**A device has been developed to generate electrical energy from everyday mechanical vibrations**

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**Abstract.** The development of a device for generating electrical energy from everyday mechanical vibrations is a significant step in the field of alternative energy. Such devices are capable of capturing and converting kinetic energy resulting from various mechanical movements into electrical energy. This can happen in a variety of conditions.: from vibrations in vehicles to vibrations in buildings caused by wind or human movement. The basic principle of operation of the device is the use of piezoelectric materials or microgenerators that react to mechanical stresses, creating an electric current. Such technologies can be integrated into various fields, including transportation, building structures, and consumer electronics. The advantages of using such devices include environmental sustainability, as they allow the use of available resources to generate electricity, as well as reducing dependence on traditional energy sources. In addition, they open up new possibilities for the autonomous power supply of low-power devices such as sensors and wearable electronics. Thus, devices that convert mechanical vibrations into electrical energy can become an important element in the transition to more sustainable and efficient energy systems, contributing to reducing the carbon footprint and providing new opportunities for innovation in various industries.

**INTRODUCTION**

The most important technological methods of primary enrichment of mineral raw materials based on the use of mechanical vibrations include: ore preparation, transportation of rock mass, separation of mineral products into productive (concentrate) and unproductive fractions (tailings). In ore preparation processes, vibrating crushers, jaw and cone crushers, are mainly used for crushing high-strength ores, usually at the stages of fine crushing [1, 2]. A design feature of jaw crushers is the creation of vibrations of the working body (cheeks) due to the use of a mechanical vibrator that ensures antiphase synchronization of the cheeks. In this case, the crushing force is transmitted to the rock, eliminating the impact on the bed. The advantages of vibrating jaw crushers are, first of all, a greater degree of crushing and increased unloading of the crushed product. This effect is achieved due to the increased oscillation frequency of the working organ (cheeks) of 16.5 - 25 Hz.

**EXPERIMENTAL RESEARCH**

Other types of vibrating crushers include cone inertia crushers developed at the Michelob Institute. They differ from the known ones in that the crushing cone is set in motion not by means of an eccentric, but by means of an unbalanced vibration exciter. Another distinguishing feature is that in inertial cone crushers, the principle of crushing is implemented at a given force, depending on the rotational speed of the unbalance, whereas in conventional crushers, destruction occurs at a given deformation. This circumstance, along with the increased frequency of cone oscillations (6-25 Hz) and the ability to develop large crushing forces, determines a number of their important technological advantages over conventional crushers [1,2,3]. In particular, inertia crushers have the following advantages over eccentric crushers:

• degree of crushing - up to 30;

• the size of the finished product varies from - 10 mm to - 3 mm and is determined by the parameters of the discharge slot;

• control of obtaining the required size class by changing the number of revolutions and the static torque of unbalanced vibrators;

• avoiding damage to mechanical devices when non-crushing bodies enter the crushing cavity;

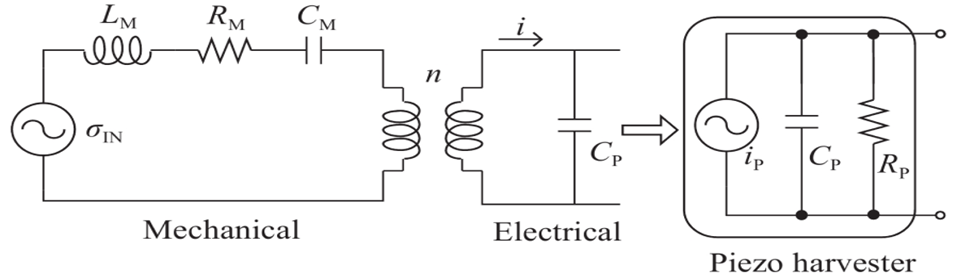
• can be used for rocks and high-strength materials (ferroalloys, hard alloys, etc.).

Another important distinguishing feature of bucket and cone vibration crushers is that instead of using massive foundations, they are mounted on soft vibration-insulating supports. This allows them to be used as mobile modules. A characteristic feature of such crushers is the time control of destructive loads. Despite the existing practice of their application, there is still no justification for optimal crushing modes, taking into account the strength of rocks, which does not allow directional control of the process of their destruction. Another important area of use in ore preparation processes is wet and dry crushing of rocks. At the same time, the mills operate in both open and closed grinding cycles. A characteristic feature of them is a certain field of application, due to the physical and mechanical characteristics of rocks. The size of the crushed material, in turn, depends on the main parameters, the amplitude and frequency of mechanical vibrations. According to [4], the recommended parameters of the frequencies and amplitudes of vibrations of the grinding drum of mills are in the range of 25-50 Hz, 3-20 mm. At the same time, the size of the feedstock of the mills should be no more than 6 mm. As a result, the lower fineness class of the crushed ore is up to 1 micron. This dispersion of the product is due to both the grinding method itself (impact and abrasion) and the condition of the material in the mill. In this regard, they are recommended to be used for fine and ultrafine grinding of ceramic raw materials, special cements, micas and other products [5].

The mechanical energy to electrical energy conversion device includes at least one element of an electro volumetric transducer, an oscillable mass, and a minimum of one element of transmission of oscillations. In this, the transducer element is attached to the transmission element such that an oscillation of the mass can be propagated at least partially into a change of volume of the transducer element through the use of the transmission element with the creation of an electrical voltage. The AC voltage obtained as a result can be tapped on connection wires of the electro volumetric converter element. [8]. The element of transmission may in this case be of an elastic element, and especially a spring element in the shape of a lever or in the shape of a bending beam. Nonetheless, the transmission element may also be made in the shape of a device that transmits the vibrations using fluid. It can be held in one hand in a clamp and / or can be mechanically contacted with a free-swinging subregion of a mass. The "free-swinging subregion" may usually be thought of as an area of the transmission element that is not attached in any way but can be approached to a vibrating mass or linked to such a mass. [9]

**RESEARCH RESULTS**

**Different kinds of oscillators can be understood and their functionality can assist in selecting an appropriate oscillator to use in your project.** They will need a certain degree of precision depending on the application of the oscillator - e.g. a significantly more precise oscillator will be needed when used in radio than it will be in other devices. Oscillators can be a trifle, and may be ignored when considering a project, the stance of any available oscillator that fits within the frequency range specified in the datasheet, which occupies board space and fits the cost considerations. The decision, however, may be much more complicated and may depend on the power needs of PCB and the amount of space, which should be assigned to the board, and on the frequency accuracy which has to be achieved. Others can be operated with microamps or less power whereas others can use several amperes.



**FIGURE-1.** Acoustic waves

Generating energy from acoustic waves:

The power supply of autonomous, unattended marine information sources, such as buoy automatic meteorological stations, involves the use of replaceable power supplies, which is laborious, economically unprofitable, and environmentally unsafe. Piezo electrics are widely used as converters of non-electrical quantities into electrical ones [1]. An alternative to replaceable galvanic power cells or batteries that need periodic recharging may be a device with piezoelectric converters of sea surface waves into electrical energy. Environmentally friendly methods and devices for converting thermal and other types of energy into electrical energy are known. Thus, the method and device for converting gravitational energy [2], which consists in moving the masses of matter and, due to the difference in the product of the masses on the arms of the levers, rotating the rotor of an electric power generator, has significant complexity and cost, limited-service life and reliability in operation with low output power. The method and device for converting the thermal energy of the environment [3] consists in using the known properties of ferromagnetic materials capable of generating or absorbing electricity when their temperature changes, but the complexity of their technical implementation, low power and significant cost are often unacceptable. The marine-based power plant [4], which contains an anchored floating vehicle with a counterweight, a through shaft in the hull of the floating vehicle and a DC turbo-electric generator, is characterized by significant dimensional and weight characteristics, complexity of hardware implementation, high cost and the need for anchoring, which limits its use.

Under certain conditions, ultrasonic vibrations can emit some natural and artificial substances with piezoelectric properties. These include crystalline substances: quartz, tourmaline, ferruginous salt, lithium sulfate; ceramic substances: barium titanate (TBK-3), lead zirconate titanate (CTS-19, CTSNV-1, CTS-23). The essence of the piezoelectric effect is that the compression of a piezoelectric plate leads to the appearance of electric charges on its surfaces. This phenomenon is called the direct piezoelectric effect. If the plate is placed in an alternating electric field, its thickness will fluctuate with the frequency of field changes. This piezoelectric effect is called the reverse.

*d= λ n/2* (1)

λ n - the wavelength in the piezo plate

The positive feedback is needed to shift the signal by 180 degrees. This phase shift then results in a 180 +180=360 degrees of phase shift which is effectively equivalent to 0 degrees. The overall phase change of the circuit must therefore be 0, 360 or any other multiple of 360 degrees. This can be achieved by taking advantage of the fact that in the input to an RC network the phase difference is added onto the path to the output of the same network and interconnected RC elements are fed back. As it is possible to observe in the picture above, each cascaded RC network introduces a 60-degree phase shift to the output voltage. The combination of three networks forms a 180 degrees shift.

**CONCLUSIONS**

A resistor-capacitor feedback network may be connected in either a form that produces a leading phase shift (phase advance network) or in a form that produces a trailing phase shift (phase delay network). The frequency of the network can be altered by changing one or several resistors or capacitors of the RC phase shift circuit. This transformation may be achieved through maintaining the resistors constant and variable capacitors as the capacitive reactance is dependent on frequency. The new frequency however may require an adjustment of the voltage gain of the amplifier. Nonetheless, the combination of the RC oscillator network is a damper and it decreases the signal by some percentage as it goes through each of the RC stages. Hence the amplifier stage voltage gain must be large enough to recover the signal lost. The RC network should be associated with the inverting input of the operation amplifier thus rendering inverting amplifier arrangement. The inverting arrangement causes a phase shift of 180 degrees at the output, caused by the inverting arrangement in addition to the RC networks causes a total phase shift of 360 degrees. By connecting the capacitor and the coil, in which the switch occurs, the capacitor releases its charge through the coil. The current through the coil starts gaining momentum and thus starts retaining energy by causing the generation of an electromagnetic field near the coil. Once the capacitor had been discharged the energy in it was imparted to the coil in the form of an electromagnetic field. As the energy flow of the capacitance reduces, the current flow in the coil also reduces - this leads to reduction in the electromagnetic field in the coil. When the crystal is shock excited either through a physical compression or in our case through an applied voltage, it will be able to vibrate in a mechanical way with a certain frequency. This vibration will persist some period of time forming an alternating voltage between its terminals. This is the piezoelectric effect, just as with a ceramic resonator. The oscillation of the crystal will take a longer time than the oscillation of an LC resonant circuit - a consequence of the inherently high Q factor of the crystal. A Q of 100,000 is not unusual with a high-quality quartz crystal. Q value of LC circuits is usually of several hundreds. They cannot, however, vibrate indefinitely, though the Q is much greater. The mechanical oscillation causes some losses and therefore you require an amplifier circuit like RC and LC oscillators.

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