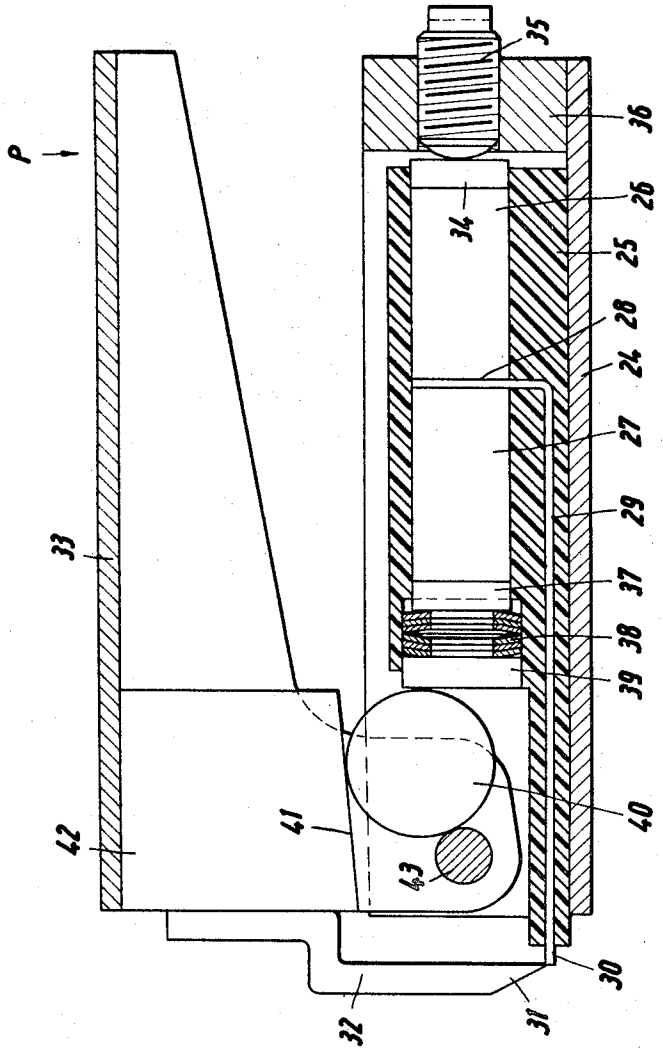
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PIEZO-ELECTRIC SPARK IGNITER

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PIEZO-ELECTRIC SPARK IGNITER

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9 Claims. (Cl. 317—81)

ABSTRACT OF THE DISCLOSURE

A piezo-electric igniter includes a tranducer crystal having a pair of poles and stress generating means which is arranged to subject the crystal to compressive stresses in direction of its piezo-electric axis so that the crystal generates a voltage. The stress generating means comprises actuating means movable from a starting position to a second position to thereby effect compression of the crystal. A pair of electrodes is normally in current-conducting contact with each other and are each connected with one of the poles to short-circuit the crystal. One of the electrodes is movable away from the other electrode in response to movement of the actuating means from the starting position to thereby terminate the current-conducting connection between the poles.

Cross references to related applications

There is copending an application, Ser. No. 397,801 of Wolfgang Maltner et al., filed on Sept. 21, 1964, and entitled "Piezo-Electric Igniter," of which the present application is a division.

Background of the invention

The present invention relates to igniters in general, and more particularly to piezo-electric igniters. Still more particularly, the invention relates to piezo-electric igniters for lighters or the like.

Specifically, the invention relates to piezo-electric igniters of the type in which the effectuation of tension or compression in the direction of a piezo-electric axis in a single or composite transducer crystal generates an electrostatic voltage which is utilized to produce one or more sparks to thus ignite a jet of gaseous fuel or a fuel-impregnated wick in a table lighter or the like.

The application of the piezo-electric phenomenon is assuming ever-increasing importance in many fields of art. Thus, piezo-electric generating arrangements are becoming more and more popular as igniters in lighters and similar structures. The principle of generation of piezo-electricity is well known, namely the fact that compression of a piezo-electric crystal in the direction of its piezo-electric axis generates a high voltage which can be utilized to produce a spark at a spark gap consisting of a pair of spaced-apart conductors. This process is reversible, i.e. the crystal will generate voltage in response to tension or to put this differently, in response to a reduction of compressive stresses. Thus, when a crystal is used in a piezo-electric igniter for lighters, compression of the crystal generates one or more sparks which are used to ignite the fuel. When the compressive stress is subsequently relaxed, this again results in one or more sparks. These latter sparks, however, are highly undesirable because they can very well cause a shock to the operator.

It has long been assumed that the voltage of a piezo-electric system returns to zero once the expanding crystal has produced one or more additional sparks, unless the stress generating mechanism is purposely operated in order to produce a new set of sparks, for instance when the operator again decides to utilize the lighter provided with a piezo-electric ignition system. In actual practice, however, it has been found that the voltage does not return to zero when the crystal is free to expand. This is true even if the voltage generated during an expansion has produced one or more sparks. Thus, the lighter is likely to cause a shock to the operator even when the lighter is not in use but is only touched by the operator or another person. Experiments which have been carried out indicate that these problems also arise in igniters wherein the stress generating mechanism is totally disengaged from the crystal so that the crystal is normally not subjected to any compressive stresses. In fact, the situation does not change if the crystal is a composite structure which is assembled of two or more crystals consisting of the same or of different materials. Thus, the presence of some potential between the poles of a piezo-electric transducer crystal which is not subjected to any stresses is a phenomenon which must be accepted as a characteristic feature of such crystals. If a piezo-electric ignition system is used in a miniature lighter where it must produce a voltage in the range of several kilovolts, even the best insulation cannot prevent current leakage and the potential of the piezo-electric transducer does not return to zero in such arrangements.

The above-mentioned copending application to Wolfgang Waltner et al., Ser. No. 397,801, has overcome this problem by providing an improved piezo-electric igniter which is so constructed and assembled that the presence of "residual" electric charge between the poles of an unstressed transducer crystal does not affect the utility or safety of the device and cannot cause a shock to a person who happens to touch the apparatus in which the igniter is utilized. However, while the invention disclosed in this copending application is fully operative and has been found highly practical, it is desirable in terms of large-scale manufacture to provide an arrangement which is still simpler and which can be accommodated in very small lighters.

Summary of the invention

The present invention provides the improvements just outlined as desirable.

More particularly, the present invention provides a piezo-electric igniter for lighters and the like which is so constructed that the presence of a "residual" electrical charge between the poles of an unstressed transducer crystal does not affect the utility or safety of the device and cannot cause a shock to a person touching the apparatus in which the system is installed, while at the same time it is still simpler than the device set forth in our above-mentioned copending application Ser. No. 397,801.

The device according to the present invention is also adapted for use in very small lighters because of the small number of components of which it is constructed. It is furthermore exceptionally rugged, compact and reliable and provides for the generation of electrical energy without any need for resorting to batteries, household current and other sources of electrical energy.

The device according to the present invention enables the production of a voltage in the range of several kilovolts by finger pressure to initiate ignition of a flame at the discretion of the lighter user.

At the same time, the device according to the present invention automatically presents the piezo-electric transducer crystals from causing ignition of a flame as soon as the operator releases the stress generating mechanism of a lighter in which the igniter is utilized, and the electrodes which define the spark gap serve in this device as

a safety arrangement to render the igniter shockproof. In accordance with one feature of our invention, we provide a piezo-electric igniter, particularly a piezo-electric igniter which is suitable for use in lighters and the like. Our igniter comprises a transducer crystal having a pair of poles. Stress generating means is provided and is arranged to subject the crystal to compressive stresses in the direction of its piezo-electric axis whereby the crystal generates a voltage. Such stress generating means comprises actuating means which, in accordance with the invention, is movable from a starting position to a second position and during such movement effects compression of the crystal. A pair of electrodes are provided as a part of the novel piezo-electric igniter and are normally in current-conducting contact with each other. Each of these electrodes is connected with one of the poles of the crystal to short-circuit the latter, and one of the electrodes is movable away from the other electrode in response to movement of the actuating means from the starting position to thereby terminate the current-conducting condition between the poles of the crystal.

The novel features which are considered as characteristic are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

Brief description of the drawing

The single figure is a longitudinal vertical section through a piezo-electric igniter which is constructed in accordance with our invention and which comprises a single pair of electrodes.

Description of the preferred embodiments

Discussing now the drawing in detail, it will be seen that the piezo-electric igniter shown therein comprises a U-shaped holder **24** and an insulator **25**, the latter being supported by the holder **24** and accommodating two reciprocable crystals **26, 27**. These crystals are piezo-electric crystals as will be understood and they are reciprocable in the direction of their common piezo-electric axis. An assembly **38** consisting of four dish-type springs is arranged between the outer pole of the crystal **27** which is shown on the left-hand side in the drawing, and a stress generating mechanism including an actuating lever **33** which is pivotable about the axis of a pin **43** fixedly provided on one end portion of the holder **24**. The holder further supports a block-shaped carrier **36** for an adjustable stop screw **35** whose tip bears against a stress transmitting plate **34** adjacent to the outer pole of the crystal **26**.

The assembly of springs **38** is disposed between a pair of stress transmitting plate members **37, 39**, of which the member **37** bears against the outer pole of the crystal **27**. The member **39** in turn bears against a circular stress transmitting disc **40** which engages a shoulder **41** of the lever **33**, such shoulder being provided on a plate-like insert **42** which is rigid with the lever **33** and may be considered as an integral part of the latter. The plate **28** between the inner poles of the crystals **26, 27** is a conductor and is connected to a conductor wire **29** which leads to an electrode **30**. This latter is normally in contact with a second electrode **31** provided at the lower end of a bracket **32** which is rigid with the head of the lever **33**. When the dishes of dish-shaped springs of the assembly **38** are free to expand, the lever **33** is maintained in the starting position shown in the drawing, and the electrode **31** bears against the electrode **30**, thus connecting the opposite poles of the crystals **26** and **27** with one another. The electrode **31** on the other hand is conductively connected with the holder **24** through the lever **33** and pin **43** and the outer poles of the crystals **26, 27** are also conductively connected with the holder in the manner which is evident from the drawing. Reference to the "outer poles" of course designates the poles which face away from each other in direction of the common piezo-electric axis of the crystals **26, 27**.

Operation of the ignition system according to the present invention will be clear from the drawing and from what has been described so far. Pressure on the lever **33** exerted in the direction of the arrow P, for instance by the fingers of an operator, causes the lever **33** to pivot in clockwise direction from the inoperative position shown in the drawing to its operative position. As a result, the disc **40** compresses the assembly **38** of dished springs. At the same time, the electrode **31** moves away from the electrode **30** to form therewith a spark gap. The plate **37** will begin to move in a direction towards the right hand side of the drawing once the springs of the assembly **38** seize to yield. Such movement of the plate **37** results in compression of the crystals **26, 27** which thereupon generate an electrostatic voltage. Generation of this voltage causes one or more sparks to jump across the gap between the electrodes **30, 31** and to serve to ignite a jet of gaseous fuel issuing from the fuel supply tank of the lighter, or if desired, to ignite a fuel impregnated wick or the like.

Releasing the lever **33** permits the same to return to its initial position as shown in the drawing because the springs of assembly **38** expand. Of course, the pressure upon the crystals **26, 27** decreases while this takes place and the crystals again generate an electrostatic voltage which produces again one or more sparks. These sparks naturally also jump across the now narrowing gap between the electrodes **30, 31**. When the lever **33** has returned to its starting position the opposite poles of the crystals are again connected to each other and the operator is thus fully protected against shock.

In accordance with the invention the lever **33** is made to undergo lost motion. To this end, the resilient assembly **38** of springs is provided which insures that the ignition arrangement will develop a spark gap between the electrodes **30, 31** before the crystals can undergo compression high enough to generate a voltage which will produce one or more satisfactory sparks. In other words, the assembly **38** prevents the ignition arrangement from producing sparks prematurely which would be unsatisfactory for an electric lighter. In view of the fact that the electrode **31** is closely adjacent to the pivot pin **33** and further because the angular movement of the electrode **31** subsequent to compression of the assembly **38** is negligible, the width of the spark gap between the electrodes **30, 31** remains substantially unchanged as soon as the springs of the assembly **38** seize to yield and the pivoting lever **33** causes actual compression of the crystals **26, 27**.

It will be understood that the ignition arrangement in accordance with the present invention can be modified in various ways without departing from the scope of the present invention. Thus, the stress generating mechanism illustrated may be replaced by another suitable type of mechanism, for instance a multi-stage toggle mechanism. It is also clear that the electrode **31** need by no means be directly connected to the lever **33** as long as it is assured that the electrode **31** will move away from the electrode **30** when the lever **33** is displaced in the direction of the arrow P. The insulator **25** may obviously consist of several sections, rather than of a single unit, and these sections may be movable with the crystals **26, 27** if this should be desired. The holder **24** may similarly be modified to permit installation of the ignition arrangement in various different lighter types.

It is clear that the ignition arrangement disclosed herein is exceptionally simple in its construction because the same pair of electrodes which define the spark gap is simultaneously used as a stop against excessive anti-clockwise movement of the lever **33** and as a means for connecting the opposite poles of the crystals to each other when the igniter is not in use. This arrangement

can be accommodated in very small lighters of different types because its simplicity of construction makes it not only rugged but makes it highly compact, it being clear that the absence of additional complicating components reduces the space requirements substantially.

It should be understood that the ignition arrangement according to the present invention may also be provided with a discharge resistance whose resistance value is such that it prevents discharge of the spark at a time when the crystal or crystals undergo either compressive or tensile stresses. The resistance enables the crystal to generate a spark subsequent to release of the actuating member, namely when the actuating member returns to its initial position. In other words, the spark may be produced one or more seconds after the lever **33** has been released by the operator. If such an arrangement is provided the crystal constitutes the capacitor of an R-C unit whose time constant may be readily selected by those skilled in the art in such a way that it exceeds the length of time necessary to complete a stress generating and relieving stroke.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of arrangements, differing from the types described above.

While the invention has been illustrated and described as embodied in a piezo-electric igniter, it is not intended to be limited to the details shown since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

1. In an electric lighter, in combination, a transducer crystal having a pair of poles; stress generating means arranged to subject said crystal to compressive stresses in the direction of its piezo-electric axis so that the crystal generates a voltage, said stress generating means comprising actuating means movable from an inoperative position to an operative position to thereby effect compression of said crystal, and biasing means permanently biasing said actuating means to said inoperative position thereof; and a pair of electrodes in current-conducting contact with each other when said actuating means is in said inoperative position thereof and each being connected with one of said poles to short-circuit said crystal, one of said electrodes being associated with said actuating means for movement away from the other electrode in response to movement of said actuating means from said inoperative position to terminate the current-conducting connection between said poles.

2. In a lighter as defined in claim **1**, wherein said electrodes are arranged to define with each other, in response to movement of said one electrode away from the other electrode, a spark gap for discharge of voltage generated on compression of said crystal.

3. In a lighter as defined in claim **1**, wherein said one electrode is connected with said actuating means for movement therewith.

4. In a lighter as defined in claim **1**, further comprising means for effecting movement of said actuating means with lost motion from said inoperative position to said operative position.

5. In a lighter as defined in claim **4** wherein said means comprises resilient spring means arranged in the path of movement of said stress generating means so as to effect said lost motion of said actuating means prior to compression of said crystal.

6. In a lighter as defined in claim **1**, wherein said electrodes each comprise a main body portion and an engaging portion, said engaging portions being normally in current-conducting contact with one another and defining said spark gap in response to movement of said one electrode; and insulating means insulating said main body portions from one another.

7. In a lighter as defined in claim **1**, wherein said one electrode is a movable electrode and the other conductor is a fixed electrode, said electrodes being arranged to automatically arrest said actuating means in said inoperative position thereof when said movable electrode engages said fixed electrode.

8. In a piezo-electric igniter, particularly for use in lighters and the like, in combination, a transducer crystal having a pair of poles; stress-generating means arranged to subject said crystal to compressive stresses in the direction of its piezo-electric axis so that the crystal generates a voltage, said stress-generating means comprising actuating means including a fixed pivot and an actuating lever pivotable about said fixed pivot from a starting position to a second position to thereby effect compression of said crystal; and a pair of electrodes normally in current-conducting contact with each other and each connected with one of said poles to short-circuit said crystal, one of said electrodes being movable away from the other electrode in response to movement of said actuating means from said starting position to thereby terminate the current-conducting connection between said poles.

9. In an igniter as defined in claim **8**, wherein said one electrode is connected to said actuating lever in close proximity to said pivot so as to move away from said other electrode in response to pivotal movement of said actuating lever from said starting position, said electrodes defining between themselves a spark gap when said lever is moved from said starting position.

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