TALK AND CHARGE

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ABSTRACT

By the extend use of mobile phones for communication, GPRS, entertainment, etc a worn out battery or a lost charge are the two difficulties every mobile user goes through. To overcome this we have to look for a new technology that can be adopted to charge the mobile phones. Use of non-conventional sources to recharge portable devices is the need of the hour. On the other hand we see that in this modern world there is lot of noise pollution in roads, airports, industries....which involves mainly sound energy. As sound has enormous amount of energy with it, which could be used, it can be treated as an alternative source of energy. Sound is a mechanical form of energy which travels in the form of wave, mechanical wave that is an oscillation of pressure this pressure created by the sound could be used to convert it into electric energy or other form of energy. Random sound energy around us can be treated as a source of electric power after efficient conversion using suitable transducer. An effective way of producing usable electric power from available random sound energy is presented here. Piezoelectric transducers are used for conversion of sounds into electric energy. Piezoelectric transducer converts mechanical strain into electric energy this property of Piezo material could be used to make a device which would be able to sustainably convert the sound energy to electric energy. So suppose your mobile phone get discharge you could shout at it and then it will again get charged or it could also get charge by using sound pollution around us.

Keywords : Charging, Conversion, Mobile Phone, Piezoelectric, Sound

I. INTRODUCTION

In the present scenario a Mobile phone is the basic necessity for everyone. A recent survey shows that the telecommunication market in the India is projected to have 1.159 billion mobiles subscribers by 2013 [1]. An incredibly huge amount of electric energy is being expended for the charging of mobile phones. Various researches are being conducted all over the world to find alternative means for charging mobile phones. Using conventional sources like body temperature, body vibrations and human activities have been proved to provide a considerable amount of electrical energy. [2]

But have we ever imagined that the sound that always exists in our everyday life and environments can be considered as a source of energy. This is was a stone which was left unturned by the researchers up till now but this hidden source is now emerging as the a new era in the world of renewable sources of energy.

Sound is type of energy which travels in the form of wave, mechanical wave that is an oscillation of pressure which needs a medium to travel. The medium can be air, water, wood, or any other material, but the only place in which sound cannot travel is a vacuum. Through liquid and gas state sound is transmitted as longitudinal wave whereas through solid it could be transmitted as both longitudinal wave and transverse wave. Longitudinal waves are of alternating pressure deviation from the equilibrium pressure, causing local region of compression and rarefaction, while transverse wave are waves of alternating shear and stress at right angle to the direction of propagation. Sound that is perceptible by humans has frequencies from about 20 Hz-20,000 Hz. In air at standard temperature and pressure, the corresponding wavelengths of sound waves range from 17 m-17 mm. [3]
But how can we use this sound to solve our electric energy problems? This could be easily understood by the third "law of thermodynamics" which states that the mechanical energy can be converted to electrical energy. [4] Sound energy could be easily converted into heat energy which could then converted into electricity but it is not highly efficient as the loss in conversion will be more, whereas the other method is converting sound energy to electricity by Piezoelectricity. Piezoelectricity is the conversion of mechanical strain to electric energy. So it could be seen that theoretically sound energy could be converted into electricity.

1.1.Piezoelectric Technology

Piezoelectric materials have found applications as gas igniters, displacement transducer/accelerometers, actuators, delay lines, wave filters, and as generators of ultrasonic energy. Arrays of piezoelectric elements have been used to produce ultra-sonic imaging equipment. [3] This link between electricity and mechanism forms the basis of the method for evolving conversion technique. The Piezoelectric materials have established a platform for mechanical energy to be utilized in novel ways such as generation of high voltages, electronic frequency generation and many other major applications. Now next, we have mentioned a number of sources of vibration which are already being used for piezoelectric energy harvesting.

Japan has already started experimenting use of piezoelectric effect for energy generation by installing special flooring tiles at its capitals' two busiest stations. Tiles are installed in front of ticket turnstiles. Thus every time a passenger steps on mats, they trigger a small vibration that can be stored as energy.

Energy thus generated by single passenger multiplied by many times over by the 400,000 people who use Tokyo station on an average day, according to East Japan Railway, generates sufficient energy to light up electronic signboards, run automatic ticket gates and electronic displays. [5]

In United States, Defence Advance Research Project Agency (DARPA) initiated an innovative project on Energy harvesting which attempts use piezoelectric generators embedded in soldiers' boots. DARPA's effort to harness 1-2 watts from continuous shoe impact while walking was abandoned due to the discomfort and its impact on body. [6]

Constructing special types of roads that generates electricity just by driving over them is next step towards use of piezoelectric crystals. Though small charge is generated by single car but 1 km stretch of such road could generate around 400kW-enough to run eight small cars. Such experimenting have already started in Israel. According to the Environmental Transport Association (ETA), if such system was installed on every stretch of British motorway it would generate enough energy to run 34,500 small cars. Certain vehicles could thus be powered entirely by road on which they drive and the street lights too. [5]

In Netherlands, Rotterdam's new club WATT has a floor that harnesses the energy created by dancer's steps. Designed by Dutch company called the Sustainable Dance club, the floor is based on the piezoelectric effect. As club goers dance on floor, the floor is compressed by less than half an inch. It makes contact with the piezoelectric material under it and generates around 2-20 watts of electricity, depending on the impact of the dancers' feet. At present, it's just enough to power LED light present in the floor. In London, Surya, another new eco-nightclub, uses the same principle. A similar idea was used in some night clubs of Europe where crystals were laid underneath the dance floor to generate electricity by which they could power their strobes and stereos.

1.2 Other energy harvesting ideas through piezoelectric materials include:

i) To lay down piezoelectric crystals under the keys of a mobile unit and keyboards. For the press of every key, the created vibrations and pressures can be used for charging purpose. [7]

ii) Harvesting the energy from human movements in train stations or other public places by laying piezoelectric materials under floor mats, carpets and tiles in those places. [7]

iii) At workplaces, while sitting on the chair, energy can be stored in the batteries by laying piezoelectric crystals in the chair. [6]

iv) Also, the studies are being carried out to utilize the vibrations in a vehicle, like at clutches, gears, seats, shock-ups, foot rests.[6]

v) Vibrations from industrial machinery or from the machines in the gym can also be harvested by piezoelectric materials to charge batteries for backup supplies or for low power microprocessors and wireless radios. [7]

All these researches show the potential of piezoelectric materials in producing usable electrical power. It is also noted that, all these possible applications utilize the sensitivity of piezoelectric materials to any kind of pressure or vibration. Now let us look into the phenomenon of Piezoelectricity.

II.MECHANISM FOR PIEZOELECTRICITY

The word piezoelectricity means electricity resulting from pressure. Piezoelectricity is the charge that accumulates in certain solid materials in response to applied mechanical stress. The piezoelectric effect exists in two domains, the first is direct piezoelectric effect that describes the material's ability to transform mechanical strain into electrical charge, the second form is the inverse effect, which is the ability to convert an applied electrical potential into mechanical strain energy.

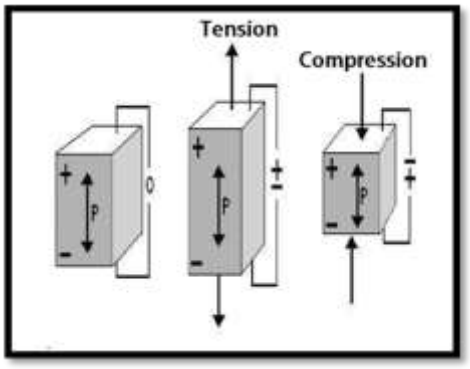

Fig.1 the direct piezoelectric effect.

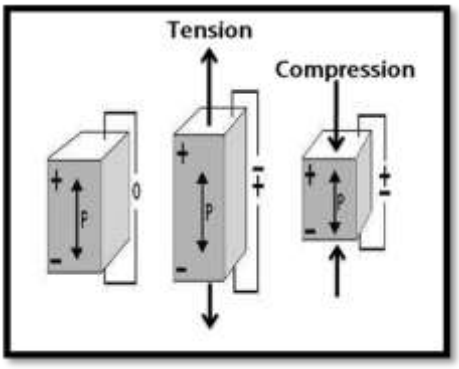

Fig.2 the inverse piezoelectric effect.

The direct piezoelectric effect is responsible for the materials to function as a sensor and the reverse piezoelectric effect is accountable for its ability to function as an actuator. A material is deemed piezoelectric when it has this ability to transform electrical energy into mechanical energy, and vice versa. The piezoelectric materials are transducers and exist naturally as quartz, possess properties for the production of electricity in very small quantity, however, compare to quartz, an artificial piezoelectric materials such as PZT (Lead Zirconate Titanate) presents advantageous characteristics of generating more electricity. [5]

Piezoelectric materials belong to the class called ferroelectrics. One of the defining traits of a ferroelectric material is that the molecular structure is oriented such that the material exhibits a local charge separation, known as an electric dipole. Throughout the artificial piezoelectric material composition the electric dipoles are oriented randomly, but when a very strong electric field is applied, the electric dipoles reorient themselves relative to the electric field, this phenomena occurs in case of reverse piezoelectric effect. When the material is deformed or stressed an electric voltage can be recovered along surface of the material (via electrodes).

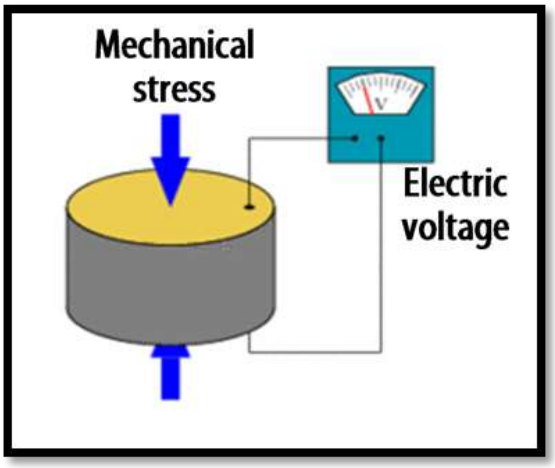

Fig.3 piezoelectric material

The process whereby the piezoelectric effect takes place is based on the fundamental structure of a crystal lattice. Crystals generally have a charge balance where negative and positive charges precisely nullify each other out along the rigid planes of the crystal lattice. When this charge balance is disrupted by an external force,

such as, applying physical stress to a crystal, the energy is transferred by electric charge carriers, creating a surface charge density, which can be collected via electrodes.

As sound is nothing but the vibrations in air and piezoelectric transducer is sensitive to any kind of vibrations, piezoelectric material is found to have useful application in the detection of pressure variations in sound. This inspired us to bring this application to use and hence we have proposed an effective method for charging of mobile phones using sound energy.

III.PROPOSED METHOD

An effective way of producing usable electric power from available random sound energy is presented here. Piezoelectric transducers are used for conversion of sounds into electric energy.

The produced electric energy from multiple piezoelectric transducers is stored in multiple super-capacitors which are then summed up and amplified through adder and voltage multiplier circuits. The resultant electric power was used to charge a rechargeable mobile battery using sound as source through the proposed conversion circuit.

In this way, random sound energy from numerous sources around us can be stored as electric energy which can be used later to deliver electric power to drive compatible small loads.

The overall conversion process can be summarized in the block diagram as shown:

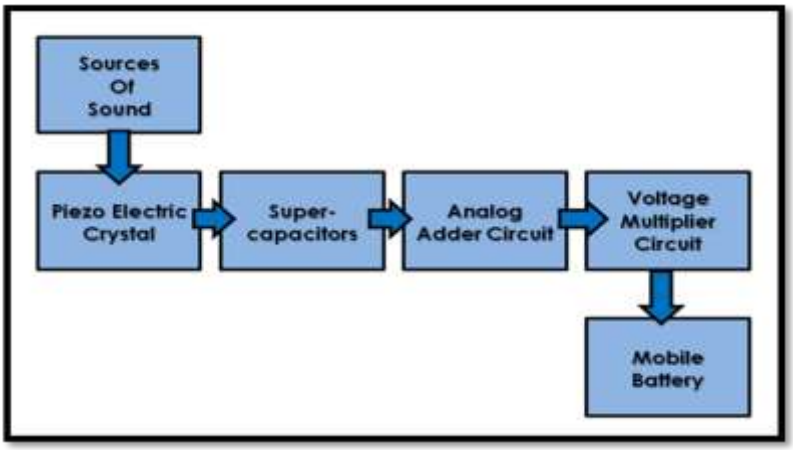

Fig. 4 block diagram

In this proposed method, at first, sound energy generated was used to produce small electric energy at the terminal of piezoelectric transducer As the generated voltage will be noisy in nature, so a super-capacitor is used in parallel to the piezoelectric transducers for both filtering and storing the produced electric energy. The super-capacitor also known as Electrical Double-Layer Capacitor (EDLC) is a relatively new technology. Super-capacitors have the highest capacitance values per unit volume and have the greatest energy density compared with other capacitors.

Due to its quick charging characteristics, super-capacitor can effectively store momentarily produced electrical energy through piezoelectric material from available sound energy. Due to its slow discharging characteristics, it can hold this stored electric energy for a longer time than usual capacitors, hence output from multiple super-capacitors can be added easily. A number of this transducer-super-capacitor parallel set up can be constructed as shown in Fig.5 and their output voltages are added using a LM 324 Op Amp adder circuit. More transducers-super-capacitors parallel set up could be used but in that case the added output will exceed the highest saturation voltage of LM 324 Op Amp.

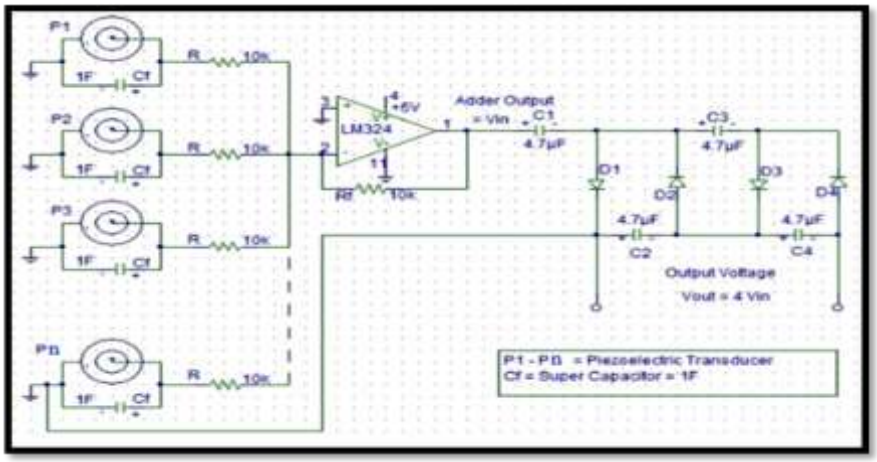

Fig. 5 circuit diagram

The output of the adder circuit was then fed to the input of a voltage multiplier (here, Quadrupler) circuit in order to increase the produced voltage level. The resultant voltage at the output of the Quadrupler circuit can now be used to charge a suitable rechargeable mobile battery.

Higher output voltage can be achieved at the output of adder by increasing the number of transducers-super-capacitors parallel stages before adder circuit if the biasing voltage of LM 324 Op Amp is increased accordingly. The purpose of using a diode in the direction of Quadrupler to rechargeable battery in the circuit is to prevent the discharging of the battery when there is not enough sound. In the absence of no sound or low level sound, output of the Quadrupler circuit will be below the required voltage and the battery will try to discharge by flowing current in reverse direction assuming the Quadrupler circuit as a load. The diode is placed to stop this reverse flow of current from battery so that it only take charge from the Quadrupler circuit and cannot get discharged in the absence of sufficient sound.

If sound is converted to electricity and then used to charge mobiles then there is a very wide scope of application for it. It can be utilized for military purpose (war field, border and hilly regions). When travelling in a long journey, during a trek or beach when switch boards are not available. While continuously talking on the phone with a low battery especially in android and smart phones where battery gets quickly discharged due to running applications. During lectures, long hour seminars or when a person has to talk for a long time. In outdoors with various sources like train whistle in railway station, noise in traffic, industries and public places. Sound produced from a running hydraulic pump and construction piling.

IV.CONCLUSION

An effective way of producing usable electric power from available sound energy is presented. Piezoelectric transducers can be used for conversion of sounds into electric energy. The produced electric energy from multiple piezoelectric transducers is stored in multiple super-capacitors which is then summed up and amplified through adder and voltage multiplier circuits. The resultant electric power can be used to charge a rechargeable mobile battery. The proposed method opens the door of a relatively less explored source of energy i.e. Sound energy and can contribute in global search for renewable energy.

If we will be able to convert sound energy to electric energy efficiently it could help us to reduce the scarcity of electrical energy globally and help in the development of mankind and reduction of CO2 as electric energy is one of the cleanest energy. The noise pollution on roads and runways due to traffic could be converted into electric energy and power the street lightning, signals and various other electrical appliances.[4] Future work of the proposed idea encompasses further amplification of the crystal output to a greater extent. Future lies in the inclusion of advanced material used to design the piezoelectric crystal which further amplifies the crystal output in terms of voltage as well as current.[6] With considerable research and sophistication to this technology, we can expect a world with no external chargers for mobile phones in the future.

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