Design and Fabrication Development of Power-Generating Knee Strap Hints

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Abstract – The power generation which is designed to fit onto the outside of the knee, is circular and consists of two spur gears. The spur gear rotates as the knee joint goes through a walking motion. The knee itself is an ideal starting point for energy generation as it has a large change in angle during walking and does so at significant speeds. A spur gear attached to the joint could therefore generate large amounts of power. Non-conventional energy system is very essential at this time to our nation. Non-conventional energy using foot step is converting mechanical energy into the electrical energy. This project using simple spur gear drive mechanism for power generation. In 21st century, the need of electricity and use of electronic devices has increased drasticallty. To overcome it many, source are available i.e. conventional and non-conventional for the generation of electricity. In this paper the focus is drawn towards the use of mechanical power of human to produce electricity. Here a mechanism is developed which is mounted on the knee of human being and by their mechanical movement, electricity is generated. The production of power and its result are also concluded.

Index Terms – Energy production, knee mounted energy harvester, mechanical energy.

1. INTRODUCTION

Man has needed and used energy at an increasing rate for his sustenance and well being ever since he came on the earth a few million years ago. Primitive man required energy primarily in the form of food. He derived this by eating plants or animals, which he hunted. Subsequently he discovered fire and his energy needs increased as he started to make use of wood and other bio mass to supply the energy needs for cooking as well as for keeping himself warm.

1. Cultivate land for agriculture. He added a new dimension to the use of energy by domesticating and training animals to work for him. With further demand for energy, man began to use the wind for sailing ships and for driving windmills, and the force of falling water to turn water for sailing ships and for driving windmills, and the force of falling water to turn water wheels. Till this time, it would not be wrong to say that the sun was supplying all the energy needs of man either directly or indirectly and that man was using only renewable sources of energy.
2. At such places there are not any power
3. Generating companies so people in such area have to depend on non-conventional source of energy. They have to be dependent
4. On natural source like solar, wind etc. such type of energy are very unreliable as it need certain criteria to be fulfilled. During
5. Extreme conditions a person might need a power source for small appliances like a torch light or for charging mobile phone.

Further there are some areas which are still to be explored, in such places one has to depend on navigating device such as GPS they have to widely depend on satellite maps and navigation system. But due to lack of power source one can face difficulty using such instruments. A portable battery pack might come in handy for a while but once the charge in battery gets depleted one has to find a power source. For instance a person going for hiking in a forest will have to rely on navigation system for knowing his position in the jungle. His adventure can turn into a disaster once if he gets himself lost into the forest and couldn't find a way back home. During such extreme scenario he might need some power source so that he can power his navigation system or he could transmit his location using GPS but, the need of electricity remains a problem. This type of problem are not limited to such conditions only but also during blackouts in the cities. Especially in case of blackouts in cities there will be huge need of power source because people in the cities are more dependent on electricity than anyone else. For powering small appliances without which one cannot survive we might need a capable power.

2. LITERATURE REVIEW

Qingguo Li, Veronica Naing and J Maxwell Donelan in [2] have developed a biomechanical energy harvester. In this researchpaper, they recently developed a wearable knee-mounted energy harvesting device that generated electricity during human walking. In this methods-focused paper, they explained the physiological principles that suggested there design process and present a whole description of their device design with an emphasis on new analyses. Effectively harvesting energy from walking need a small lightweight device that efficiently converts intermittent, bi-directional, low speed and high torque mechanical power to electricity, and selectively engages power generation to assist muscles in performing negative mechanical work. To achieve this, there device used a one-way clutch to transmit only knee extension motions, a spur gear transmission to induce the angular speed, a brushless DC rotary magnetic generator to convert the mechanical power into electrical power, a control system to determine when to open and close the power generation circuit based on measurements of knee angle, and a customized orthopedic knee brace to distribute the device reaction torque over a large leg surface area.

Raziel Riemer and Amir Shapiro has researched in [3] that the field of biomechanical energy harvesting from human motion. In this research paper, they analysed major motions performed during walking and identified the amount of work the body expends and the portion of recoverable energy. During walking, there are phases of the motion at the joints where muscles act as brakes and energy is lost to the surroundings. During those phases of motion, the required braking force or torque can be replaced by an electrical generator, allowing energy to be harvested at the cost of only minimal additional effort. The amount of energy that can be harvested was estimated experimentally and from literature data. Recommendations for future directions are made on the basis of our results in combination with a review of biomechanical energy harvesting devices and energy conversion methods. Consideration for the device is higher the gear ratio and the greater the losses due to friction or also the higher theweight of the device.

Michele Pozzi ,Min S. H. Aung , Meiling Zhu, Richard K. Jones, John Y. Goulermas has developed Pizzicato knee-joint energy harvester. This research paper [4] suggested that the reduced power requirements of miniaturized electronics offer the opportunity to create devices; human-based piezoelectric energy harvesting is particularly difficult due to the mismatch between the low-frequency of human activities and the high-frequency requirements of piezoelectric transducers. They propose apiezoelectric energy harvester, to be worn on the knee-joint that relies on the plucking technique to Achieve frequency up conversion.

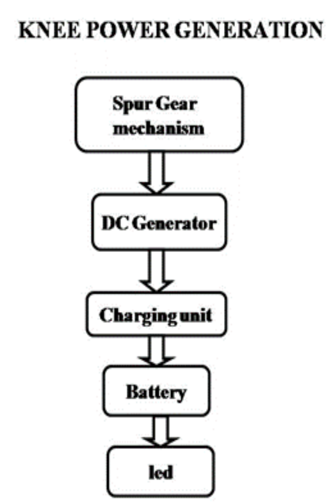
During a plucking action, a piezoelectric bimorph is deflected by a Plectrum; when released due to loss of contact, the bimorph is free to vibrate at its resonant frequency, Generating electrical energy with the highest efficiency. The knee-joint piezoelectric energy harvester is fixed to the outside of the knee by braces. As the wearer walks, the inner hub and the outer ring rotate relatively to each other with reciprocating motion, so that the four bimorphs (mounted on the hub) are forced to pass in front of the plectra (embedded in the outer ring). In this way, the plectra pluck the four bimorphs. The prototype of the EH was realized based on this design. For testing, the prototype was mounted on a knee-joint simulator, which uses a stepper motor to reproduce the kinematics of the knee-joint of a Human subject.

Amar Vatambe has developed a Power Generating Knee straps with Hints at End. This paper [5] represented that the biomechanics of walking presented four main challenges for designing a device to harvest energy from the motion of the knee joint. The first challenge was to determine an effective mechanism for converting biomechanical power into electrical power.

This generator had to be worn on the body so it needed to be small and lightweight. The second challenge was to design a mechanism for converting the intermittent, bidirectional and time-varying knee joint power into a form suitable for efficient electrical power generation. The third challenge was to optimize the system parameters in order to maximize the electrical power generation without adversely affecting the walking motion. At any given point in the walking cycle, there is only a certain amount of knee mechanical power available– attempting to harvest too much power will cause the user to limp or stop walking while harvesting too little results in less electrical power generated. The final design challenge was to determine a mechanism for selectively engaging power generation during swing Extension to achieve generative braking.

They have developed a biomechanical energy harvester for generating electricity from walking.

3. HARDWARE DESCRIPTION



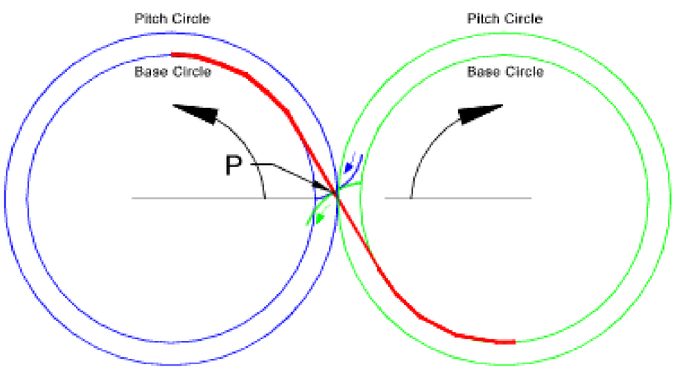
COMPONENTS

1. Spur gear

Gears are machine elements used to transmit rotary motion between two shafts, normally with a constant ratio.

The pinion is the smallest gear and the larger gear is called the gear wheel. A rack is a rectangular prism with gear teeth machined along one side- it is in effect a gear wheel with an infinite pitch circle diameter. In practice the action of gears in transmitting motion is a cam action each pair of mating teeth acting as cams. Gear design has evolved to such a level that throughout the motion of each contacting pair of teeth the velocity ratio of the gears is maintained fixed and the velocity ratio is still fixed as each subsequent pair of teeth come into contact.

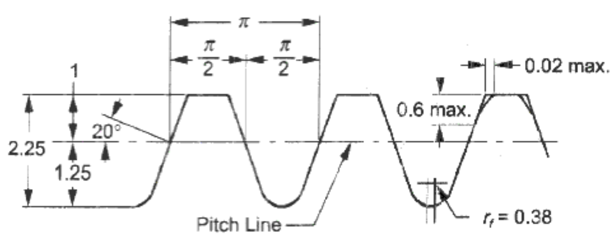
When the teeth action is such that the driving tooth moving at constant angular velocity produces a proportional constant velocity of the driven tooth the action is termed a conjugate action. The teeth shape universally selected for the gear teeth is the involute profile



m = (Pitch Circle Diameter (mm)) / (Number of teeth on gear).

In the USA the module is not used and instead the Diametric Pitch d_p is used

d_p = (Number of Teeth) / Diametrical Pitch (inches)



Flywheel:

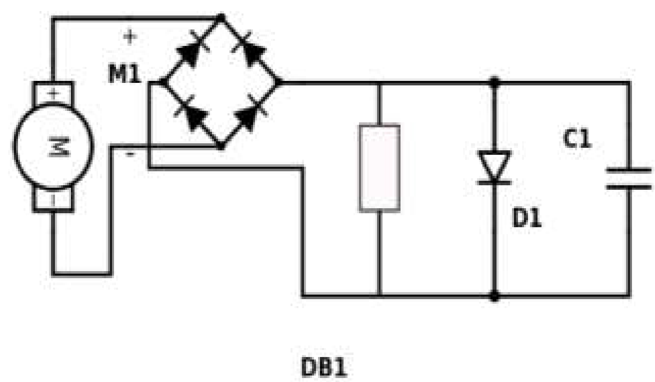
A flywheel is a mechanical device with significant moment of inertia used as a storage device for rotational energy.Power storage devices for uses in vehicles

It is a heavy metal disk at the rear end of the crankshaft; its inertia was used to smooth out speed fluctuations in the revolving crankshaft.

The flywheel effect is the continuation of oscillations in an oscillator circuit after the control stimulus has been removed. This is usually caused by interacting inductive and capacitive elements in the oscillator

Flywheel effect is used in class C modulation where efficiency of modulation can be achieved as high as 90%

Charging Circuit



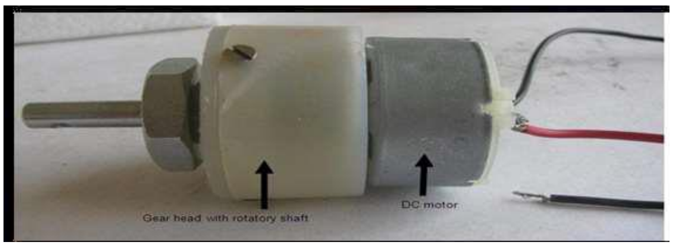
DC Generator:

Generator principle

An electrical generator is a machine which converts mechanical energy (or power) into electrical energy (or power). Induced e.m.f is produced in it according to Faraday's law of electromagnetic induction. This e.m.f causes a current to flow if the conductor circuit is closed. Hence, two basic essential parts of an electrical generator are:

a) Magnetic field.

b) Conductor or conductors which can move as to cut the flux.



Aluminum Chassis:

Chassis is the frame structure on which all components are attached. This chassis has a functional use also as it is reason because of which we are obtaining rotary motion in gear train. The whole chassis is made from aluminum thus ensuring light weight structure.

Battery pack:

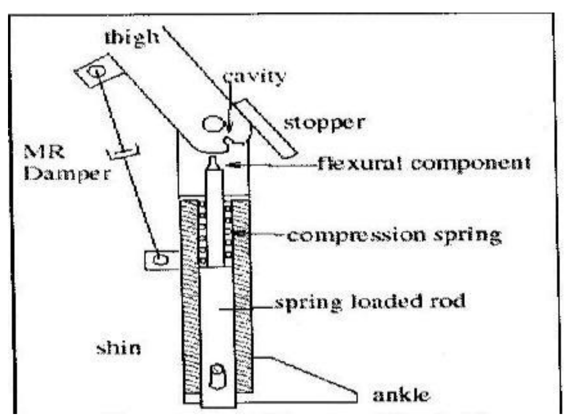
A battery pack is basically a set of rechargeable lithium ion cell which can be used to store power and can be utilized as a powersource when in need. The power stored in the battery pack depends on the storage size of the cells. This battery pack can beutilized to charge or power a small device like mobile phone

Flow batteries, used for specialized applications, are recharged by replacing the electrolyte liquid.

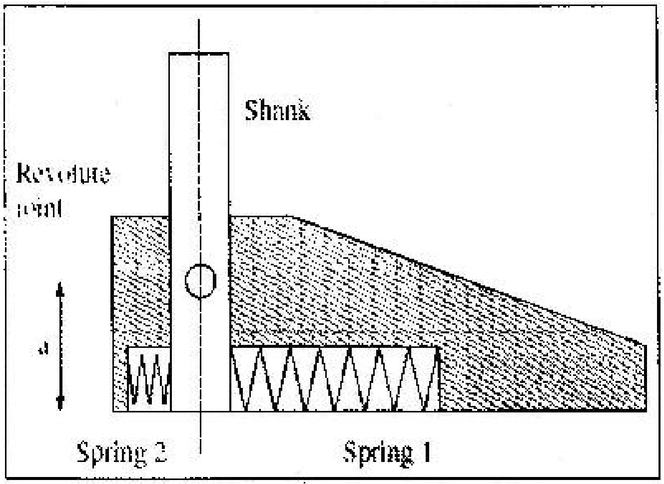
Battery manufacturers' technical notes often refer to VPC; this is volts per cell, and refers to the individual secondary cells that make up the battery. (This is typically in reference to 12-volt lead-acid batteries.) For example, to charge a 12 V battery (containing 6 cells of 2 V each) at 2.3 VPC requires a voltage of 13.8 V across the battery's terminals.

4. METHODOLOGY

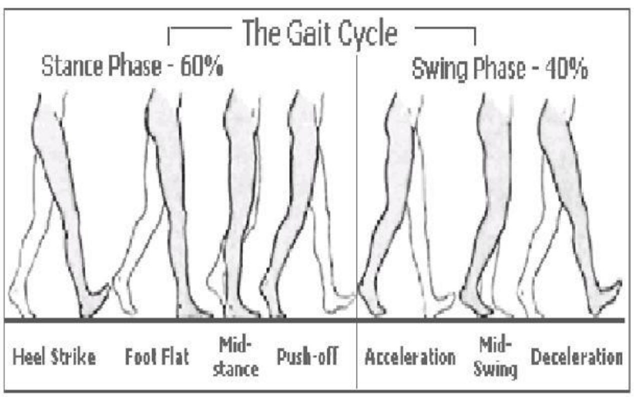
Methodology: At the beginning of the stance phase, the spring loaded rod moves through the hollow tube due to weight and the flexural component sinks into the cavity on the lower femur surface and thus locks the whole system



Between heel strike to foot flat, the spring 1 in the ankle acts as cushion to reduce impact of foot flat and spring 2 acts as storage of energy as foot moves forward.



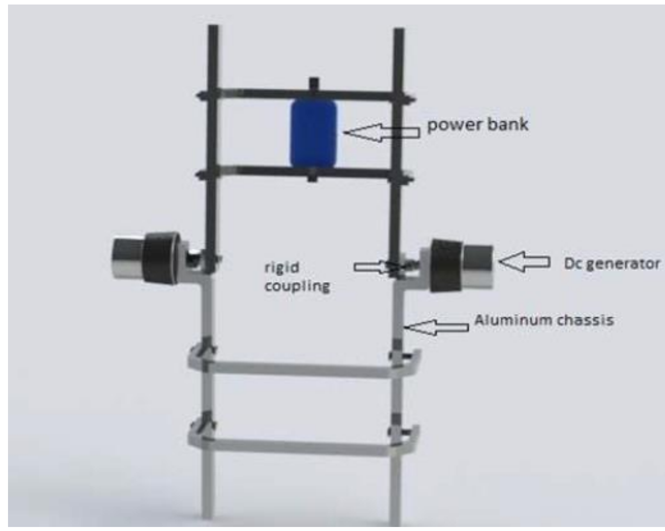
At heel off, the weight stops acting on the spring loaded rod and rod comes out of the cavity, due to compression spring. The knee thus becomes revolute.The hyper extension motion of the knee is prevented by using a simple stopper. FIG-2



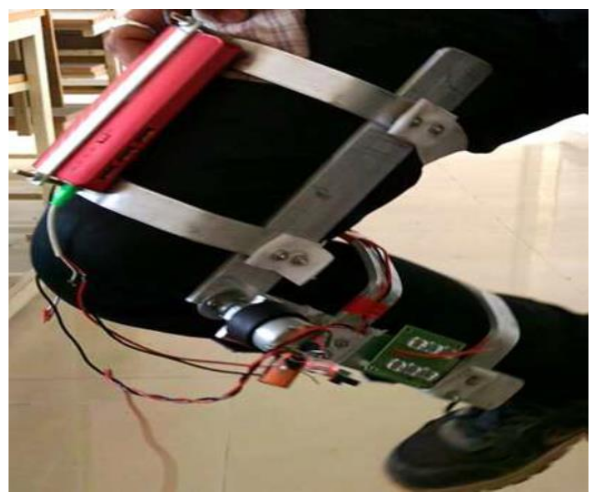
Prosthetic design involves making a replacement of a missing body part of the appropriate shape and size. The prosthesis must be comfortable, functional, and cosmetic (appearance of the prosthetic device, including visual appearance, smell, sound). The prosthesis should take into account the client's general health, weight, activity level, and motivation so as to set realistic goals. The patient's residual limb length, shape, skin condition, circulation, range of motion, and maturation should also be taken into account. Since prostheses are expensive and many insurance companies provide limited reimbursement or a single artificial limb, cost may also be a factor. The principal function of the residual limb is to serve as the lever to power and control the prosthesis. The prosthetic socket must support the patient's body weight and hold the residual limbfirmly and comfortably during all activities. As such, the prosthetic socket should be designed to support the residual limb tissues, facilitate control of the prosthesis during stance and swing, provide suspension during swing, and facilitate alignment of the artificial limb. Near-total contact between the distal limb and socket is required to aid proprioceptive feedback and prevent edema and skin problems.

Since the design of the prosthesis varies with amputation level, prosthetic design will be reviewed for the aforementioned lower extremity amputation levels. Since the primary levels of lower extremity amputation are transtibial (54 percent11) and transfemoral (33 percent11), the prostheses for these amputation levels will be presented in greater detail.

5. DESIGN DEVICE



6. FABRICATION MODEL



Advantages:

1. Conservation of Non Renewable energy sources.
2. Maximum output can be obtained.
3. Efficient and low cost design.
4. Low power consumption.

5. Power generation is simply walking.
6. Power also generated by running or walking through knee strap set up.
7. No need fuel input.
8. This is a Non-conventional system.

Applications:

1. This energy can be utilized for simple house hold appliances.
2. This energy can be stored and utilized as backup power supply mainly in industries.

7. RESULT

The project "POWER-GENERATING KNEE STRAP HINTS AT END FOR BATTERIES" was designed such that to generate electrical power as non-conventional method by simply walking with knee strap set up using spur gear mechanism. Non-conventional energy using walking or running using converting mechanical energy into the electrical energy.

8. CONCLUSION

Believe that ways will be developed that allow people to re-connect with their arms and legs without being amputated, which can be very useful to the paralysed and the disabled. Already, the latest technology is capable of enhancing people.As we design artificial leg which operates by its own using human weight and the project what we are doing will reduce the cost of artificial legs considerably so that people with poor financial background can easily afford it.

9. SCOPE FOR FUTURE WORK

For years, prosthetic technology has been limited—both in terms of functionality and the materials they are made from. In addition, many artificial limbs are heavy, making them burdensome to use. In the past decade or so, however, prosthetic limbs have evolved substantially, and, in many cases, as transitioning towards bionics. Engineers have pushed the boundaries of what was possible in prosthetics using a variety of new materials, electronics, and techniques, such as integrating implants directly with muscle fibers.

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