Design of Flywheel to Minimize Human Efforts to Generate Electricity

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Abstract— Power Generation Using human effort is a force for the future. With increasing demand for fuel and a new source of energy, development of human powered generators become a necessity. The most famous human powered generator is dynamo. On similar lines various human powered generators like backpack generators, bio mechanical energy harvester and shoe generator are being developed. These harvesters are under development and are considered one of the best inventions of recent times. One such way is to develop alternate source of energy which will help us to save energy. Geothermal energy, biogas, solar energy, wind energy are various forms of energy which are used alternatively today. One such source of energy is Human Power. Human power is an endless source of energy which has been wasted. The energy is stored in a mechanical form and retransmitted to the wheel in order to help the acceleration. Electric vehicles and hybrid have a similar system called Regenerative Brake which restores the energy in the batteries. The device recovers the kinetic energy that is present in the waste heat created by the car's braking process. It stores that energy and converts it into power that can be called upon to boost acceleration. There are principally two types of system - battery (electrical) and flywheel (mechanical). Electrical systems use a motor-generator incorporated in the car's transmission which converts mechanical energy into electrical energy and vice versa.

Key words: Flywheel, Electricity, Power Generation

I. INTRODUCTION

Humans are a rich source of energy. An average-sized person stores as much energy in fat as a 1000-kg battery (1, 2). People use muscle to convert this stored chemical energy into positive mechanical work with peak efficiencies of about 25% (3). This work can be performed at a high rate, with 100 W easily sustainable (1). Many devices take advantage of human power capacity to produce electricity, including hand-crank generators as well as wind-up flashlights, radios, and mobile phone chargers (4). A limitation of these conventional methods is that users must focus their attention on power generation at the expense of other activities, typically resulting in short bouts of generation. For electrical power generation over longer durations, it would be desirable to harvest energy from everyday activities such as walking.

There is one other option available - hydraulic KERS, where braking energy is used to accumulate hydraulic pressure which is then sent to the wheels when required. Kinetic storages, also known as Flywheel Energy Storages (FES), are used in many technical fields. While using this technical approach, inertial mass is accelerating to a very high rotational speed and maintaining the energy in the system as rotational energy. The energy is converted back by slowing down the flywheel. Available performance comes from moment of inertia effect and operating rotational speed. Flywheel mass is either mechanically driven by CVT (Continuously Variable Transmission) gear unit or electrically driven via electric motor / generator unit . Devices that directly use mechanical energy are being developed, but most FES systems use electricity to accelerate and decelerate the flywheel. In comparison with other conventional ways of storing electricity (batteries and capacitors), electric FES systems combined with innovative concept offer essential advantages. Thus FES provides minimally much higher power output and energy efficiency.

II. LITERATURE SURVEY

Bicycling is growing in popularity both as a form of transportation and for recreation. This research endeavor relied most heavily on prior class work and datasheets for our designs. This final result is entirely our own and unique. Though we didn't model our system off of any external resources, other bicycle power generators can be observed and compared in the Mechanical, Aerospace, and Structural Engineering laboratory. A search online would yield other bicycle power generation approaches as well. Before the connection between magnetism and electricity was discovered, electrostatic generators were used. They operated on electrostatic principles. Such generators generated very high voltage and low current. They operated by using moving electrically charged belts, plates, and disks that carried charge to a high potential electrode. The charge was generated using either of two mechanisms: Electrostatic induction and the turboelectric effect. Because of their inefficiency and the difficulty of insulating machines that produced very high voltages, electrostatic generators had low power ratings, and were never used for generation of commercially significant quantities of electric power.

If you want to stay fit and healthy at the same time it is important that you keep yourself active all the time. With cycling you can overcome the serious illnesses and in the way you can even escape the condition of obesity. Cycling will help you get rid of the heart diseases and you can stay safe from cancer and mental ailments. It is the best solution for arthritis and diabetes. When you ride the bicycle on regular basis you can get rid of the primary health problems and this has got to do with the sedentary life style. Cycling is the healthiest and the sort of low impact exercise and it is enjoyed by people of all age groups. Both adults and children love to go for cycling and this is the great way you can really enjoy exercising.

III. GENERAL DESIGN CONSIDERATIONS

Generally, the design of this system depends primarily on the ratings of the DC permanent magnets which produce the DC and the required output power. The output power to be

produced affects the dimensioning as well as the input parameters like torque, speed, etc. In light of the above constraints, the following design considerations and assumptions have been made for this project design;

A. Sizing and economic considerations:

This system is design to compact in consideration of the power requirement as well as reduction in the cost of fabrication. For affordability, the device is relatively small.

B. Safety Considerations:

This system is design in such a way that women and children can use it for sustained period of time. It preserves the safety of our immediate environment from noise and air pollution because it's noiseless and smokeless. Stability of the unit was also considered to ensure that the equipment remains upright at all time, i.e. it should not drift or bend to one direction and it should remain stationary.

C. Ergonomics:

The ergonomics aspect has to do with optimizing the physical contact between human and the equipment. Four important areas of bike ergonomics are usually considered:

1) The strain of the arm and shoulder.
2) The muscle support and the position of the lower back.
3) The work of proper pedaling.
4) The crank length.

D. Technological consideration:

The design of this system is well considered in such a manner that it can be produced within the technology of our immediate environment.

IV. BLOCK DIAGRAM

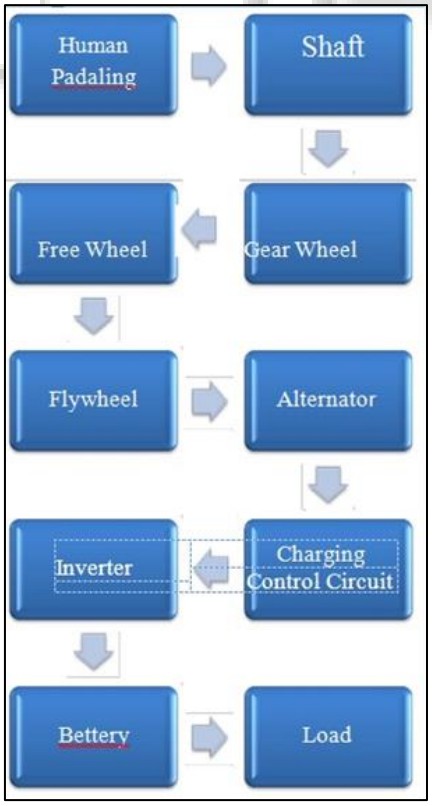

Fig. 1:

V. MATERIAL COMPONENTS

1) Frame Design.
2) Paddle.
3) Bicycle Rim.
4) Alternator: 12 VOLT.
5) Pulley.
6) Shaft.
7) Flywheel Design.

VI. FLYWHEEL DESIGN

Flywheels are designed to store and release kinetic energy. A Flywheel is disc-shaped, and true to its weight on all sides and locations of the disk. The flywheel is designed to provide a more steady flow of momentum. The size and weight of the flywheel will determine the amount of energy that can be produced from peddling the bike. The mechanical advantages of using a flywheel is that its energy output is consistent and, depending on the size of the flywheel, it is able to store and release great amounts of energy even after the peddling has ceased. The kinetic energy stored in the flywheel is given as: $K.E = / * I * w$

Where I = polar moment of inertia.

w = angular velocity of the flywheel.

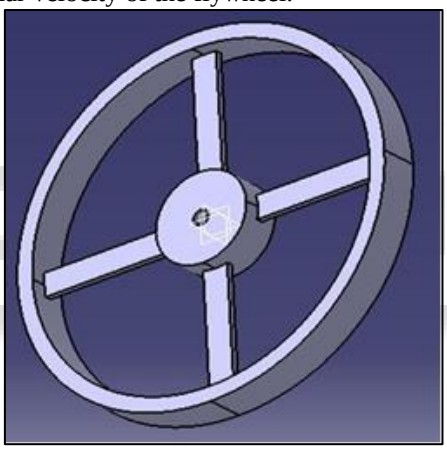

Fig. 2: Flywheel Model in CATIA V5 Software

Fig. 3: Diameter of the flywheel is 61 cm

Weight of Flywheel = 21.525kg.

Two types of flywheel are available: Heavy and light flywheel;

1) A heavy flywheel will take much more effort to get started but will be able to provide the steadiest flow of

energy once the heavy weighted disk is in motion. The disadvantage in using a heavy flywheel to power a mechanical device is the individual peddling the bicycle would also have a hard time getting the wheel's momentum engaged and would require more energy input than is required.

2) A light flywheel will be easy to engage through peddling power. The amount of momentum is not as great as a heavier flywheel but will be sufficient enough to rotate the pulley of the DC permanent magnet without causing much stress on the individual. A flywheel weighing about 25 - 35 pounds is light enough for an individual to mechanically power.
3) In the light of the above, the light flywheel scored higher than the heavy flywheel. Because the aesthetics of the drive is not crucial to the appearance of the design project in general, the use of the light flywheel for the final design is chosen over the use of the heavy flywheel.

VII. Output & Calculation

1) Maximum rpm of Flywheel = 600 rpm.
2) Rotation of Pedal per min = 72 rotation.
3) Ratio of pedal to Gear Wheel = 1:2
4) Alternator Rotational Speed = 1400 rpm
5) Voltage Output Current = 14.2 Volt
6) Output = 9.8 Amp.
7) Energy Produced by cycling: Peak Voltage is 14.2 V maximum by cyclist.
8) Power = Voltage * Current
   =14.2 * 9.8 = 139.16 watt.
   139.16 watt Energy is generated from this Model.
9) Time elapsed for charging a 12 V battery: 7 hours by cyclist.
10) Energy consumption: It consume 0.1 V in 10 minutes for a 10 Watt LED bulb so LED bulb Continue lighting 15hour.

VIII. Applications

1) Used save Environment from Pollution.
2) For glowing of LED bulbs & CFL bulbs.
3) Household use.
4) Gymnasium.
5) Use to charge small batteries.
6) Rural Area facing electricity problem.

IX. Conclusion

1) The power generation using gym get its energy requirements from the Non-renewable source of energy. There is no need of power from the mains and there is less pollution in this source of energy. It is very useful to gym and house hold and gyms.
2) Generated Electricity form our system is Renewable Energy Source.
3) It's total Pollution free means Save Environment as well as Earth.
4) Exercise is important for human health so our device exercised also done.
5) In countries like India where ample human power is available, such human powered man machine systems will help in a great extend to improve the economic condition and employability of such countries in backward or remote areas.
6) This system is only used for small type of devices not Suitable for heavy devices. Such systems are of utmost importance in Asian countries as almost all Asian countries are facing electricity scarcity which results in ten to twelve hours load shedding in rural areas.

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