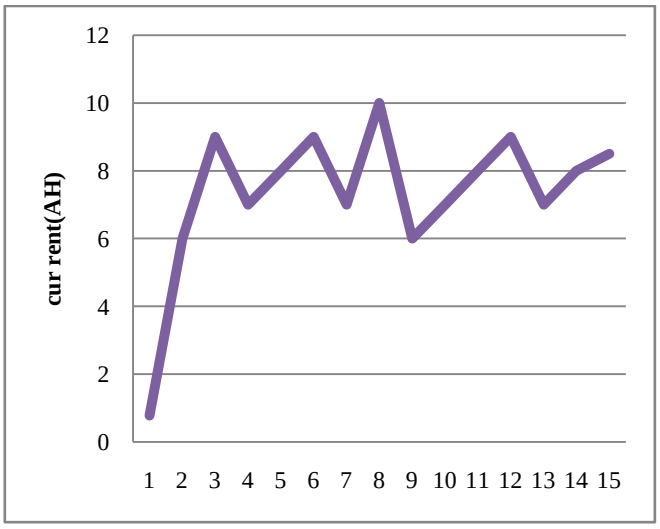

Fig. 4: Time (in minutes) vs. Current in AH.

5. COST ESTIMATED

Muscle 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
Cost iron gear	68 & 18 teeth	3400
Steel shaft	40 mm diameter	450
Steel angle	35×35×5	450
bearing	50 mm	1500
pulley	18 inch	1000
belt	A size	150
Alternator	12V 40AH	4200
Amps meter	40 Amp	100

6. CONCLUSIONS

The present work provides a mechanical device for small scale industry for producing electricity for home lighting using the biological energy of the human. The project goal was to fabricate and cost estimation of mechanical device to charge a battery array with a 12 volt DC output for1.5 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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