Jan. 12, 1960 E. L. SCHIAVONE 2,921,252

ELECTRIC GENERATOR

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Fig. 1.

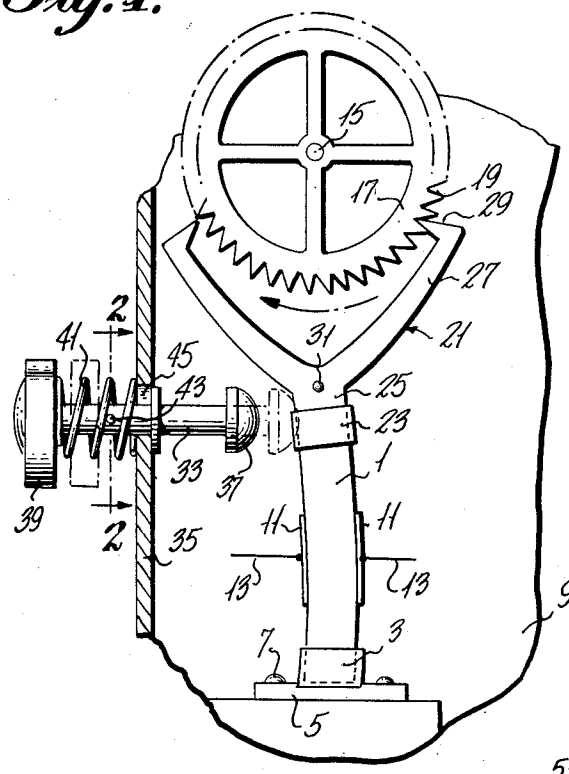


Fig. 2.

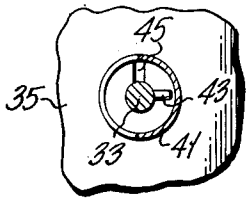


Fig. 3.

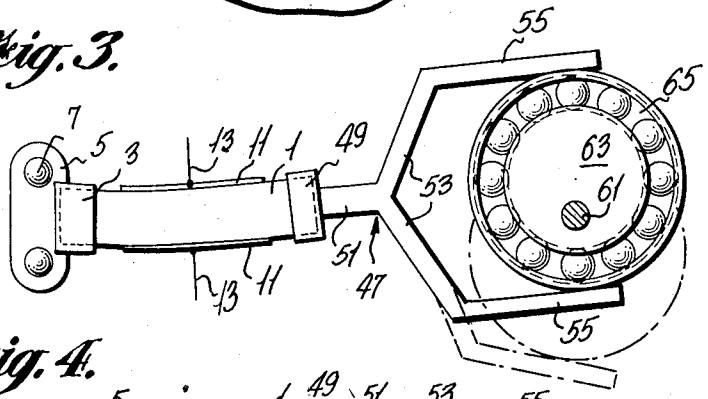
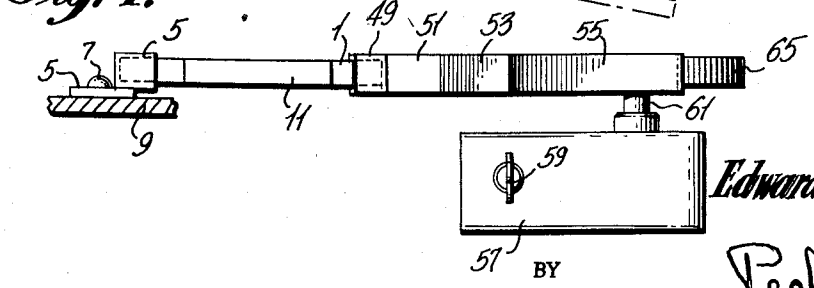


Fig. 4.



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Fig. 5.

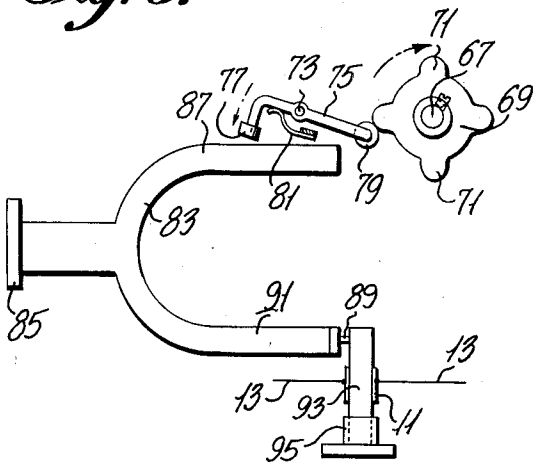


Fig. 6.

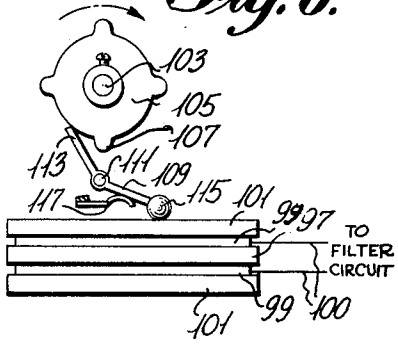


Fig. 7.

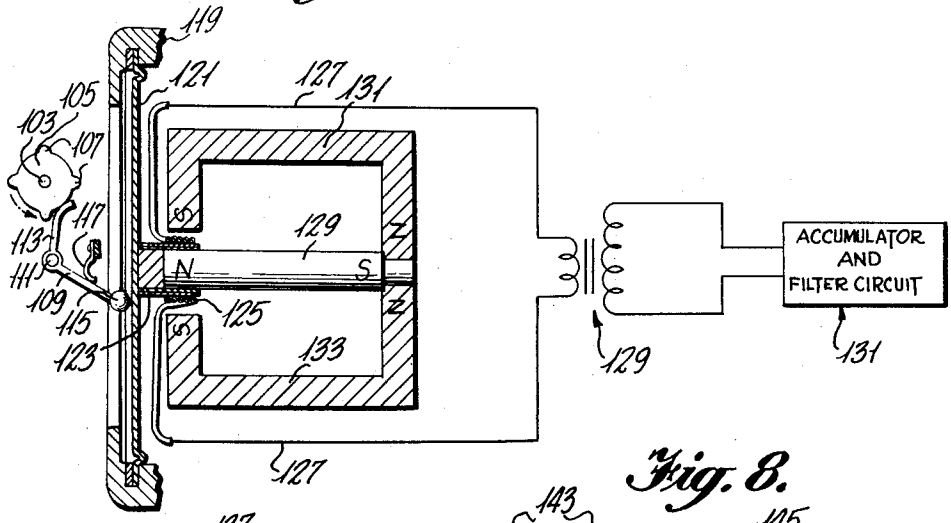
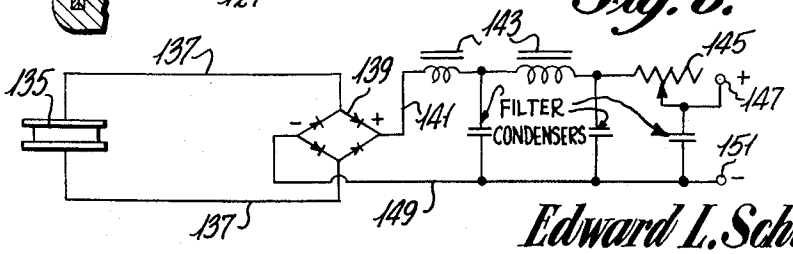


Fig. 8.



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ELECTRIC GENERATOR

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Application May 28, 1957, Serial No. 662,228

2 Claims. (Cl. 322—2)

This invention relates broadly to the electric power generator arts and in its more specific aspects it relates to apparatus for translating mechanical motion into a constant voltage; and the nature and objects of the invention will be readily recognized and understood by those skilled in the arts to which it relates in the light of the following explanation and detailed description of the accompanying drawings illustrating what I at present believe to be preferred embodiments or mechanical expressions of my invention from among various other forms, arrangements, combinations and constructions, of which the invention is capable within the spirit and scope thereof.

It is one of my primary purposes to provide mechanism providing uniform mechanical motion in a simple, economical and efficient manner and to translate such mechanical motion into usable electrical energy.

It is well known that usable energy in the form of an electric current may be generated by the distortion or vibration of certain crystals such as barium titanate and similar piezoelectric crystals and that the frequency of such current impulses depends upon the frequency of the vibrations to which the crystal is subjected. As far as I am aware no one has heretofore devised a highly efficient and commercially practical apparatus using the principle of crystal distortion as a source of current which will automatically operate over long periods of time to furnish a constant voltage.

It is therefore a purpose of my invention to provide a piezoelectric generator for furnishing operating voltage for a great many types of electrical devices, for instance my generator may supply operating voltage for hearing aids, life boat and the like transmitters and receivers, ultrasonic generators, audio generators, walkie talkie units, portable radios and phonographs, alarm systems, photocell units, microphone preamplifiers, micro-wave communication, intercom units, signal generators, moisture meters, electric eye control for lens, music boxes, smoke indicators, temperature indicators, weather transmitters, and the like.

In evolving my generating apparatus I have eliminated the necessity for using batteries and thus have banished from my apparatus the undesirable features which are inherent in systems using chemical batteries, such as the large voltage drop that occurs over a period of time and especially toward the end of the "shelf-life" of the battery. My invention also eliminates the danger of harmful radiations from batteries which are made from radio-active materials. Many other highly advantageous features flow from a power generating system which does not use batteries, for instance my crystal generating apparatus may be used in high moisture and temperatures where batteries would have a short life and my generator may be used in applications where units must be stored under operating conditions for long periods of time. Obviously under such stored non-use conditions batteries would rapidly deteriorate and would not function properly when required to.

While electric current has heretofore been generated by distorting or vibrating piezoelectric crystals such distortion has generally been accomplished by manual means and there has been no prior concept of an organization by means of which a constant voltage may be automatically furnished over long periods of time. It is thus an object of this invention to provide an apparatus which incorporates mechanical means for causing uniform distortion of the crystal to thereby produce a constant voltage. In accomplishing this object I have not sacrificed simplicity in the generating apparatus nor have I sacrificed economy of production of the apparatus or in the operation thereof. In other words I have devised an apparatus involving mechanical means, such as a resilient motor to cause a transducer to function to produce electrical impulses, which apparatus is economical to produce and operate for long periods of time and is therefore more than a device adapted merely for experimental laboratory work; instead it is a commercially feasible apparatus of substantial utility for the production of voltage for the operation of many and varied types of electrical apparatus.

In attaining an apparatus endowed with the aforementioned and other highly desirable characteristics, I have, in certain forms which my invention may take, used a spring motor as the prime mover and have used an escapement mechanism which is associated with the motor and a crystal in a manner to cause distortion of the crystal to produce voltage when the motor is operating. I have evolved a mounting and arrangement of the various components of the apparatus which is simple and results in a highly efficient operation. For instance, I may use an elongated crystal or transducer element which is fixed at one end while the other end is subject to physical forces which cause distortion of the body of the crystal to thereby cause generation of electrical impulses. The free end of the crystal may be operatively associated with the escapement mechanism for receiving therefrom distortive forces, or the free end of the crystal may be operatively associated with vibration generating means whereby vibrations are transmitted to the crystal to thereby cause the generation of electrical impulses. It is within my contemplation to provide various arrangements for producing voltage by distortion of a crystal or by subjecting it to vibrations and in these various arrangements, systems and organizations limited to use mechanical motorized means for generating the distortive or vibratory forces which are applied to the crystal. In all such apparatus I provide for the application of uniform forces on the crystal to thereby produce a constant voltage.

It is also within my contemplation to provide a generator which provides mechanical means for causing reciprocatory action by a coil within a magnetic field to thereby generate an electric current.

My invention also includes an accumulator and filter and voltage limiting circuit for use with the voltage generating crystal or other voltage generating means.

The electric generator of this invention is of a compact form which will produce uninterrupted voltages for long periods of time while requiring little or no maintenance.

With the foregoing general objects, features and results in view, as well as certain others which will be apparent from the following explanation, the invention consists in certain novel features in design, construction, mounting and combination of elements, as will be more fully and particularly referred to and specified hereinafter.

Referring to the accompanying drawings:

Fig. 1 is a fragmentary plan view illustrating the preferred form of my invention more or less schematically.

Fig. 2 is a view taken on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary plan view of a further form of my invention illustrated more or less schematically.

Fig. 4 is a side elevational view of the generator illustrated in Fig. 3.

Fig. 5 is a fragmentary schematic view of a further form of my invention.

Fig. 6 is a fragmentary schematic view of a still further form of my invention.

Fig. 7 is a fragmentary schematic view of another form of electric generator.

Fig. 8 illustrates an electric circuit which may be used with any of my electric generators.

In Figs. 1 and 2 of the accompanying drawings I have schematically illustrated the preferred form of my invention which comprises novel and unique means for applying distortive forces to a crystal in order to generate electric impulses. I have used the numeral **1** to designate an elongated generally rectangular crystal transducer element which may be a barium titanate or other similar piezoelectric crystal having the necessary properties to function as desired. The crystal **1** is fixedly mounted at one end in a socket **3** which is provided on a bracket **5** which is fixed by screws **7** to any suitable supporting surface **9** which may be a wall of a housing. The crystal **1** is preferably removably inserted in the socket **3** to project upwardly therefrom and is fixed within the socket against any lateral movements relative thereto. Any suitable types of electrodes **11** may be fixedly applied to the crystal in longitudinally extending position therealong and an electric lead **13** is connected to each conductor and to an accumulator and filter circuit which will be hereinafter described. The electrodes **11** may comprise a flexible conductive material conductively fixed to the crystal or it may comprise a conductive film which is sprayed on the crystal or any other appropriate electrodes may be used.

I provide a resilient motor and escapement or actuating mechanism for operative association with the other or free end of the crystal for uniformly applying distortive forces to said free end to thereby cause a bending or distortion of the elongate body of the crystal. Such motor and actuating organization may embody a shaft **15** which is driven by a spring motor which is not shown in connection with Figs. 1 and 2 but is illustrated in connection with the form of invention illustrated in Figs. 3 and 4 of the drawings and will be described hereinafter. As the conventional spring motor is operating it will drive the shaft **15** at a constant speed which may, of course, be predetermined, and the shaft drives what I shall term an "escape or actuating wheel" **17** which is fixed to the shaft for rotation therewith, the actuating wheel being driven at the same predetermined constant speed. A continuous series of actuating teeth **19** are formed about the periphery of the escape or actuating wheel, each tooth of the series of teeth being curved backwardly against the rotative path of the wheel as indicated by the arrow in Fig. 1 of the drawings.

Operatively mounted on the other or free end of the crystal **1** is a force applying member designated generally by the numeral **21** and which forms a part of the actuating mechanism. The force applying member **21** is of yoke-like rigid construction and is incorporated in the apparatus between the actuating wheel and the crystal for transmitting forces from the wheel to the crystal and converting said forces into distortive forces within the crystal. The member **21** comprises a base providing a socket **23** which is mounted over the free end of the crystal. A stem **25** projects from the socket and a pair of arms **27** divergingly extend from the stem **25**, the arms being slightly curved inwardly toward each other and an inwardly directed working pawl **29** being formed on the outer end of each arm. The force applying member **21** is pivotally mounted as at **31**, the pivot being suitably supported from any appropriate stationary point which may be a wall of a housing. The force applying member is preferably of integral construction and is pivotally mounted in position so that the working pawls **29** will be in engagement with teeth **19** of wheel **17** for a purpose which will become apparent as this description proceeds.

As the actuating wheel is rotated by its shaft **15** which in turn is caused to rotate at a uniform rate of speed by the motor the working pawls **29** of the arms **27** will ride over the teeth **19**, thus when one working pawl is riding over the crest of a tooth the other will be at a low point between teeth and as the wheel rotates the positions of the working pawls relative to the teeth will change to thereby cause the force applying member to pivot or rock on pivot **31** and since the end of the crystal or transducer is in inserted position in socket **23** this rocking motion will be transmitted to the crystal to distort or bend it in first one direction and then the other to thereby produce voltage which is carried off through the electrodes **11** and leads **13** to a suitable accumulator and filter circuit which will be described hereinafter.

I have provided means for stopping operation of the apparatus when it is not desired to generate electricity. One example of such means is disclosed in Figs. 1 and 2 of the drawings and may consist of a pin or plunger **33** mounted on a wall **35** of a housing or in any other fixed surface, the pin **33** being extended through the surface **35** for reciprocation therein and may be provided with an abutment head **37** on the inner end thereof and an operating button or knob **39** on the other end thereof. I wind a spring **41** about the plunger between button **39** and the wall so that the spring constantly biases the plunger outwardly into retracted or inoperative position. A radially projecting locking pin **43** is fixed in the plunger and when the plunger is pushed inwardly into operative position locking pin **43** extends into a slot **45** which is provided through wall **35** whereupon a slight rotary action on button **39** will move the pin **43** into the position behind surface **35** as illustrated in Fig. 2 of the drawings to hold the plunger in projected operative position. When it is in such position the head **37** will engage or abut the adjacent arm **27** of the force applying member to thereby restrain it from rocking which will, of course, stop rotation of wheel **17** and consequent unwinding or operation of the motor. To release the force applying member it is merely necessary to rotate the plunger until locking pin **43** is aligned with slot **45** whereupon the plunger will be retracted under the action of spring **41**.

In Figs. 3 and 4 of the drawings I have disclosed a modified form of voltage generator which, however, follows the same operating and generating principles as those involved in the apparatus described above. In this form of my invention I use the same type of crystal or transducer and I mount it in the same manner as described above and I have also used the same reference numerals to designate similar parts.

The force applying member designated generally by numeral **47** comprises a socket forming base **49** into which the other or free end of the crystal is inserted. A neck or stem **51** extends from the socket **49** and a pair of diverging arms **53** extend from the stem. A pair of controlling arms **55** project in parallel relationship from the ends of the arms **53**, thus, the force applying member forms a yoke-like structure. I provide a spring wound motor **57** having a window key **59** whereby the motor may be activated when the spring has unwound or run down through operation of the apparatus. A shaft **61** extends from the motor and is driven thereby. On the outer end of the shaft I eccentrically mount a disc **63** having a ball bearing assembly **65** provided about the periphery of the disc. Consideration of the drawings indicates that the assembly is such that the disc and its ball bearing ring are positioned between and in engagement with the arms **55** of the force applying

member so that upon operation of motor **57** and rotation of shaft **61** the eccentric mechanism including the disc and bearing ring will rock member **47** and consequently the crystal or transducer **1** will be bent or distorted from side to side to thereby generate voltage as described. It is to be understood that the same means may be used for stopping operation of the apparatus as has been described in connection with Figs. 1 and 2. It will also be understood that it is my intention to drive shaft **15** (Fig. 1) by a spring motor such as the motor **57** (Fig. 4).

In Fig. 5 of the drawings I have illustrated a further mechanism whereby vibrators or distorting forces may be applied to a crystal. In this form of my invention, as in all the forms illustrated herein, I use a spring or the like motor which mechanically initiates the vibrating or distorting action. I provide a shaft **67** which is driven at a uniform rate by a motor such as motor **57** (Fig. 4) and fixed on this shaft is an actuating or kicker wheel **69** having a series of uniformly spaced projections **71** about the periphery thereof. Pivotally mounted as at **73** to any suitable support is an angled knocker arm **75** having a forward knocker head **77** and a tail wheel **79** in position to be engaged and kicked by successive projections **71** as wheel **69** rotates. I provide a spring member **81** which biases the arm **75** on its pivot so that knocker head **77** is normally in raised position. I provide a tuning fork **83** which is fixed in position by any suitable means **85** so that one arm **87** is in position to be tapped by head **77** when the apparatus is in operation. A solid vibration transmitting element **89** extends from the end of the other arm **91** of the tuning fork, the element **89** being not only fixed to arm **91** but also in engagement with a crystal **93** which is mounted in any suitable fixed socket **95**.

It will now be recognized that when wheel **69** is caused to rotate each projection **71** will engage wheel **79** of knocker arm and pivot it to cause the arm **87** of the tuning fork to be tapped by head **77** thereby setting up vibrations which are carried to the crystal or transducer through transmitting element **89** to cause distortion in the crystal and the generation of voltage. The duration of the vibrations in the tuning fork will be relatively long hence the striking intervals may not be as frequent as though the head **77** was directly striking the crystal itself.

Fig. 6 is illustrative of a further arrangement which may be used for applying distortive forces to a transducer such as a crystal. In certain installations it may be of advantage to use a ceramic disc type crystal or transducer **97** on each side of which is fixed an electrode **99** each of which has a lead **100** connected to an electric circuit. Metal covers **101** may be fixed to each electrode. I provide motor driven means for applying distortive forces or vibrations to the transducer **97**, such means comprising a shaft **103** which may conveniently be driven by a spring motor **57** (Fig. 4). A kicker wheel **105** is fixed on the shaft and is provided on its periphery with a series of uniformly spaced projections **107**. I pivotally mount a knocker arm **109** as at **111**, the tail **113** being engageable with projections **107** and on the other end of the arm I provide a knocker head **115** and a spring element **117** biases the head into position away from the crystal assembly. Thus, when wheel **105** rotates the head **115** will intermittently knock against the crystal assembly to produce in the crystal the desired voltage.

Fig. 7 of the drawings illustrates another form of electric generator in which I again utilize a spring motor for initiating the voltage generating action. I have schematically disclosed a frame **119** across which is stretched any suitable type of diaphragm **121** formed of any suitable material. Fixed to and extending rearwardly from the center of the diaphragm is a short tubular element **123** about which I form a coil **125** of copper or the like wire from the ends of which leads **127** extend and are connected to a step-up transformer **129** which in turn is connected to an accumulator and filter circuit **131**. The apparatus also includes permanent magnet members **129**, **131** and **133** and the tubular element **123** telescopically receives the free end of member **129**. The magnet members may be formed of a highly magnetized alloy which provides an intense magnetic field around the free end N of members **129**, **131** and **133** and the tubular element **123** telescopically receives the free end of member **129**. The magnet members may be formed of a highly magnetized alloy which provides an intense magnetic field around the free end N of member **129**. Thus when tubular element **123** is caused by diaphragm vibrations to move in this field a pulsating D.C. current will be generated in the coil **125**. In order to vibrate the diaphragm I provide a tapping mechanism which may be the same as that illustrated in Fig. 6 of the drawings and is powered by a spring motor. I have used the same reference numerals to designate elements in Fig. 7 which are the same as those shown in Fig. 6.

In Fig. 8 of the drawings I have illustrated an example of an electric circuit which may be used with any of the generators which I have described above. The circuit includes any suitable voltage generating means **135** which is connected by leads **137** to a bridge rectifier **139**, a conductor **141** is connected to the positive side of the bridge rectifier and to a pair of choke coils **143** which in turn are connected to a voltage limiting resistor **145** and the positive terminal **147** of the circuit. A lead **149** connects the negative side of the bridge rectifier **139** to the other terminal **151** of the circuit, thus making the voltage usable in a large variety of electrical devices.

It will now be appreciated that I have evolved electric generating apparatus which is simple and efficient and will operate over long periods of time to produce a constant voltage.

I claim:

1. Apparatus for translating mechanical motion into a constant voltage, including a piezoelectric crystal element and an escapement mechanism, means operatively connected to said escapement mechanism and fixed to said piezoelectric crystal element to apply distortive forces thereto for the generation of voltage thereby, and a resilient motor for operating said escapement mechanism at a uniform rate and means engageable with said escapement mechanism to stop the operation thereof.

2. Apparatus for translating mechanical motion into a constant voltage, including in combination, a piezoelectric crystal element productive of voltage when subjected to distortive forces, said piezoelectric crystal element being fixed at one end to a supporting surface and the other end thereof being free, and an escape wheel having actuating teeth about the periphery thereof and means for rotating said escape wheel at a constant speed, a pivotally mounted force applying member connected to the free end of said piezoelectric crystal element and having arms diverging therefrom and in engagement with said actuating teeth on opposite sides of the axis of rotation of said escape wheel to cause said force applying member to rock up on rotation of said escape wheel to thereby distort said crystal.

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