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Research Paper

DESIGN AND FABRICATION OF ENERGY EFFICIENT ALARM CLOCK

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As the world is heading towards advancement, its expectations from technology are changing. The topmost priority of technology is not only to provide ease of access to people but also to save the remaining sources of energy as much as possible. Saving one unit of energy is equivalent to the production of more than one unit because of the losses involved in production and transmission of energy. Thus, even a small contribution in energy-saving is welcomed by the modern world .This research work focuses on a bulk energy-banking. This has been done by a minor modification in a regularly used gadget in every person's life—'an alarm clock '. It is achieved by the application of the concept of 'piezoelectricity '.The research starts by conceptualizing the method to harness the electrical energy of the piezoelectric element to enable the sustenance of an electronic device. A well-designed circuit diagram shows the proper technique to develop this device. A theoretical comparison has been done between an ordinary alarm clock and the fresh innovative version. The outcome has been used to show that a bulk production of such gadget is practically possible taking into consideration the cost of components involved in production.

Keywords: Energy-saving, Piezoelectric effect, Piezoelectricity, Electrical/electronic device, Alarm clock, Innovative devices

INTRODUCTION

On 4th September 1882, when the first central power plant of United States –"*The Pearl Street Station"* started delivering power, it used one D.C. generator and was burdened with 400 lamps of 85 customers (http://en.wikipedia.org/). However, as the population and the living standard of individuals grew, it was accompanied both by a rising demand of energy and depleting reserve of energy source. Thus the vision of technology bent towards development of alternative sources of energy that could decelerate the exhaustion of non-renewable resources of energy. Saving one unit of energy is equivalent to production of more than one unit because of the losses involved in production. Nowadays every possible method is adopted to realize the operation of devices by using renewable energy-sources.

The State of California employs a tiered energy tax whereby every consumer receives a baseline

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energy allowance that carries a low tax. As usage increases above that baseline, the tax increases dramatically. Such programs aim to protect poorer households while creating a larger tax burden for high energy consumers (Zehner Ozzie, 2012). The intention of this research is

1. To widen the scope of energy conservation.
2. To take energy-banking to the micro level.

- The discussion in the research enables a simple configuration of alarm clock to extend its efficiency.
- The alarm clock can operate longer on the same value of input voltage. This saves the additional amount of energy that was unnecessarily wasted until now.
- This research also discusses the prospect of the bulk production of such a piece of equipment bearing in mind the expenditure involved in its manufacturing.

PRINCIPLE OF OPERATION

A piezoelectric transducer (as already discussed) has the property to convert mechanical stress to electrical signals. According to the principle of conservation of energy-"*Energy can neither be created nor destroyed but changes from one form to another*".

It is remarkable that improvements in energy efficiency are most often achieved by adopting a more efficient technology or production process (Diesendorf Mark, 2007). The crucial idea is a construction that traps any unnecessary wastage of energy in an alarm clock. There is some energy that is constantly wasted by the device but still goes unnoticed-'*the sound energy of the alarm clock'*. Thus, the piezoelectric transducer is being used to exploit the sound energy and convert it to electricity. The sound waves procreate vibrations that can be sensed by the piezoelectric transducer .These vibrations will act as a mechanical stress input to the transducer which will response immediately with a certain voltage output.

Thus, the energy that was purely being wasted is now harvested by the transducer.

The boundary between efficient energy use and energy conservation is nebulous, but both are important in environmental and economic terms (Dietz T, 2009).

MATERIALS AND METHODS

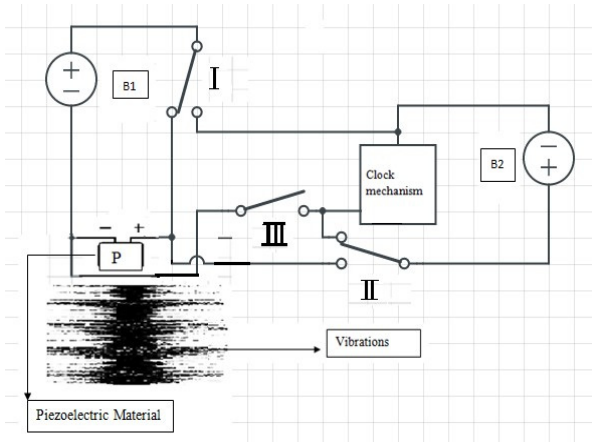
The configuration requires

1. A piezoelectric element
2. two rechargeable batteries
3. 2 SPDT switches
4. A simple switch

The construction of the device is depicted by the circuit diagram given below.

The description of the devices involved in the experiment is as follows

Figure 1: Circuit Diagram of the Device



1. Piezoelectric Element

Certain solid materials develop electric charge in response to the application of mechanical stress. These materials are termed as 'Piezoelectric Materials' and the charge that accumulates in such materials is called 'Piezoelectricity' (Cooper W D and Beltried A P, 1985).

Examples of such materials are:

- Biological elements like bone, silk, D.N.A. etc.
- Natural elements like quartz and Rochelle salt.
- Synthetic ceramics like Barium Titanate ($BaTiO_3$), Lead Titanate($PbTiO_3$), etc. (Sawhney A K, 2011).
- Synthetic crystals like Gallium Orthophosphate ($GaPo_4$) etc. (http://en.wikipedia.org/).
- Polymers like Polyvinylidene Fluoride (PVDF) etc. (http://en.wikipedia.org /).

The piezoelectric element can respond to mechanical deformations by thickness expansion, transverse expansion, thickness shear and face shear

This phenomenon of the conversion of mechanical force/stress to electrical signal exhibited by piezoelectric materials is termed as the *'Piezoelectric Effect'.*The piezoelectric element (in this case) is placed strategically at such a position where it receives maximum amplitude and density of vibrations when the alarm plays. The piezoelectric element will be used to catch the vibrations and convert them to electrical signals

2. Batteries

An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Batteries are classified into primary and secondary forms.

Primary batteries- irreversibly transform chemical energy to electrical energy (Dingrando Laurel, 2007).

Secondary batteries- can be recharged; they can have their chemical reactions reversed by supplying electrical energy to the cell, approximately restoring their original composition. (Fink Donald G, 1978).

In this device the secondary batteries are employed. These rechargeable batteries will be used to provide supply to the clock.

3. SPDT Switches

The SPDT refer to Single pole double throw switches. They are simple changeover switches that are used to change the path of the current. These uncomplicated switches are used to cut off the supply as and when required. They serve dual purposes:

A. To open or close the circuit.

B. To change the path taken by the current supply from one loop to another.

As depicted in the circuit diagram working of this configuration occurs in 2 different ways:

CASE I: *When the switches I, II, III have the same position as shown*

1. In this case the battery B2 supplies energy to the clock mechanism.
2. The piezoelectric element is excited by the oscillations produced in it by the vibration due to the alarm.
3. The element develops voltage across their terminal which is supplied to the battery B1.
4. Thus indirectly the sound energy of the clock charges B1.

CASE II: *When the position of I, II, III is opposite to their previous position.*

1. In this case the battery B1 supplies energy to the clock mechanism.
2. The piezoelectric element is again excited by the oscillations produced in it by the vibration due to the alarm.
3. The element develops voltage across their terminal which is supplied to the battery B2.
4. Thus indirectly the sound energy of the clock charges B2.

This cycle carries on until the life of the two batteries B1 and B2 is consumed.

Sensitivity of a Piezoelectric transducer

Sensitivity is defined as the charge developed by the piezoelectric element when a force of some magnitude is applied to it. The unit of sensitivity is *Coulomb/Newton*. [2]

Mathematically, it is expressed by the following relationship:

Sensitivity = Charge Developed **/** Applied Force

OBSERVATIONS

The following observations were made by using a simple piezoelectric element. The specifications of the above element are as follows-

- Brass plate
- Ceramic piezoelectric crystal
- Plate of 20mm diameter
- Element of 14mm diameter

Table 1 shows the amount of voltage obtained on a multimeter with different loads on the piezoelectric material.

Table 1: Variation of Voltage with Weight/Load

S. No.	Load (in gm)	Output Voltage (in mV)
1	700	22.5
2	750	23.5
3	800	24.5

CALCULATIONS

Efficiency = output**/**input

Output = (22.5+23.5+24.5)/3

= (70.5)/3

= 23.5 milli volts or 0.0235 volts

Input = (700+750+800)/3

= 750 grams or 0.75 kilograms

Efficiency in terms of the voltage developed per unit load = 0.0235/0.75

So, efficiency in terms of the voltage developed per unit load = 0.03133 volts/kg

INFERENCE

Thus, the result shows that by using a single cheap ceramic piezoelectric element, a voltage of 0.0235 volts is developed across the terminals of the element on the application of a load as light as 750 grams. It can be easily inferred that a greater amount of voltage will be generated when the piezoelectric element will receive high impulses by the alarm clock as the pressure exerted will be of higher magnitude.

COMPARISON OF THE PERFORMANCE

This device is preferable over the ordinary alarm clock due to the 2 obvious reasons-

- Saves energy

- No need to replace batteries on regular basis
- Overall cost reduction

Now, even if the device is compared with a clock operating on pair of rechargeable batteries charged by the A.C. supply, it proves to be better as charging batteries through A.C. may simplify the machine but does not solve the major problem i.e. saving energy that was about to be wasted. This innovative model is smarter and better as it is able to recycle energy and satisfy its needs on its own!

CONCLUSION

This research work is based on the principle of piezoelectric transduction. The device is completely focused on energy utilisation. If the model is developed by proper judgement of the components and cost a mass-production of the device is feasible. Even if it will be costlier than a contemporary alarm clock it accomplishes 3 objectives which the primitive model fails to achieve. They are saving energy, getting rid of regular replacement of dead batteries, overall cost reduction.

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REFERENCES

1. Cooper W D and Beltried A P (1985), Electronics Instrumentation and Measurement Techniques, *Prentice Hall International.*
2. Diesendorf Mark (2007), “Greenhouse Solutions with Sustainable Energy”, UNSW Press, p. 86.
3. Dietz T (2009), “Household actions can provide a behavioural wedge to rapidly reduce US carbon emissions”, *PNAS*, Vol. 106, p. 44.
4. Dingrando Laurel (2007), “Chemistry: Matter and Change”, *McGraw-Hill.*
5. Fink Donald G (1978), “Standard Handbook for Electrical Engineers”, Eleventh Edition, *McGraw-Hill.*
6. Online Document: http://material.eng. usm.my/stafhome/sabar/EBB443/Chapter%204-Piezoelectric%20Ceramics.ppt
7. Sawhney A K (2011), “A Course in Electrical and Electronic Measurements and Instrumentation”, *Dhanpat Rai & Co.*
8. Wikipedia: http://en.wikipedia.org /
9. Wikipedia: http://en.wikipedia.org /
10. Zehner Ozzie (2012), “Green Illusions”, Lincoln and London, University of Nebraska Press, pp. 179-182.

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