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PIEZOELECTRIC POWER GENERATION FROM TYRES

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Abstract - *In our project Piezoelectric Power Generation from Tyres, mechanical energy generated by vehicle's wheel due to the contact on the road is converted into electric energy by piezoelectric effect. Piezoelectricity is the electric charge that accumulates in certain solid material (notably crystal, certain ceramic and biological matter such as bone, DNA and various proteins) in response to applied mechanical stress. The aim of this project is to make power generation more sustainable, economic and ecological by utilizing the advancement in the technology. Converting waste and unused vibrational mechanical energy from vehicle's tire to electrical energy. So, therefore on our project we are going to use piezo electric patches inside the wheel rim. When the tyre is contact on the road and the pressure of the vehicle's weight the electricity is generated by the piezo electric patches. In our project we are going to use a hybrid engine in which the vehicle is run by both IC Engine and an electric motor. Therefore, the electric motor is recharged by the current produced from the wheels due to piezoelectric patches.*

Key Words: **Ceramics, Electrical Energy, Hybrid Engine, Piezoelectricity, Piezoelectric Patches**

1. INTRODUCTION

As piezo energy harvesting has been investigated only since the late 1990s, it remains an emerging technology. When vehicles move on the road, the piezoelectric materials under the road are vibrated due to vehicle suspension in the tires that force the road and produces electricity in large amount. Piezoelectricity is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and various proteins) in response to applied mechanical stress. Piezoelectricity was discovered in 1880 by French physicists Jacques and Pierre Curie. The piezoelectric effect is understood as the linear electromechanical interaction between the mechanical and the electrical state in crystalline materials with no inversion symmetry.

The piezoelectric effect is a reversible process in that materials exhibiting the direct piezoelectric effect (the internal generation of electrical charge resulting from an applied mechanical force). Also exhibit the reverse piezoelectric effect (the internal generation of a mechanical strain resulting from an applied electrical field). For example, lead zirconate titanate crystals will generate measurable piezoelectricity when their static structure is deformed by about 0.1% of the original dimension. Conversely, those same crystals will change about 0.1% of their static dimension when an external electric field is applied to the material. The inverse piezoelectric effect is used in production of ultrasonic sound waves. Piezoelectricity is found in useful applications such as the production and detection of sound, generation of high voltages, electronic Frequency generation, microbalances, and ultrafine focusing of optical assemblies. It is also the basis of a number of scientific instrumental techniques with atomic resolution, the scanning probe microscopies. Most piezoelectric electricity sources produce power on the order of milli watts, too small for system application, but enough for hand-held devices such as some commercially available self-winding wristwatches. One proposal is that they are used for micro-scale devices, such as in a device harvesting micro-hydraulic energy. Acquire a charge when compressed, twisted or distorted are said to be piezoelectric.

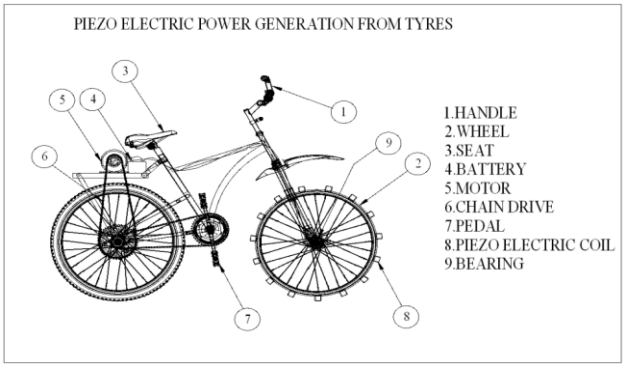

Fig.1. Design of the prototype

1.1 METHODOLOGY

The main reason of electricity for not becoming a practical fuel for automobiles is the fact that it is not practical as fossil fuel. Electricity is a great alternative to fossil fuels as it does not compromise on any of the performance vehicle and the running cost is a lot cheaper. So in order to increase the practicality of electricity so that the popularity of electricity as fuel in automobile should increase, our team came up with an idea of harvesting energy from tyres. Our project increases its reliability up to a limit by generating electricity while the automobile is in motion. We use piezoelectric patches on the rims of the wheel to generate electricity and extracted using carbon brush. This extracted electricity is stored in the battery for further use.

2. COMPONENTS AND WORKING

2.1 COMPONENTS USED

The main components are given below

- Frame
- Chain drive
- Pedal

- Dc motor
- Battery
- Carbon brush
- Bearings
- Piezo electric patches

2.1.1 FRAME

This is made of mild steel material. The whole parts are mounted on this frame structure with the suitable arrangement. Boring of bearing sizes and open bores done in one setting so as to align the bearings properly while assembling. Provisions are made to cover the bearings with grease.

2.1.2 SPROCKET AND CHAIN DRIVE

This is a cycle chain sprocket. The chain sprocket is coupled with another generator shaft. The chain converts rotational power to pulling power, or pulling power to rotational power, by engaging with the sprocket.

The sprocket looks like a gear but differs in three important ways:

1. Sprockets have many engaging teeth; gears usually have only one or two.

2. The teeth of a gear touch and slip against each other; there is basically no slippage in a sprocket.

3. The shape of the teeth is different in gears and sprockets.

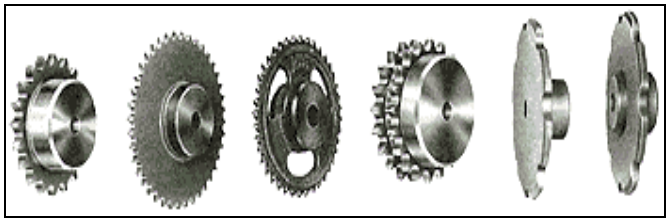

Fig.2. Sprockets

2.1.3 PEDAL

The bicycle pedal is the part of a bicycle that the rider pushes with their foot to propel the bicycle. It provides the connection between the cyclist's foot or shoe and the crank allowing the leg to turn the bottom bracket spindle and propel the bicycle's wheels. Pedals usually consist of a spindle that threads into the end of the crank and a body, on which the foot rests or is attached, that is free to rotate on bearings with respect to the spindle.

Pedals were initially attached to cranks connecting directly to the driven (usually front) wheel. The safety bicycle, as it is known today, came into being when the pedals were attached to a crank driving a sprocket that transmitted power to the driven wheel by means of a roller chain.

2.1.4 DC MOTOR

An electric motor is a machine which converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a magnetic force whose direction is given by Fleming's left hand rule.

When a motor is in operation, it develops torque. This torque can produce mechanical rotation. DC motors are also like generators classified into shunt wound or series wound or compound wound motors.

2.1.4A PRINCIPLE OF OPERATION OF DC MOTOR

Figure I show a uniform magnetic field in which a straight conductor carrying no current is placed. The conductor is perpendicular to the direction of the magnetic field.

In figure II the conductor is shown as carrying a current away from the viewer, but the field due to the N and S poles has been removed. There is no movement of the conductor during the above two conditions. In figure III the current carrying conductor is placed in the magnetic field. The field due to the current in the conductor supports the main field above the conductor, but opposes the main field below the conductor.

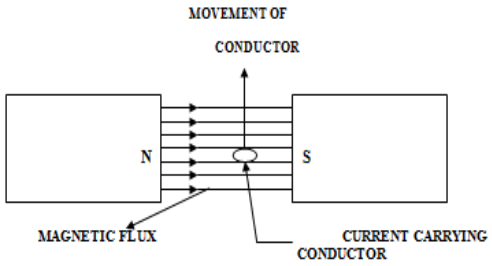

Fig.3. Electromagnetic Induction

The result is to increase the flux density in to the region directly above the conductor and to reduce the flux density in the region directly below the conductor. It is found that a force acts on the conductor, trying to push the conductor downwards as shown by the arrow. If the current in the conductor is reversed, the strengthening of flux lines occurs below the conductor, and the conductor will be pushed upwards.

2.1.5 BATTERY

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact, for small units with output less than one kilowatt.

Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic

system and batteries are high in capital costs. It is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties:

(1) Low cost

(2) Long life

(3) High reliability

(4) High overall efficiency

(5) Low discharge

(6) Minimum maintenance

(A) Ampere hour efficiency

(B) Watt hour efficiency

We use lead acid battery for storing the electrical energy from the solar panel for lighting the street and so about the lead acid cells are explained below.

2.1.6 LEAD-ACID WET CELL

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery.

The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortens the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.

2.1.7 CARBON BRUSH

A brush is a device which conducts current between stationary wires and moving parts, most commonly in a rotating shaft. Typical applications include electric motors, alternators and electric generators. In our project to keep piezo patches in contact during rotation of the wheel.

2.1.8 PIEZOELECTRIC PATCHES

Piezoelectricity is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and various proteins) in response to applied mechanical stress. The word *piezoelectricity* means electricity resulting from pressure. Piezoelectricity was discovered in 1880 by French physicists Jacques and Pierre Curie. The piezoelectric effect is understood as the linear electromechanical interaction between the mechanical and the electrical state in crystalline materials with no inversion symmetry. The piezoelectric effect is a reversible process in that materials exhibiting the direct piezoelectric effect (the internal generation of electrical charge resulting from an applied mechanical force) also exhibit the reverse piezoelectric effect (the internal generation of a mechanical strain resulting from an applied electrical field). For example, lead zirconate titanate crystals will generate measurable piezoelectricity when their static structure is deformed by about 0.1% of the original dimension.

2.2 WORKING

In our project, we are using a piezo electric power generation system. We are using piezo electric patches which has the piezo electric material in it. These piezo electric patches are fixed in the rim of the wheel. The connection of these patches are done using carbon brushes in the center of the wheel shaft. In the end of the wheel a special roller setup is placed. This roller on tightening, it applies pressure on the tyre and in turn the piezo electric patches receives the pressure. When the cycle starts rotating, When the wooden roller is tightened, the pressure is applied the tyre. This pressure directly applies on the piezo electric patches onside the rim. Due to mechanical force the piezo material starts generating electricity. This generated electricity is stored in a battery. This battery in turn powers the DC motor which is also used to power the chain drive and to wheels.

Fig.4. Final Prototype

3. CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries. We are proud that we have completed the work with the limited time successfully. The Piezo Electric Power Generation from Tyres is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making

maximum use of available facilities. In conclusion remarks of our project work, let us add a few more lines about our impression project work. Thus we have developed a "Piezoelectric Power Generation from Tyres" which helps to design a robot. In this project, we have combined the mechanisms of robotic and monitoring systems using an electronic control unit which actually moves and records the instants of the soil report and feeds it back to the control unit.

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