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Exploring energy generation by Locomotion of mass / Crowd with help of piezoelectric material

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ABSTRACT

Man has required energy and he is exploring energy at an increasing rate for survival as well growth. Due to this a lot of energy resources are going to be exhausted. Proposal for the utilization of waste energy with human locomotion is very much relevant and important for highly populated countries like China, India where the railway station, metro station, Street lights, temples etc., are overcrowded all round the clock .When the flooring is designed with piezo electric technology, the electrical energy produced by the pressure is captured by floor sensors and converted to an electrical charge by piezo transducers, then stored and used as a power source. And this power source has many applications as in agriculture, home application and street lighting and as energy source for sensors in remote locations.

I. INTRODUCTION

Energy is fundamental input for life and it also plays a very significant role in the growth of any country. The proportion of conventional energy is very much which nearly 85% is. We are also moving towards renewable sources of energy

The conventional sources of energy are mainly fossil based fuel which will be depleted in some decades. They also have hazards towards environment. Greenhouse effect, acid rain and pollution are main problem with usage of fossil based fuel.

The renewable sources of energy are Wind energy, Hydro energy, Solar energy, Tidal energy, Ocean energy. The advantage with renewable energy is that they are never ending, eco friendly. They do not cause any pollution.

In continuation of this, in future piezoelectric effect may be one aspect for converting movement of persons / crowd into useful work. The availability of this energy will increase with increase in the population.

We can generate ample energy in the places where we have great public movement / mass movement.

For example – Railway Station or metro station.

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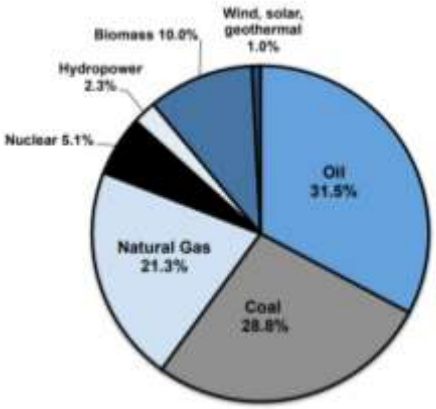
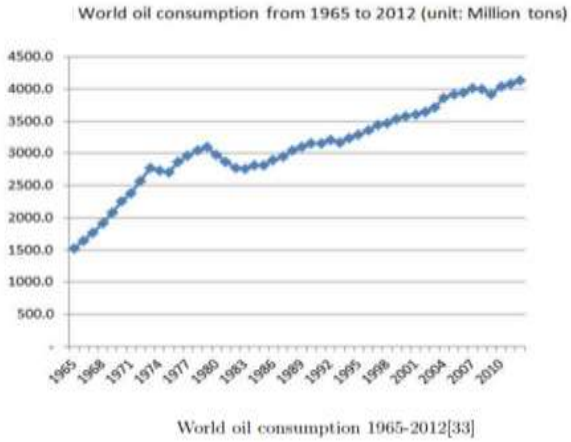
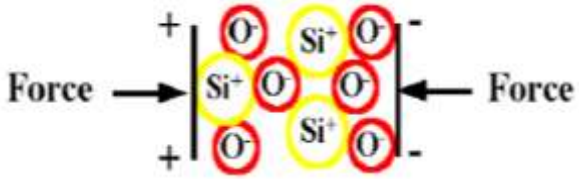




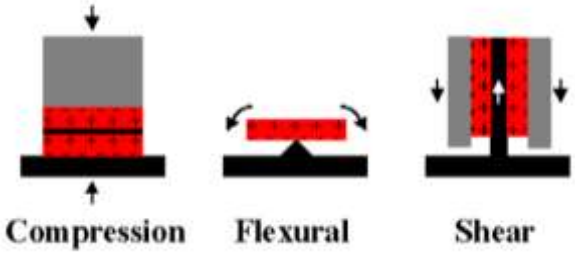
World oil consumption 1965-2012[33]

II. INDENTATIONS AND EQUATIONS

When the piezoelectric elements are strained by an external force, displaced electrical charge accumulates on opposing surfaces. Figure illustrates the displacement of electrical charge due to the deflection of the lattice in a naturally piezoelectric quartz crystal. The larger circles represent silicon atoms, while the smaller ones represent oxygen. Crystalline quartz, either in its natural or high-quality, reprocessed form, is one of the most sensitive and stable piezoelectric materials available.



Many different sizes and shapes of piezoelectric materials can be used in piezoelectric sensors. Acting as true precision springs, the different element configurations are shown in the next Figure.The red represents the piezoelectric crystals, while the arrows indicate how the material is stressed.



The way a piezoelectric material is cut produces three main operational modes:

Transverse effect

A force applied along a neutral axis (y) displaces charges along the (x) direction, perpendicular to the line of force. The amount of charge (C_x) depends on the geometrical dimensions of the respective piezoelectric

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element. When dimensions a, b, c apply,

$$,C_x = \frac{d_{xy}F_y b}{a}$$

where aa

is the dimension in line with the neutral axis, bb is in line with the charge generating axis and d is the corresponding piezoelectric coefficient.

Longitudinal effect

The amount of charge displaced is strictly proportional to the applied force and independent of the piezoelectric element size and shape. Putting several elements mechanically in series and electrically in parallel is the only way to increase the charge output. The resulting charge is

$$C_x = d_{xx}F_x n,$$

where $d_{xx}d_{xx}$ is the piezoelectric coefficient for a charge in x-direction released by forces applied along x-direction (in pC/N). F_xF_x is the applied Force in x-direction [N] and n corresponds to the number of stacked elements.

Shear effect

The charges produced are strictly proportional to the applied forces and independent of the element size and shape. For $n\,n$ elements mechanically in series and electrically in parallel the charge is

$$C_x = 2d_{xx}F_x n$$

In contrast to the longitudinal and shear effects, the transverse effect make it possible to fine-tune sensitivity on the applied force and element dimension.

Examples of Piezoelectric materials are

1) Quartz (SiO_2)
2) Berlinite ($AlPO_4$)
3) Gallium Orthophosphate ($GaPO_4$)
4) Barium Titanate ($BaTiO_3$)
5) Tourmaline

When the crowd moves, the feet of people exert pressure on the floor. This pressure is converted in the form of charge by use the piezoelectric effect in the pressure sensor, then the sensor uses the diaphragm, when the pressure is applied it deflects slightly. The pressure on the crystal causes a small voltage to be produced that is proportional to the pressure. The following figure shows the example of the piezoelectric sensor.

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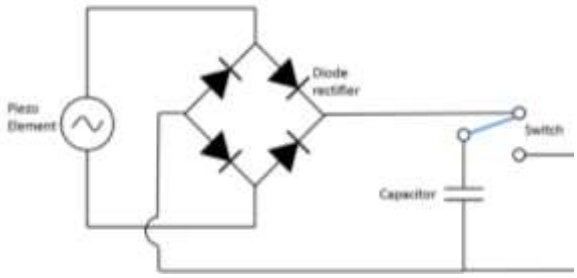
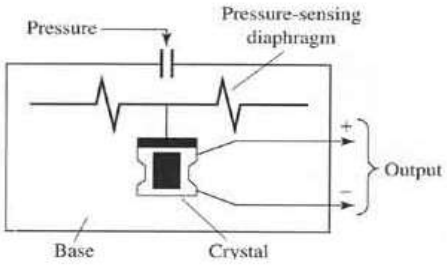
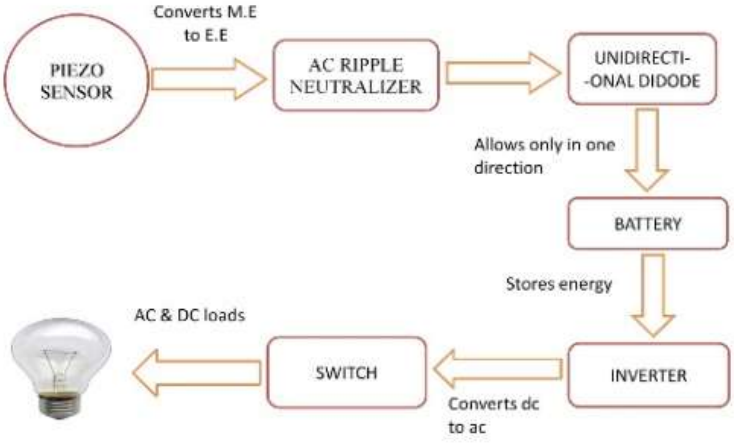




Piezoelectric Pressure Sensor

Following is the block diagram



III. FIGURES AND TABLES

Following is the data table for energy production from footsteps (Average person wt is 80 Kg)

(SOURCE:JIEMS, Akkalkuwa)

No of Foot Steps	Duration of Lighting of 100W and 230V (In sec)	Total energy (J)	Energy / Step (J)
250	6	600	2.4
500	12	1200	2.4
750	18	1800	2.4
1000	25	2500	2.5

Taking a case of Delhi Railway station

If approx 500000 passengers are moving in/out per day through station

And assuming one person takes effectively 1000 footsteps.

So total energy produced in 24 hrs = $1.25X10^9$ J

That means one bulb of 100W can glow for 3472 hours through the power produced in a single day.

IV. CONCLUSION

This type of energy is never lasting and available for ever. It has great potential.

It has following benefits

A) This also does not create any pollution

B) This does not leave any residue

C) It does not release any toxic substance

D) It is purely eco friendly

E) This energy has very bright scope in future.

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