Power Generation by Footsteps

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Abstract

The main purpose of this Project is that to design a system that convert the mechanical energy harvested from human motion into electrical energy.This project report contains the complete literature review and implementation of an alternative to electrical power supplied by batteries for portable electronic devices and for computerized and motorized prosthetics. The report presents the idea to generate power harvesting from human motion. Electrical devices have been liberated from the wall socket. Battery powered computers, phones and music devices come along everywhere we go. The limiting factor is electricity. In the end the battery always goes dead. Ironically, when we move around with our portable devices we produce a lot of energy. But a lot of this energy is lost as heat. If that mechanical energy could be converted into electricity, our very mobility could charge our mobile devices. Using the working principal of dynamo, we intend to generate a small power which then can be used to charge the portable devices. We are charging mobile battery for testing purpose.

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CHAPTER 1

INTRODUCTION

This is the introductory chapter of the project. It includes the description, motivation and objective of the project also brief description of what all the chapters include.

1.1 Description

Electricity is an integral utility in modern society, with links to everything from a human's subconscious fear of the dark to the practical need for working illumination in an industrialized world. The entire world essentially runs on electricity, in one form or another, and while combustibles are essential at the present time as well, their time is nearing an end. Electricity is not only ingrained in modern life, it is also critical for its continued existence, as electricity will soon be the main source of power produced world-wide. All of the modern energy alternatives are focused on creating electricity by renewable means, such as wind turbines, solar arrays and geothermic heating, ultimately using steam to turn large turbines, creating electricity. Electric power is and will continue to be, one of the most important energy forms available to the human race as a whole.

With the increasing use of portable electronics, such as mobile phones, global positioning systems (GPS), and laptop computers, in our daily lives, the need for mobile electrical power sources is increasing. The power demand for the operation of these devices is typically met by batteries.

However, the need to recharge batteries (or eventually to replace them) constitutes a significant limitation on the operating time (or lifespan) of portable electronic devices. For general use in the Western world, this problem is merely an inconvenience that can be solved by simply connecting the relevant device to an electrical grid. However, for some users, such as for those living in Third World countries (such as our) or travelling in remote areas, this solution is not practical, as the power grid may not be well developed or stable.

A dynamo, originally another name for an electrical generator, now means a generator that produces direct current with the use of a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. They are rarely used for power generation now because of the dominance of alternating current, the disadvantages of the commutator, and the ease of converting alternating to direct current using solid state methods. The word still has some regional usage as a replacement for the word generator.

1.2 Objective

The goal of this project is to explore and experiment with the energy obtained from human body and to convert it to power electronic consumer products. After having analyzed the current electronic devices on power consumption, marketing and aesthetic aspects, we complied a problem definition comprising the following issues: reliability, comfort and environment.

As a result of the initial analysis, next to the design assignment, three research subjects were identified;

• The design of integrated energy systems taking optimal advantage of the specific characteristics of human power, turning input and output power.

• The aesthetics of integrating human-powered energy systems into the product.

• The ergonomics and behavioral aspects; how to keep it comfortable, convenient and fun.

The motivation of this project is actually from the current power crisis of the country.

1.3Advantages

- To store the electricity in battery.
- It can be used at any time when it required.
- Easy construction.
- Less number of parts required.
- Electricity can used for many purposes.

CHAPTER 2

BACKGROUND

2.1 Power Generation

Power generation is the process of generating electrical power from other sources of primary energy. The fundamental principles of power generation were discovered during the 1820s and early 1830s by the British scientist Michael Faraday. His basic method is still used today: electricity is generated by the movement of a loop of wire, or disc of copper between the poles of a magnet. For electric utilities, it is the first process in the delivery of electricity to consumers. The other processes, electricity transmission, distribution, and electrical power storage and recovery using pumped-storage methods are normally carried out by the electric power industry.

Electricity is most often generated at a power station by electromechanical generators, primarily driven by heat engines fuelled by chemical combustion or nuclear fission but also by other means such as the kinetic energy of flowing water and wind. Other energy sources include solar photo volataics and geothermal power.

2.2 Methods of Power Generation

There are seven fundamental methods of directly transforming other forms of energy into electrical energy:

- **Static electricity :**From the physical separation and transport of charge (examples: triboelectric effect and lightning).
- **Electromagnetic induction :**Where an electrical generator, dynamo alternator transforms kinetic energy (energy of motion) into electricity. This is the most used form for generating electricity and is based on Faraday's law. It can be experimented by simply rotating a magnet within closed loops of a conducting material (e.g. copper wire).
- **Electrochemistry:** The direct transformation of chemical energy into electricity, as in a battery, fuel cell or nerve impulse.
- **Photoelectric effect:** The transformation of light into electrical energy, as in solar cells.
- **Thermoelectric effect:** The direct conversion of temperature differences to electricity, as in thermocouples, thermopiles, and thermionic converters.
- **Piezoelectric effect:** From the mechanical strain of electrically anisotropic molecules or crystals. Researchers at the US Department of Energy's Lawrence

Berkeley National Laboratory (Berkeley Lab) have developed a piezoelectric generator sufficient to operate a liquid crystal display using thin films of M13 bacteriophage.

- **<u>Nuclear transformation:</u>** The creation and acceleration of charged particles (examples: betavoltaics or alpha particle emission).

Electrochemical electricity generation is also important in portable and mobile applications. Currently, most electrochemical power comes from closed electrochemical cells ("batteries"), which are arguably utilized more as storage systems than generation systems; but open electrochemical systems, known as fuel cells, have been undergoing a great deal of research and development in the last few years. Fuel cells can be used to extract power either from natural fuels or from synthesized fuels (mainly electrolytic hydrogen) and so can be viewed as either generation systems or storage systems depending on their use.

2.3 Literature Review

We can acquire energy through many sources for example;

• Sun.

• Pressure.

• Wind.

• Water.

• Sound.

• Waste material.

• Coal

With the assistance of these resources we can harvest or produce electricity and acquire energy.

We can assess abundant energy from the sun which is known as “solar energy” but we cannot use it directly. This energy travels from the sun to Earth in the form of rays. First we store it in battery then we can transfer it to ourdevices. Besides this it has some disadvantages.

• It cannot be use in those areas where there is a lot of moisture.

• Secondly in rainy season its ability becomes zero, due to the absence of sun.

There are many substances along with water that contains two kinds of energy. The first kind is known as “kinetic energy”. During the execution of processes kinetic energy is used. Such as movement. Due to this energy waves can exist and water can flow. But in water potential energy is also present. This is the energy that can be stored in the water but can’t be used.

Dynamo generator has the ability to generate small power working on the faraday’s law. The working explanation and detailed history of dynamo is discussed in the next chapter.

A dynamo, originally another name for an electrical generator, now means a generator that produces direct current with the use of a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. They are rarely used for power generation now because of the dominance of alternating current, the disadvantages of the commutator, and the ease of converting alternating to direct current using solid state methods.

Mechanical energy is changed into electrical energy in case of dynamo. When a coil of wire is rotated in the vicinity of magnetic field then magnetic flux will be cut. This would cause an induced emf in the coil and this phenomenon is known as electromagnetic induction.

The movement of another body is transmitted to a rectangular coil of wire that is inside a U-Shaped magnet. The motion of this coil of wire cuts the magnetic flux in the magnet. Faraday once stated that-Whenever there is a change in magnetic flux linked with a circuit there is an induced current and the strength of this induced current is directly proportional to the rate of magnetic flux-. So according to this rule when the magnet is in motion it is constantly cutting the magnetic flux, and as it does this there is a current that is induced (eddy currents). However a dynamo can either be A.C or D.C according to the brushes and number of commutators used (Flemings Right-hand rule). If we refer back to Faraday's rule it says that the strength of this induced current is directly proportional to the rate of magnetic flux. This rule can be seen practically in a bicycle that has a dynamo. The faster the rider rides the faster the change in magnetic flux and hence the brighter the light.

Dynamo is just the opposite/ reverse action of motor operation. When a conductor is moved across a magnetic field, there induces an emf (voltage) across conductor terminals so as it opposes the change of flux (Lenz rule).

Dynamo is constructed with a cylindrical permanent magnet (which rotates at the center) amidst windings that we take the voltage output from. When the magnet rotates its flux path changes relative to the windings and across the winding there exists an electro-motive-force as a voltage.

The objective of designing this system is given in the following figure.

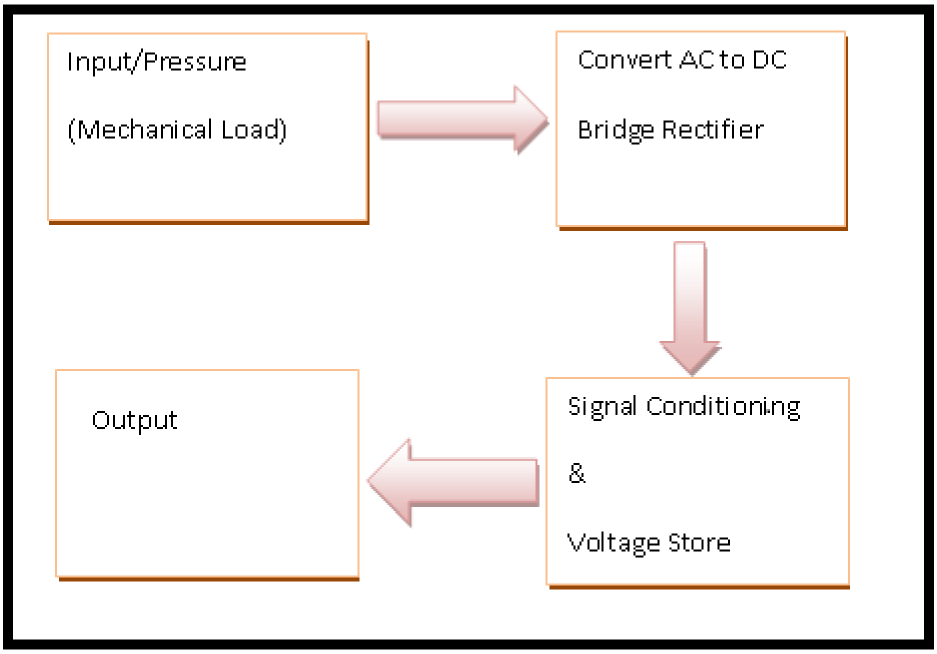

FIGURE 2.2: OBJECTIVE

CHAPTER 3

DESIGN SPECIFICATION

This chapter shows the schematic of the project and provides detailed description about the components used in the project.

3.1 Block Diagram

Following is the basic building block diagram of the project.

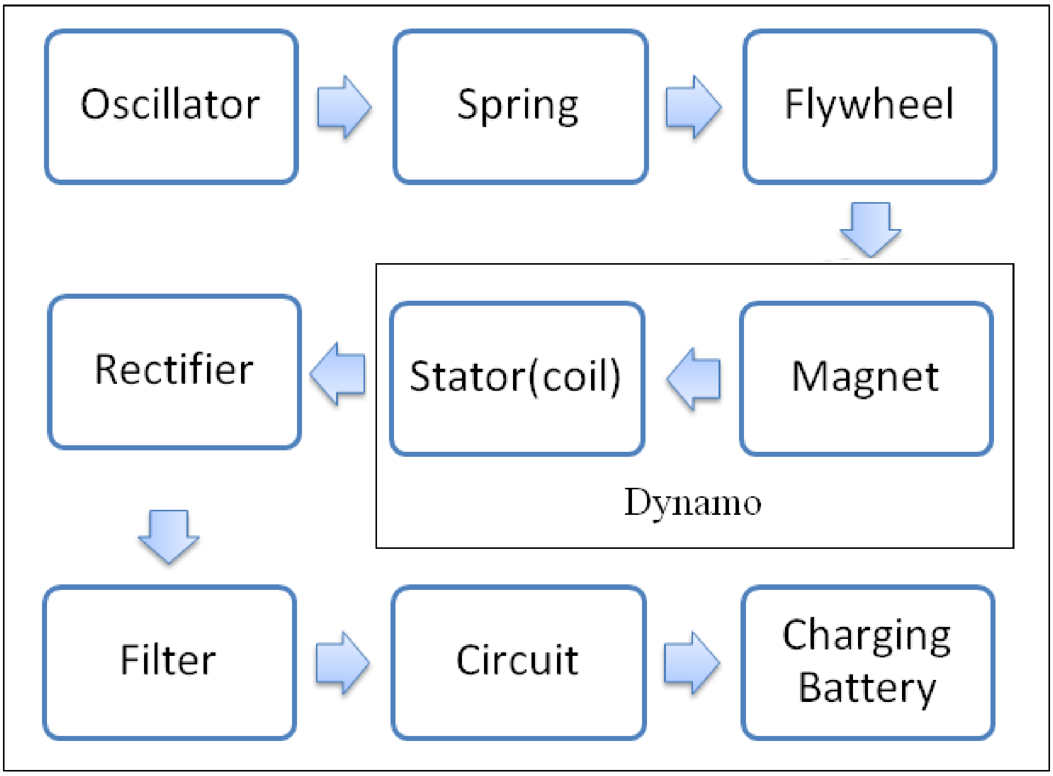

FIGURE 3.1: BLOCK DIAGRAM

It demonstrates all the working of the project from the initial to final stage. When the subject walks, pressure/force is exerted on the force Oscillator which give it To and Fro motion whenever the force is applied on it. Then we use spring which temporarily stores the mechanical input and then forward it to the flywheel. Flywheel stores the rotational energy and is used to provide continuous energy in the systems when the energy source is not continuous. Then this energy acts as the mechanical input to the dynamo, which converts it into the electrical signals working on the faraday's law. To convert the obtained signal from ac to dc, rectifier is used. Then to remove the ripples and distortion filtering is done, after filtering the signal is given to the battery and then finally to the circuit (charger circuit) for charging purpose.

3.2 Forced oscillator

It is a device which we used in our project, whenever the user walks it handles the pressure as the force exerted on the oscillator. Oscillation is the repetitive variation, typically in time, of some measure about a central value (often a point of equilibrium) or between two or more different states. Familiar examples include a swinging pendulum and AC power. The term vibration is sometimes used more narrowly to mean a mechanical oscillation but is sometimes used as a synonym of "oscillation".

FIGURE 3.2: OSCILLATOR

3.3 Spring

A spring is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after fabrication. Some non-ferrous metals are also used including phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current (because of its low electrical resistance).

When a spring is compressed or stretched, the force it exerts is proportional to its change in length. The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. That is, it is the gradient of the force versus deflection curve. An extension or compression spring has units of force divided by distance, for example lbf/in or N/m. Torsion springs have units of force multiplied by distance divided by angle, such as N·m/rad or ft·lbf/degree. The inverse of spring rate is compliance, that is: if a spring has a rate of 10 N/mm, it has a compliance of 0.1 mm/N. The stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series.

Depending on the design and required operating environment, any material can be used to construct a spring, so long as the material has the required combination of rigidity and elasticity: technically, a wooden bow is a form of spring.

3.3.1 History

Simple non-coiled springs were used throughout human history e.g., the bow (and arrow). In the Bronze Age more sophisticated spring devices were used, as shown by the spread of tweezers in many cultures. Ctesibius of Alexandria developed a method for making bronze with spring-like characteristics by producing an alloy of bronze with an increased proportion of tin, and then hardening it by hammering after it is cast.

Coiled springs appeared early in the 15th century, in door locks. The first spring powered-clocks appeared in that century and evolved into the first large watches by the 16th century.

In 1676 British physicist Robert Hooke discovered the principle behind springs' action, that the force it exerts is proportional to its extension, now called Hooke's law.

3.3.2 Types

Springs can be classified depending on how the load force is applied to them:

- Tension/Extension spring – the spring is designed to operate with a tension load, so the spring stretches as the load is applied to it.
- Compression spring – is designed to operate with a compression load, so the spring gets shorter as the load is applied to it.
- Torsion spring – unlike the above types in which the load is an axial force, the load applied to a torsion spring is a torque or twisting force, and the end of the spring rotates through an angle as the load is applied.
- Constant spring - supported load will remain the same throughout deflection cycle.
- Variable spring - resistance of the coil to load varies during compression.

They can also be classified based on their shape:

- Coil spring – this type is made of a coil or helix of wire
- Flat spring – this type is made of a flat or conical shaped piece of metal.
- Machined spring - this type of spring is manufactured by machining bar stock with a lathe and/or milling operation rather than coiling wire. Since it is machined, the spring may incorporate features in addition to the elastic element. Machined springs can be made in the typical load cases of compression/extension, torsion, etc.

The most common types of spring are:

- Cantilever spring – a spring which is fixed only at one end.
- Coil spring or helical spring – a spring (made by winding a wire around a cylinder) and the conical spring – these are types of torsion spring, because the wire itself is twisted when the spring is compressed or stretched. These are in turn of two types:
  - **Compression springs** are designed to become shorter when loaded. Their turns (loops) are not touching in the unloaded position, and they need no attachment points.
    - A volute spring is a compression spring in the form of a cone, designed so that under compression the coils are not forced against each other, thus permitting longer travel.
  - Tension or extension springs are designed to become longer under load. Their turns (loops) are normally touching in the unloaded position, and they have a hook, eye or some other means of attachment at each end.
- Hairspring or balance spring – a delicate spiral torsion spring used in watches, galvanometers , and places where electricity must be carried to partially rotating devices such as steering wheels without hindering the rotation.
- Leaf spring – a flat spring used in vehicle suspensions, electrical switches, and bows.
- V-spring– used in antique firearm mechanisms such as the wheel lock, flintlock and percussion cap locks.

Other types include:

- Belleville washer or Belleville spring – a disc shaped spring commonly used to apply tension to a bolt (and also in the initiation mechanism of pressure-activated landmines).

- Constant-force spring — a tightly rolled ribbon that exerts a nearly constant force as it is unrolled.
- Gas spring – a volume of gas which is compressed.
- Ideal Spring – the notional spring used in physics: it has no weight, mass, or damping losses.
- Mainspring – a spiral ribbon shaped spring used as a power source in watches, clocks, music boxes, windup toys, and mechanically powered flashlights.
- Negator spring – a thin metal band slightly concave in cross-section. When coiled it adopts a flat cross-section but when unrolled it returns to its former curve, thus producing a constant force throughout the displacement and negating any tendency to re-wind. The commonest application is the retracting steel tape rule.
- Progressive rate coil springs – A coil spring with a variable rate, usually achieved by having unequal pitch so that as the spring is compressed one or more coils rests against its neighbour.
- Rubber band – a tension spring where energy is stored by stretching the material.
- Spring washer – used to apply a constant tensile force along the axis of a fastener.
- Torsion spring – any spring designed to be twisted rather than compressed or extended. Used in torsion bar vehicle suspension systems.
- Wave spring – a thin spring-washer into which waves have been pressed.

In our system we have used compression spring along with the properties of main spring.

FIGURE 3.3: COMPRESSION SPRING

3.3.3 Hooke's law

As long as they are not stretched or compressed beyond their elastic limit, most springs obey Hooke's law, which states that the force with which the spring pushes back is linearly proportional to the distance from its equilibrium length:

$$F=-kx$$

where

x is the displacement vector, the distance and direction the spring is deformed from its equilibrium length.

F is the resulting force vector, the magnitude and direction of the restoring force the spring exerts

k is the rate, spring constant or force constant of the spring, a constant that depends on the spring's material and construction.

3.4 Flywheel

A flywheel is a rotating mechanical device that is used to store rotational energy. Flywheels have a significant moment of inertia and thus resist changes in rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. Energy is transferred to a flywheel by applying torque to it, thereby increasing its rotational speed, and hence its stored energy. Conversely, a flywheel releases stored energy by applying torque to a mechanical load, thereby decreasing its rotational speed.

FIGURE 3.4: FLYWHEEL

3.4.1 Uses

Three common uses of a flywheel include:

- They provide continuous energy when the energy source is discontinuous. For example, flywheels are used in reciprocating engines because the energy source, torque from the engine, is intermittent.
- They deliver energy at rates beyond the ability of a continuous energy source. This is achieved by collecting energy in the flywheel over time and then releasing the energy quickly, at rates that exceed the abilities of the energy source.
- They control the orientation of a mechanical system. In such applications, the angular momentum of a flywheel is purposely transferred to a load when energy is transferred to or from the flywheel.

3.4.2 Applications

Flywheels are often used to provide continuous energy in systems where the energy source is not continuous. In such cases, the flywheel stores energy when torque is applied by the energy source, and it releases stored energy when the energy source is not applying torque to it. For example, a flywheel is used to maintain constant angular velocity of the crankshaft in a reciprocating engine. In this case, the flywheel—which is mounted on the crankshaft—stores energy when torque is exerted on it by a firing piston, and it releases energy to its mechanical loads when no piston is exerting torque on it. Other examples of this are friction motors, which use flywheel energy to power devices such as toy cars.

A flywheel may also be used to supply intermittent pulses of energy at transfer rates that exceed the abilities of its energy source, or when such pulses would disrupt the energy supply (e.g., public electric network). This is achieved by accumulating stored energy in the flywheel over a period of time, at a rate that is compatible with the energy source, and then releasing that energy at a much higher rate over a relatively short time. For example, flywheels are used in punching machines and riveting machines, where they store energy from the motor and release it during the punching or riveting operation.

The phenomenon of precession has to be considered when using flywheels in vehicles. A rotating flywheel responds to any momentum that tends to change the direction of its axis of rotation by a resulting precession rotation. A vehicle with a vertical-axis flywheel would experience a lateral momentum when passing the top of a hill or the bottom of a valley (roll momentum in response to a pitch change). Two counter-rotating flywheels may be needed to eliminate this effect. This effect is leveraged in reaction wheels, a type of flywheel employed in satellites in which the flywheel is used to orient the satellite's instruments without thruster rockets.

3.4.3 History

The principle of the flywheel is found in the Neolithic spindle and the potter's wheel.

The Andalusian agronomist IbnBassal (fl 1038–1075), in his Kitab al-Filaha, describes the flywheel effect employed in a water wheel machine, the saqiya.

The flywheel as a general mechanical device for equalizing the speed of rotation is, according to the American medievalist Lynn White, recorded in the De diversibusartibus (On various arts) of the German artisan Theophilus Presbyter (ca. 1070–1125) who records applying the device in several of his machines.

In the Industrial Revolution, James Watt contributed to the development of the flywheel in the steam engine, and his contemporary James Pickard used a flywheel combined with a crank to transform reciprocating into rotary motion.

3.4.4 Working

A flywheel is a spinning wheel or disc with a fixed axle so that rotation is only about one axis. Energy is stored in the rotor as kinetic energy, or more specifically, rotational energy:

$$E_k = \frac{1}{2}I\omega^2$$

Where:

- ω is the angular velocity, and
- I is the moment of inertia of the mass about the center of rotation. The moment of inertia is the measure of resistance to torque applied on a spinning object (i.e. the higher the moment of inertia, the slower it will spin when a given force is applied).
- The moment of inertia for a solid cylinder is $I = \frac{1}{2}mr^2$,
- for a thin-walled empty cylinder is $I = mr^2$,
- and for a thick-walled empty cylinder is $I = \frac{1}{2}m({r_{external}}^2 + {r_{internal}}^2)$,

Where m denotes mass, and r denotes a radius.

When calculating with SI units, the standards would be for mass, kilograms; for radius, meters; and for angular velocity, radians per second. The resulting answer would be in joules.

The amount of energy that can safely be stored in the rotor depends on the point at which the rotor will warp or shatter. The hoop stress on the rotor is a major consideration in the design of a flywheel energy storage system.

$$\sigma_t = \rho r^2 \omega^2$$

Where:

- σ_t is the tensile stress on the rim of the cylinder
- ρ is the density of the cylinder

- r is the radius of the cylinder, and
- ω is the angular velocity of the cylinder.

This formula can also be simplified using specific tensile strength and tangent velocity:

$$\frac{\sigma_t}{\rho} = v^2$$

Where:

- $\frac{\sigma_t}{\rho}$ is the specific tensile strength of the material
- v is the tangent velocity of the rim.

3.5 Dynamo

A dynamo is an electrical generator that produces direct current with the use of a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. Today, the simpler alternator dominates large scale power generation, for efficiency, reliability and cost reasons. A dynamo has the disadvantages of a mechanical commutator. Also, converting alternating to direct current using power rectification devices (vacuum tube or more recently solid state) is effective and usually economic.

The word dynamo (from the Greek word dynamis; meaning power) was originally another name for an electrical generator, and still has some regional usage as a replacement for the word generator. A small electrical generator built into the hub of a bicycle wheel to power lights is called a hub dynamo, although these are invariably AC devices.

The dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current through Faraday's law of induction. A dynamo machine consists of a stationary structure, called the stator, which provides a constant magnetic field, and a set of rotating windings called the armature which turn within that field. The motion of the wire within the magnetic field causes the field to push on the electrons in the metal, creating an electric current in the wire. On small machines the constant magnetic field may be provided by one or more permanent magnets; larger machines have the constant magnetic field provided by one or more electromagnets, which are usually called field coils.

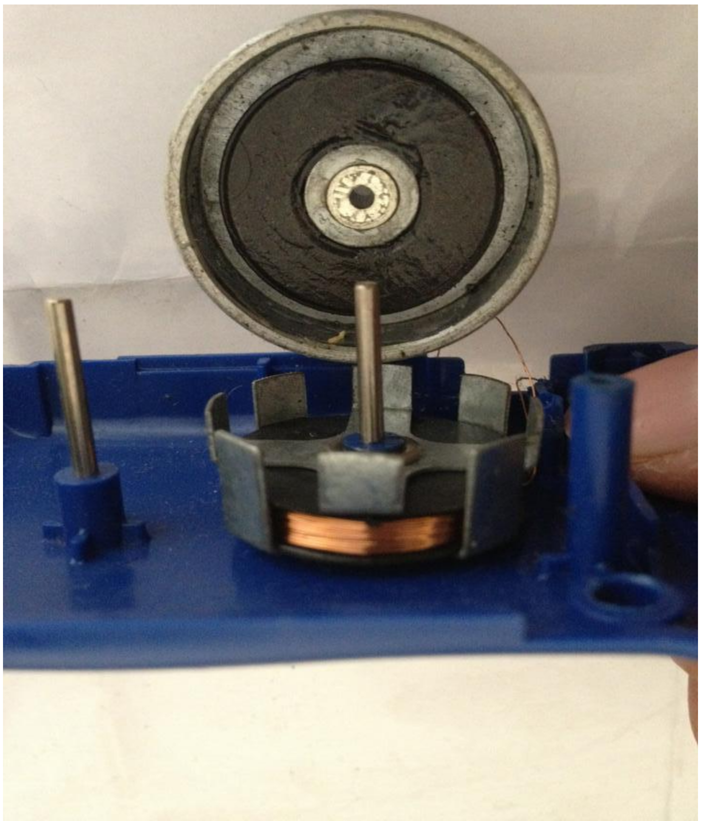

FIGURE 3.5: DYNAMO

3.5.1 Detail History

The first electric generator was invented by Michael Faraday in 1831, a copper disk that rotated between the poles of a magnet. This was not a dynamo because it did not use a commutator. However, Faraday's disk generated very low voltage because of its single current path through the magnetic field. Faraday and others found that higher, more useful voltages could be produced by winding multiple turns of wire into a coil. Wire windings can conveniently produce any voltage desired by changing the number of turns, so they have been a feature of all subsequent generator designs, requiring the invention of the commutator to produce direct current.

Jedlik's dynamo

In 1827, Hungarian AnyosJedlik started experimenting with electromagnetic rotating devices which he called electromagnetic self-rotors. In the prototype of the single-pole electric starter, both the stationary and the revolving parts were electromagnetic. He formulated the concept of the dynamo about six years before Siemens and Wheatstone but did not patent it as he thought he was not the first to realize this. His dynamo used, instead of permanent magnets, two electromagnets placed opposite to each other to induce the magnetic field around the rotor. It was also the discovery of the principle of dynamo self-excitation.

Pixii's dynamo

The first dynamo based on Faraday's principles was built in 1832 by HippolytePixii, a French instrument maker. It used a permanent magnet which was rotated by a crank. The spinning magnet was positioned so that its north and south poles passed by a piece of iron wrapped with insulated wire. Pixii found that the spinning magnet produced a pulse of current in the wire each time a pole passed the coil. However, the north and south poles of the magnet induced currents in opposite directions. To convert the alternating current to DC, Pixii invented a commutator, a split metal cylinder on the shaft, with two springy metal contacts that pressed against it.

Pacinotti dynamo

These early designs had a problem: the electric current they produced consisted of a series of "spikes" or pulses of current separated by none at all, resulting in a low average power output. As with electric motors of the period, the designers did not fully realize the seriously detrimental effects of large air gaps in the magnetic circuit. Antonio Pacinotti, an Italian physics professor, solved this problem around 1860 by replacing the spinning two-pole axialcoil with a multi-pole toroidal one, which he created by wrapping an iron ring with a continuous winding, connected to the commutator at many equally spaced points around the ring; the commutator being divided into many segments. This meant that some part of the coil was continually passing by the magnets, smoothing out the current.

Siemens and Wheatstone dynamo (1867)

The first practical designs for a dynamo were announced independently and simultaneously by Dr. Werner Siemens and Charles Wheatstone. On January 17, 1867, Siemens announced to the Berlin academy a "dynamo-electric machine" (first use of the term) which employed self-powering electromagnetic field coils rather than permanent magnets to create the stator field.On the same day that this invention was announced to the Royal Society Charles Wheatstone read a paper describing a similar design with the difference that in the Siemens design the stator electromagnets were in series with the rotor, but in Wheatstone's design they were in parallel. The use of electromagnets rather than permanent magnets greatly increases the power output of a dynamo and enabled high power generation for the first time. This invention led directly to the first major industrial uses of electricity. For example, in the 1870s Siemens used electromagnetic dynamos to power electric arc furnaces for the production of metals and other materials.

Gramme ring dynamo

ZénobeGramme reinvented Pacinotti's design in 1871 when designing the first commercial power plants, which operated in Paris in the 1870s. Another advantage of Gramme's design was a better path for the magnetic flux, by filling the space occupied by the magnetic field with heavy iron cores and minimizing the air gaps between the stationary and rotating parts. The Gramme dynamo was the first machine to generate commercial quantities of power for industry. Further improvements were made on the Gramme ring, but the basic concept of a spinning endless loop of wire remains at the heart of all modern dynamos.

Brush dynamo

Charles F. Brush assembled his first dynamo in the summer of 1876 using a horse drawn treadmill to power it. U.S. Patent #189997 "Improvement in Magneto-Electric Machines" was issued April 24, 1877. Brush started with the basic Gramme design where the wire on the sides and interior of the ring were outside the effective zone of the field and too much heat was retained. To improve upon this design, his ring armature was shaped like a disc rather than the cylinder shape of the Gramme armature. The field electromagnets were positioned on the sides of the armature disc rather than around the circumference. There were four electromagnets, two with north pole shoes and two with south pole shoes. The like poles opposed each other, one on each side of the disc armature. In 1881 one of The Brush Electric Company dynamos was reported to be; 89 inches long, 28 inches wide, and 36 inches in height, and weighs 4,800 pounds, and ran at a speed of about 700 revolutions per minute. It was believed to be the largest dynamo in the world at that time. Forty arc lights were fed by it, and it required 36 horse power.

3.5.2 Uses

Dynamos still have some uses in low power applications, particularly where low voltage DC is required, since an alternator with a semiconductor rectifier can be inefficient in these applications. Hand cranked dynamos are used in clockwork radios, hand powered flashlights, mobile phone rechargers, and other human powered equipment to recharge batteries.

3.6 Rectifier

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification. Physically, rectifiers take a number of forms, includingvacuum tube diodes, mercury-arc valves, copper and selenium oxide rectifiers, solid-state diodes, silicon-controlled rectifiers and other silicon-based semiconductor switches. Historically, even synchronous electromechanical switches and motors have been used. Early radio receivers, called crystal radios, used a "cat's whisker" of fine wire pressing on a crystal of galena (lead sulfide) to serve as a point-contact rectifier or "crystal detector".

Rectifiers have many uses, but are often found serving as components of DC power supplies and high-voltage direct current power transmission systems. Rectification may serve in roles other than to generate direct current for use as a source of power. As noted,detectors of radio signals serve as rectifiers. In gas heating systems flame rectification is used to detect presence of flame.

The simple process of rectification produces a type of DC characterized by pulsating voltages and currents (although still unidirectional). Depending upon the type of end-use, this type of DC current may then be further modified into the type of relatively constant voltage DC characteristically produced by such sources as batteries and solar cells.

A more complex circuitry device which performs the opposite function, converting DC to AC, is known as an inverter.

3.6.1 Full Wave Bridge Rectifier

This type of single phase rectifier uses four individual rectifying diodes connected in a closed loop "bridge" configuration to produce the desired output. The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown.

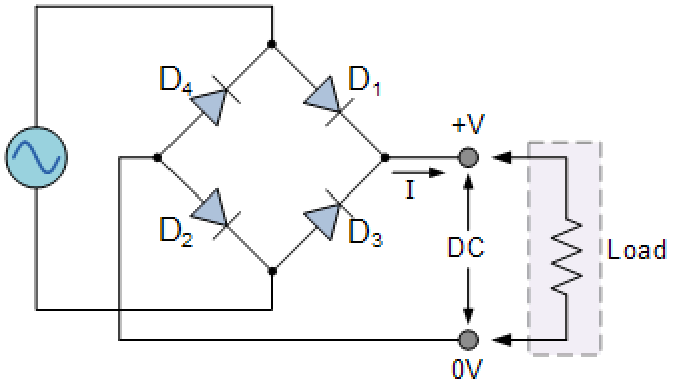

FIGURE3.6.1: DIODE BRIDGE RECTIFIER

The four diodes labelled D_1 to D_4 are arranged in "series pairs" with only two diodes conducting current during each half cycle.

The Positive Half Cycle

During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.

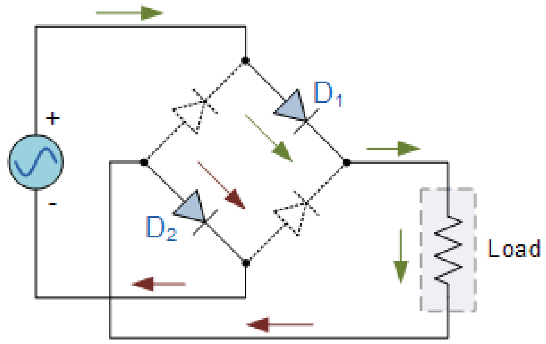

FIGURE 3.6.2: POSITIVE HALF CYCLE

The Negative Half Cycle

During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2switch "OFF" as they are now reverse biased. The current flowing through the load is the same direction as before.

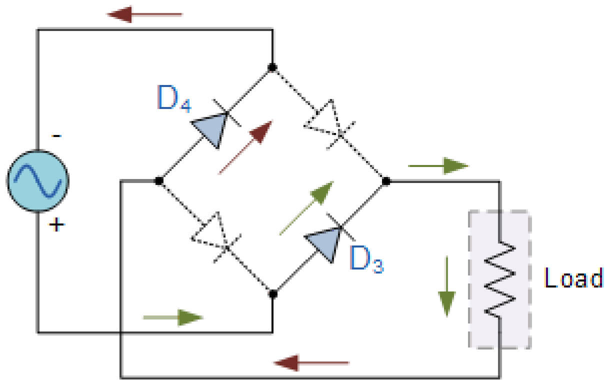

FIGURE 3.6.3: NEGATIVE HALF CYCLE

3.7 Filtering

Electronic filters are electronic circuits which perform signal processing functions, specifically to remove unwanted frequency components from the signal, to enhance wanted ones, or both. Electronic filters can be:

- passive or active
- analog or digital
- high-pass, low-pass, band-pass, band-reject (band reject; notch), or all-pass.
- discrete-time (sampled) or continuous-time
- linear or non-linear
- infinite impulse response (IIR type) or finite impulse response (FIR type)

The most common types of electronic filters are linear filters, regardless of other aspects of their design.

Some terms used to describe and classify linear filters:

- The frequency response can be classified into a number of different bandforms describing which frequencies the filter passes (the passband) and which it rejects (the stopband):
  - Low-pass filter – low frequencies are passed, high frequencies are attenuated.

- High-pass filter – high frequencies are passed, low frequencies are attenuated.
- Band-pass filter – only frequencies in a frequency band are passed.
- Band-stop filter or band-reject filter – only frequencies in a frequency band are attenuated.
- Notch filter – rejects just one specific frequency - an extreme band-stop filter.
- Comb filter – has multiple regularly spaced narrow passbands giving the bandform the appearance of a comb.
- All-pass filter – all frequencies are passed, but the phase of the output is modified.

- Cutoff frequency is the frequency beyond which the filter will not pass signals. It is usually measured at a specific attenuation such as 3dB.
- Roll-off is the rate at which attenuation increases beyond the cut-off frequency.
- Transition band, the (usually narrow) band of frequencies between a passband and stopband.
- Ripple is the variation of the filter's insertion loss in the passband.
- The order of a filter is the degree of the approximating polynomial and in passive filters corresponds to the number of elements required to build it. Increasing order increases roll-off and brings the filter closer to the ideal response.

3.8 Circuit

Following is the charging circuit that we have used in our project.

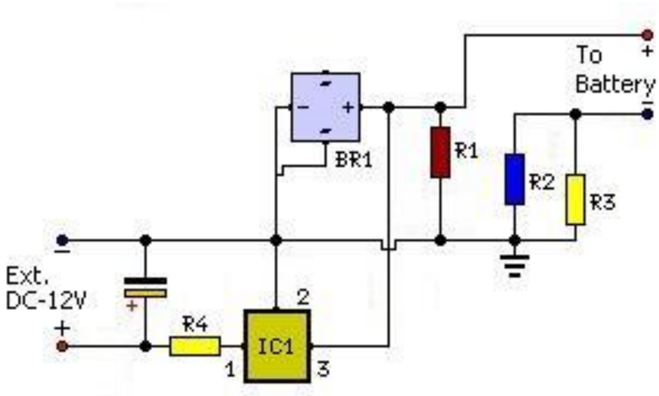

FIGURE 3.8: CIRCUIT

Components

- R1 = 1K
- R2 = 47R
- R3 = 10R
- R4 = 47R
- C1 = 1000uF-25V
- D4 = 1N4007
- D5 = 1N4007
- IC1 = LM7806
- T1 = 9VAC Xformer 250mA
- BR1 = Diode bridge 1A

Circuit Operation:

. The transformer output is rectified by BR1 and the positive DC supply is directly connected to the charger’s output contact, while the negative terminal is connected through current limiting resistor R2. D2 works as a power indicator with R1 serving as the current limiter and D3 indicates the charging status. During the charging period, about 3 volts drop occurs across R2, which turns on D3 through R3. R4, after polarity protection diode D5, limits the input current to a safe value. The 3-terminal positive voltage regulator LM7806 (IC1) provides a constant voltage output of 7.8V DC since D1 connected between the common terminal (pin 2) and ground rail of IC1 raises the output voltage to 7.8V DC.

3.9 Battery

A battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy.[1] Since the invention of the first battery (or "voltaic pile") in 1800 by Alessandro Volta and especially since the technically improved Daniell cell in 1836, batteries have become a common power source for many household and industrial applications.

There are two types of batteries: primary batteries (disposable batteries), which are designed to be used once and discarded, and secondary batteries (rechargeable batteries), which are designed to be recharged and used multiple times. Batteries come in many sizes, from miniature cells used to power hearing aids and wristwatches to battery banks the size of rooms that provide standby power for telephone exchanges and computer data centres.

CHAPTER 4

IMPLEMENTATION

This chapter demonstrates the step by step procedure of how this project is being made. Each step describes our progress towards the completion of the project. The exact reference of all these steps is the block diagram of the system.

4.1 Experiment with Spring

We are harvesting the energy from human motion, that is during walk of a person. During walk lots of human energy is dissipated as heat, to utilize it for generating power we first have to store it, so that it then be transferred to any mechanism that converts this mechanical energy into electrical signals. For this purpose we are using spring. Spring is an elastic device that is used to store the mechanical energy. In the implementation of our project we are using the compression spring because of its properties. This spring will store the mechanical energy obtain from the human motion which will then be given to the flywheel, will be discussed in the next topic.

4.2 Experiment with Flywheel

As discussed in the previous chapter flywheel are used to store the rotational energy. We are using flywheel in our project because it is capable of providing continuous energy when the energy source is discontinuous and in our project the source is discontinuous as it can’t be predicted that of what weight person will be wearing the shoe. It can deliver energy at rates beyond the ability of a continuous energy source. This is achieved by collecting energy in the flywheel over time and then releasing the energy quickly, at rates that exceed the abilities of the energy source.

4.3 Experiment with Dynamo

After storing our mechanical input and making it continuous we then proceed towards the main task that is converting that mechanical energy into electrical energy. For this purpose we used dynamo. Dynamo works on the famous Faraday’s law.Today, the simpler alternator dominates large scale power generation, for efficiency, reliability and cost reasons. A dynamo has the disadvantages of a mechanical commutator. Also, converting alternating to direct current using power rectification devices (vacuum tube or more recently solid state) is effective and usually economic. We have also preferred using dynamo for our project due to its low cost. Actually the movement of another body(flywheel) is transmitted to a rectangular coil of wire that is inside a U-Shaped magnet. The motion of this coil of wire cuts the magnetic flux in the magnet. Faraday once stated that-Whenever there is a change in magnetic flux linked with a circuit there is an induced current and the strength of this induced current is directly proportional to the rate of magnetic flux. So according to this rule when the magnet is in motion it is constantly cutting the magnetic flux, and as it does this there is a current that is induced (eddy currents). However a dynamo can either be A.C or D.C according to the brushes and number of commutators used (Flemings Right-hand rule). In our project we have used the A.C dynamo whose output we will then be converting into D.C using the rectifier. If we refer back to Faraday's rule it says that the strength of this induced current is directly proportional to the rate of magnetic flux. This rule can be seen practically in a bicycle that has a dynamo. The faster the rider rides the faster the change in magnetic flux and hence the brighter the light.

4.4 Experiment with Rectifier

The A.C signals obtained are then necessarily needs to be converted into the D.C signals. Because these D.C signals are then have to be supplied for storing in the battery. To do this, we have used the rectification phenomena. We have used the full wave bridge rectification for that purpose. Full wave rectification had already been explained in the previous chapter. In general rectification is the process of converting A.C signals to D.C signals.

4.5 Experiment with Filter

The next step after rectification of the signals is to filter them. We basically intended to eliminate the ripples from the electrical signals for which we then worked with filter.

4.6 Experiment with Circuit and Battery

The filtered signals are then ready to be supplied to the battery which will store these electrical charges and then will supply it to the circuit. We need at least 3 to 4 volts for our circuit because we have choosen to construct the circuit that will work to charge a mobile battery which need about 3.6 volts.

4.7 Hardware Modelling

The final task was to do modelling of the project as has to be convenient, light and comfortable from the user perspective. For that very purpose we use the skating shoe and fixed our project in it and then once again checked its working after wearing it.

The final look of the project is shown in the following figure.

FIGURE 4.7: FINAL HARDWARE

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.1 Conclusion

This chapter summaries the contribution of the research and suggests areas for further investigation.

Energy harvesting from human motion presents a promising clean alternative to electrical power supplied by batteries for portable electronic devices. Energy harvesting Shoe is an innovative approach for producing electrical energy for portable devices. This Shoe could serve as a power source for devices with low power requirements. In addition this model is especially for those areas where grid power is not accessible. Electricity generation while walking is a convenient method of capturing the energy that is typically lost and converting it into usable electrical energy. However to charge a battery, a desktop charger is used in our model . So you have to remove the battery from your phone to charge it. Thus showing limitation of this model.

5.2 Future Work

- Charging with Standard travel charger.
- Charging with Wireless charger.
- Utilizing knee/ hip / shoulder motion to generate electricity.
- Implementation of this technique on jogging tracks.
- Making of a Path which produces electricity.
- Road bumps “jump’s” which produce electricity whenever Vehicle pass by.
- Apply directly roller’s under the shoe’s to produce electricity.
- Night glowing shoe.

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