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HARVESTING ELECTRIC ENERGY FROM CAR TYRES

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Abstract

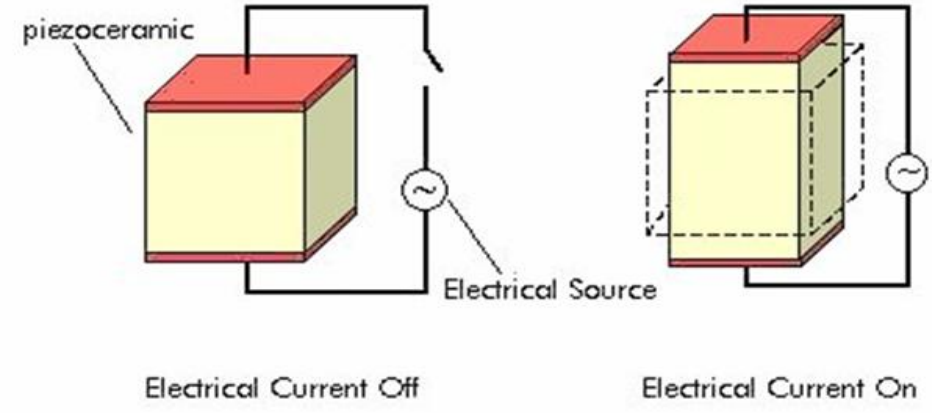
The main aim of this paper is to harvest energy that could power a car without causing any kind of pollution in an economical way. We are embedding the piezoelectric crystals in the tyres of cars and heavy vehicles which on application of force (i.e. due to the pressure applied) produces electricity. When the wheel of the vehicle rotates, the mechanical stress exerted by the vehicle on the crystal is converted in to electrical energy using the piezoelectric crystals can be coupled with circuits that could enable storage of electricity in batteries. Piezoelectric crystals are enabled to produce electricity due to the piezoelectric effect in the vehicles during the course of journey. Using this method electricity for different hybrid cars and energy efficient means of transport can be created.

Keywords: piezoelectric crystals, mechanical stress, hybrid cars.

I.INTRODUCTION

A. Piezo electric effect:

The use of a free, wasted byproduct to generate electricity is Piezoelectric energy. "Piezo" means pressure and electric or electron, which stands for amber, an ancient source of electric charge. Piezoelectricity is the direct result of the piezoelectric effect. Anything that produces pressure can produce energy. The mechanism of producing electricity from these piezoelectric materials is called piezoelectric effect. It is reversible an applied mechanical stress will generate a voltage and an applied voltage will change the shape of the solid by a small amount (up to a 4% change in volume).In physics, the piezoelectric effect can be described as the link between electrostatics and mechanics.



B.Charge accumulation in piezoelectric crystal:

Piezoelectricity is the charge which accumulates in certain solid materials in response to applied mechanical stress. The nature of the piezoelectric effect is closely related to the occurrence of electric dipole moments in solids Dipoles near each other tend to be aligned in regions called Weiss domains. The domains are usually randomly oriented, but can be aligned using the process of poling, a process by which a strong electric field is applied across the material, usually at elevated temperatures. Not all piezoelectric materials can be poled. Of decisive importance for the piezoelectric effect is the change of polarization P when applying a mechanical stress. This might either be caused by a re-configuration of the dipole-inducing surrounding or by re-orientation of molecular dipole moments under the influence of the external stress. Piezoelectricity may then manifest in a variation of the polarization strength, its direction or both, with the details depending on

1. The orientation of P within the crystal,
2. Crystal symmetry and
3. The applied mechanical stress.

The change in P appears as a variation of surface charge density upon the crystal faces. However, piezoelectricity is not caused by a change in charge density on the surface, but by dipole density in the bulk. For example, a 1 cm3 cube of quartz with 2 kN (500 lbf) of correctly applied force can produce a voltage of 12500 V.

C.Piezoelectric Materials:

The materials which exhibit piezoelectric effect are called as piezoelectric materials. Many materials, both natural and manmade, exhibit piezoelectricity. Some of the naturally occurring crystals that exhibit piezoelectric effect are belemnite, quartz, cane sugar, Rochelle salt, topaz, tourmaline group minerals, enamel, dentin, wood due to piezoelectric texture. Some of the manmade crystals are gallium orthophosphate and langasite. Of the thirty-two crystal classes, twenty-one are non-Centro symmetric, and of these, twenty exhibit direct piezoelectricity (the 21st is the cubic class 432). Ten of these represent the polar crystal classes, which show a spontaneous polarization without mechanical stress due to a non-vanishing electric dipole moment associated with their unit cell, and which exhibit pyro electricity. If the dipole moment can be reversed by the application of an electric field, the material is said to be ferroelectric.

1. Polar crystal classes: 1, 2, m, mm2, 4, 4 mm, 3, 3m, 6, 6 mm.
2. Piezoelectric crystal classes: 1, 2, m, 222, mm2, 4, 4, 422, 4 mm, 42m, 3, 32, 3m, 6, 6, 622, 6 mm, 62m, 23, 43m.

D.Converse piezoelectric effect:

Piezoelectric materials also show the opposite effect, called converse piezoelectric effect, where the application of an electrical field creates mechanical deformation in the crystal.

Currently, industrial and manufacturing is the largest application market for piezoelectric devices, followed by the automotive industry. Strong demand also comes from medical instruments as well as information and telecommunications. The largest material group for piezoelectric devices is piezoceramics, and piezopolymer is experiencing the fastest growth due to its light weight and small size. Apart from this it is also used in the high voltage and power sources, actuators, sensors.

II.APPLICATIONS OF PIEZOELECRTIC MATERIAL IN CAR TYRE:

Various application of quartz has been discovered and piezo materials are the next form of non-conventional energy resource.

A. Piezoelectric material in production of electricity.

Due to the piezoelectric effect the piezomaterials have gained a special place in non-conventional energy production.

B. Principle used in piezoelectricity in car tyres.

The piezoelectric patches are placed inside the inner rim of the tyre. Hundred piezoelectric patches are arranged . When the car starts to run due to the force applied on the materials the crystals are put into vibration .Due to piezoelectric effect the crystal produces electricity.

C. Piezo electric patch arrangement and working.

Each piezo material is connected in series with a capacitor. As each piezoelectric cannot be connected together. It is connected with a capacitor which stores the charge and discharges it. The combined piezo and capacitor are then connected in parallel with such arrangement. When the crystals are subjected to stress then electricity is produced.

The patch is constructed with stems, two stem are constructed such that they have high resistance, piezoelement and capacitor in series ,then these stems are connected in parallel.

III.CONSTRUCTIONAL DETAILS

A. Construction of piezoelectric charging element

As the piezo element produces very small voltage it is necessary that these voltage sources are connected in series so that the voltage adds up to provide minimum amount of voltage. But there are constrains in connecting them in series. It is similar to that of connecting two generators in series. If the elements are connected in series, the voltage produced from one element can excite the other piezo electric element and the crystal may start to vibrate. Hence a capacitance is connected in series so that the voltage can be extracted.

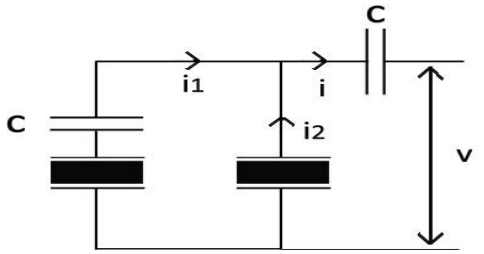
Piezoelectric harvester setup has several patch, each patch consist of high resistance, capacitor, switching device (germanium diode) and piezo element. the first patch consist of two piezoelement ,one of the piezo element is connected in series with the capacitor and another piezo element is connected in parallel ,whereas the second patch consist of three stem, two stem are constructed such that they have high resistance, piezoelement and capacitor in series and another stem consist of switching device ,then these three stem are connected in parallel, several such patch are constructed like this and then all these patches are connected in series.

B. Use of voltage regulator

The voltage regulator is used to control the supply voltage from fluctuating as the output may not be in a coherent manner. For this voltage booster is used.

C. Prototype of piezoelectric harvester

The figure gives the constructional details of piezoelectric harvester. This produces voltage according to the stages of piezo patches used



$i = i_1 + i_2$

(Piezoelectric patch)

Further on using similar technique maximum of 150 to 200 such crystal arrangements can be done in a single car tyre. This may give us sufficient voltage without step up. This can we used to harvest enough voltage to charge an electric car that needs 75 to 100v for recharging.

This 100v dc can be got by step up dc transformer. When the car runs around 100kmph, wheels are set into 875rpm. This is fairly enough to produce constant power supply.

This additionally gives a good current rating if piezo actuators are used that produce 35mA. So we can get good amp rating for charging the battery.

IV.ARRANGEMENT IN CAR TYRES

The crystals are arranged in a circular manner so that when the wheel rotates it produces equal pressure on the piezoelectric material. When there is pressure applied the voltage is produced and hence they are collectively fed to a voltage booster.
The voltage from this can be used for various application of the car. If the materials are designed in a more effective method can power a small electric car.

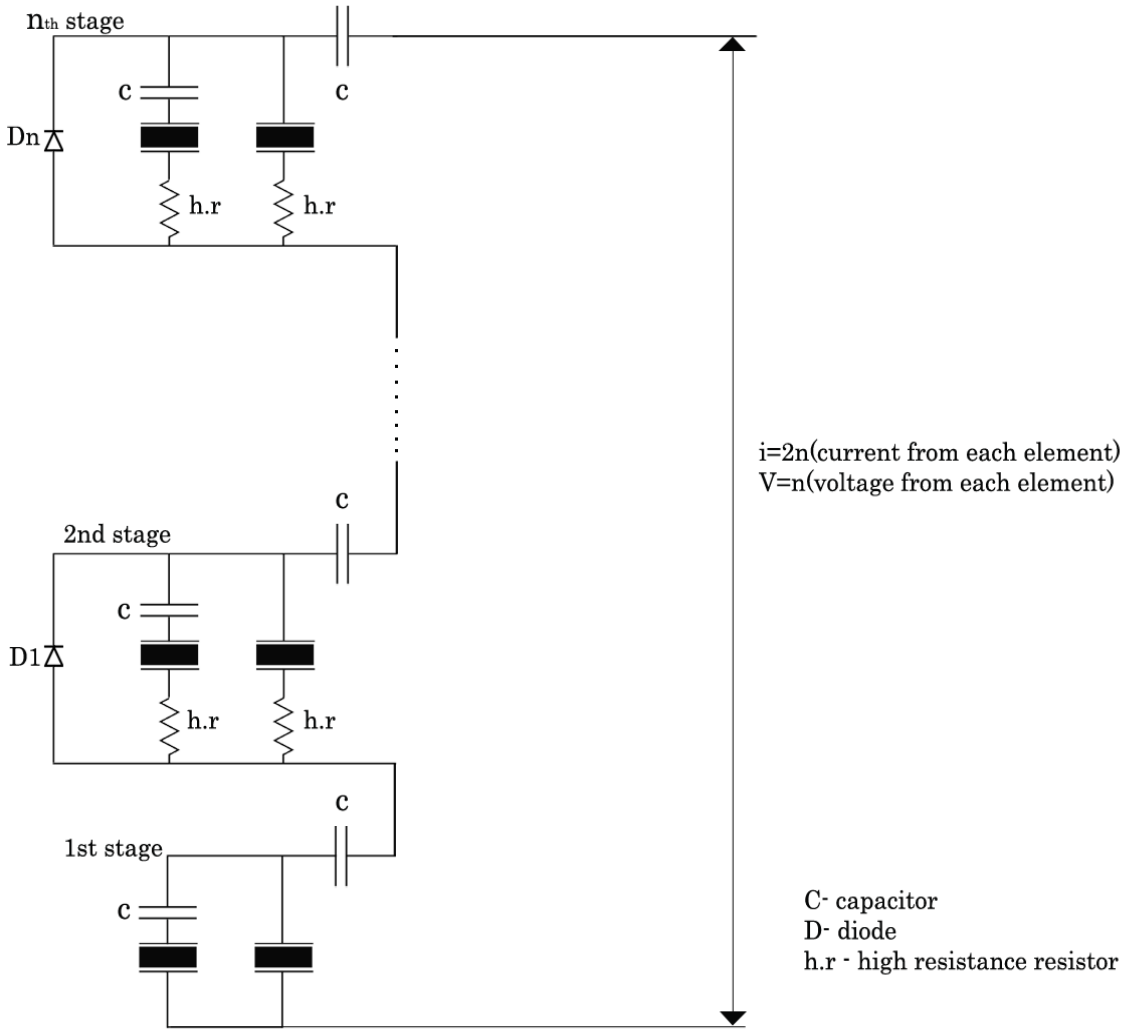


Fig. Prototype of piezo harvester

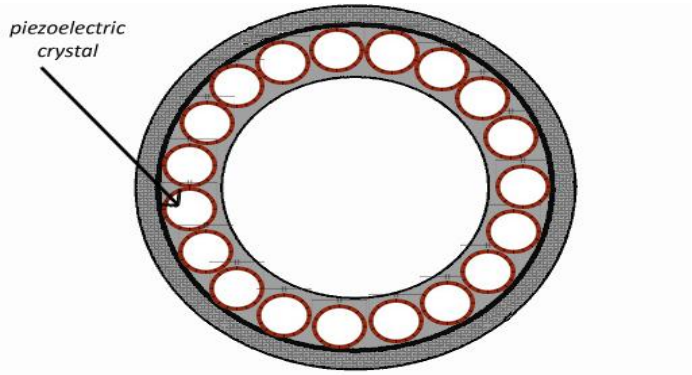


Fig. Simple arrangement of crystals inside the tyre.

V. WORKING

The working of piezoelectric harvester is based on piezoelectric effect. As the piezoelectric material produce electricity, the energy is stored into the capacitor and the capacitor discharges it. Due to parallel connection of piezo elements current will sum up and as the paches are connected in series the voltage will sum up. To avoid the inverse piezoelectric effect we are adding a high resistance with piezo element and germanium diode works as a switching device and makes the flow of current comfortable from one patch to another . So when the tyres are set into motion i.e. when the desired speed is reached, the voltage is produced which is pulsating DC in nature. This generated output voltage should be tap up by using the commutator action. The resultant output is used to charge the car battery.

VI. CONCLUSION

A non-conventional, nonpolluting form of energy can be harvested, maintaining the economic standards of common laymen. The electricity is produced from the mechanical stress on the crystals due to piezoelectric effect and thus car generates the energy needed for charging itself during the course of journey. Newer versions of hybrid cars and other transport vehicles can be manufactured.

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