

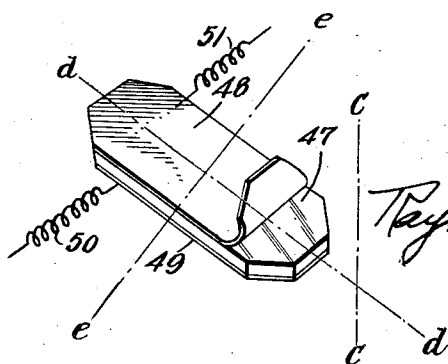
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R. W. TIBBETTS

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PIEZOELECTRIC DEVICE

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INVENTOR.

Raymond W. Tibbetts

UNITED STATES PATENT OFFICE

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PIEZOELECTRIC DEVICE

Raymond W. Tibbetts, Camden, Maine

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15 Claims. (Cl. 171-327)

This invention relates to a new and improved form of piezo-electric device for converting mechanical energy or vibrations into electrical energy or vice versa, and more particularly to a method of securing an electrode or electrodes to a soluble piezo-electric crystalline slab or plate or plates, and the resultant product.

One of the objects of my invention, and a very important one, is to apply the electrodes to the crystalline element in such a manner that they are in actual molecular contact with the surfaces of the crystalline element, thus reducing the impedance of the device greatly, since it is known that the specific inductive capacity of the Rochelle salt element or its substantial equivalent is very high when the electrodes are in actual molecular contact with the crystalline plate. A water electrode is usually considered the most ideal and is often taken as a standard since the water is in actual molecular contact with the surface of the crystalline element. Water however cannot be used with a soluble crystalline plate such as I use in my piezo-electric device. Due to the very high dielectric constant of Rochelle salt crystal any separation of the electrode and crystal surface will greatly reduce the inductive capacity of the assembly due to the much lower dielectric constant of the separating medium, as for example air or a cement substance used to secure the electrode to the surface of the crystalline plate. A further object of my invention is to secure foil electrodes to a piezo-electric crystalline plate such as Rochelle salt or other soluble substance having substantially the same properties, the electrodes being sufficiently thin and elastic to permit substantially free mechanical expansion and contraction of the crystalline plate when functioning as a piezo-electric element.

With the foregoing and other objects in view which will be readily apparent from the detailed description to follow and the appended claims, the present invention consists in an improved device for the conversion of mechanical energy into electrical energy or vice versa, and is especially adapted for acoustical apparatus, and a method of preparing it which will be readily understood by those skilled in the art to which the invention appertains.

The figure is a perspective view of a piezo-electric crystalline plate or segment thereof used in my invention showing a portion of one electrode detached and the other electrode attached, together with suitable conducting leads attached.

In the figure, I show a piezo-electric element

47 and the intimately attached electrodes 48 and 49. In the diagram I show the assembled element with one end of the electrode removed, in order that it may be more clearly understood.

5 In practice it is preferable to have the electrodes practically cover the plane surfaces perpendicular to the electrical axis $c-c$. It is desirable to have the capacitive impedance and thus the effective resistance as low as possible and to have the specific inductive capacity as high as possible, that is, the total impedance as low as possible. It is known that any separation of the electrodes from the surfaces of the crystalline element reduces materially the inductive capacity of the piezo-electric unit, furthermore it is desirable to use electrodes having as low an electrical resistance as possible, therefore with these objectives in view and to more fully utilize the mechanical and electrical principles of my invention I desire to describe a new method and principle which is part of my invention, whereby the electrodes are of a thin foil and are attached in such a manner that they are in actual molecular contact with the surface of the soluble piezo-electric crystalline material. In my experiments I have found a very suitable foil material in the commercial gold leaf used in the arts for gilding purposes. To attach the foil I wet the surface of the crystalline plate with pure water or with a solution of the crystals from which the piezo-electric plate is made, and while wet firmly apply the gold foil to the surface, pressing out any excess solution or moisture. Upon drying and/or crystallizing of the wetted surface adjacent to the foil, a firm bond is produced between the crystal surface and the foil electrode. I have found that gold foil or other metallic foil having an appreciably greater thickness than gold leaf does not have the same properties in that it does not become bonded as well to the surface of the crystal. It is therefore evident that the extremely thin gold leaf or foil commercially available having a thickness of approximately one-five hundred thousandth inch, possesses physical properties not to be found in thick foils. In all probability, although it has not been definitely proven, the molecules in the layer of gold are sufficiently few in number and have arranged themselves in such a manner, due to the beating process in its manufacture, that the molecules of the crystalline substance in solution intermingle with the molecules of gold, and upon crystallizing the commingling of the molecules produce an ideal bond. It is desirable that the electrodes be as elastic and as light as possible

to allow free motion and expansion and contraction of the crystalline element as possible, these two desirable properties are fully met with the gold leaf or foil I use. While either the so called loose leaf gold or the so called "patent" gold leaf, which is mildly secured to the tissue upon which it is placed, may be used, I prefer the "patent" type for my purposes, and after applying the gold leaf to the wet surface of the crystalline material to be electroded, applying slight pressure with a sponge rubber pad or other suitable cushion, upon the tissue back of the gold leaf, and after drying and/or recrystallization, strip off the tissue from the gold leaf adhering to the crystalline surface to be electroded. The foil electrodes may be any size or shape and there may be only one electrode or a plurality of electrodes attached to the same crystal element.

I prefer crystalline slabs or plates of Rochelle salt for the piezo-electric element and therefore the use of a solution of this salt in water or other solvent, as a medium for the attachment of the electrodes to the plate or plates. Inasmuch as a piezo-electric element is subjected to violent vibratory movements having a relatively low amplitude, it is necessary that the bond between the crystalline plate and its electrode be sufficiently great to prevent separation during the vibratory action and also to be great enough to mechanically secure other members to the plate. Therefore in order to determine these points I have made the devices contemplated by my invention and placed them in actual operation with complete success. In no case has the electrode separated from its crystal surface by vibratory action even in severe degrees of amplitude at frequencies between 10 and over 15,000 cycles per second. Mechanical bond tests have also been determined by actual measurement and it has been found that a gold leaf or foil electrode attached to a crystalline Rochelle salt surface has an ultimate strength before separating, with the force applied parallel with the surface of the crystalline element, of over 45 pounds per square inch of surface, and when the force is applied at right angles to the surface, an ultimate separating point of 27 pounds per square inch of surface. It is understood that I prefer Rochelle salt crystalline material for my piezo-electric device, however a material having substantially the same piezo-electric properties and physical and chemical properties which permit its use in conjunction with the foil electrodes and method of attaching same, may be used as the piezo-electric element.

Ordinarily I find the use of pure water or a water solution of the same crystalline substance from which the piezo-electric member or plate is made, the best medium for carrying out the principles herein disclosed for attaching the extremely thin foil electrode in molecular contact with the piezo-electric plate or plates, however under certain conditions it may be desirable to add a finely divided or colloidal substance to the solvent medium to add to the effective bond between the foil electrode or to its conductivity, or both, for example, colloidal graphite or colloidal gold may be added to the water solution, applying a thin layer to the crystalline plate and then firmly pressing or applying by any suitable means the thin foil electrode having the properties herein described, and upon recrystallization of the crystalline surface adjacent to the plate, cause an intimate and molecular bond be-

tween the plate surface and its electrode. I do not limit myself to the use of a water solution since any solvent capable of dissolving the surface of the crystalline element, or of making a solution of the crystalline substance, may be used.

While I have shown and described certain preferred embodiments of my invention, it is understood that modifications and changes may be made without departing from the spirit and scope of my invention, as will be understood by those skilled in the art.

What I claim is:

1. A method of making piezo-electric devices comprising bodies formed of homogeneous water soluble crystalline material of high specific inductive capacity and having electrodes on one or more surfaces thereof, said method comprising applying directly to the body surface to be electroded a thin coating of water or other solvent of the body material or a solution of the same material in a suitable solvent and applying under slight pressure a very thin metallic foil, such as gold leaf, having the property of forming with the recrystallized surface of the body material a molecular and intimate bond.

2. A method of making piezo-electric devices comprising in part, bodies formed of homogeneous soluble crystalline material of high specific inductive capacity and having electrodes on one or more surfaces thereof, said method comprising applying directly to the body surface to be electroded a thin coating of water or other solvent of the body material in which are suspended colloidal or very finely divided particles of a suitable conducting material such as colloidal graphite or colloidal gold, or a solution of the crystalline material identical to that of the crystalline piezo-electric body, to which a suitable conducting material of finely divided particles, either partially or wholly colloidal, has been added; and applying under slight pressure while the body surface is still wet, a very thin metallic foil, such as gold leaf, having the property of forming with the recrystallized surface of the body material and added colloidal substance, a molecular and intimate bond.

3. A piezo-electric device the combination of a soluble piezo-electric crystalline material and one or more metallic foil electrodes secured to the surfaces thereof, the electrode material having the property of adhering to the wet surface of the crystalline plate or plates, when dry, without the use of adhesive material, and causing an intimate and molecular bond throughout the surface electroded.

4. A piezo-electric device the combination of a soluble piezo-electric crystalline material and one or more composite electrodes attached to the surface or surfaces thereof, the electrode comprising in combination a finely divided and colloidal conducting material and a very thin metallic foil, the foil being the outermost layer; both the finely divided and colloidal conducting material and the foil being secured to the crystalline surface and to each other without the use of an adhesive cement, by virtue of the inherent property of the moist or wet colloidal conducting material.

5. A piezo-electric device as in claim 3, in which the electrode comprises a lead extension therefrom.

6. A piezo-electric device as in claim 4, in which the electrode comprises a lead extension therefrom.

7. A method of making piezo-electric devices comprising bodies formed of homogeneous soluble crystalline material of high specific inductive capacity and having electrodes on one or more surfaces thereof, said method comprising applying directly to the body surface to be electroded a solution of the body material and applying under slight pressure a very thin metallic foil having the property of forming with the recrystallized surface of the body material a molecular and intimate bond.

8. A method of making piezo-electric devices comprising bodies formed of homogeneous water soluble crystalline material of high specific inductive capacity and having electrodes on one or more surfaces thereof, said method comprising applying directly to the surface to be electroded of a Rochelle salt body a film of water and applying under slight pressure a gold leaf which has the property of forming with the recrystallized salt surface a molecular and intimate bond.

9. A method of making piezo-electric devices including bodies formed of homogeneous soluble crystalline material of high specific inductive capacity and having electrodes on one or more surfaces thereof, said method comprising applying directly to the body surface to be electroded a thin coating of a solvent of the body material in which are suspended colloidal or otherwise very finely divided particles of a suitable conducting material, and applying under slight pressure while the body surface is still wet a very thin metallic foil having the property of forming with the recrystallized surface of the body material and said particles a molecular and intimate bond.

10. A method of making piezo-electric devices including bodies formed of homogeneous soluble crystalline material of high specific inductive capacity and having electrodes on one or more surfaces thereof, said method comprising applying directly to the body surface to be electroded a solution of crystalline material identical to that of the piezo-electric body to which finely divided particles of suitable conducting material, either partially or wholly colloidal, have been added, and applying under slight pressure while the body surface is still wet a very thin metallic foil having the property of forming with the recrystallized surface of the body material and said particles a molecular and intimate bond.

11. A method of making piezo-electric devices including bodies formed of homogeneous water soluble crystalline material of high specific inductive capacity and having electrodes on one or

more surfaces thereof, said method comprising applying directly to the body surface to be electroded a film of water in which are suspended colloidal or otherwise very finely divided particles of a suitable conducting material such as colloidal graphite or colloidal gold, and applying under slight pressure while the body surface is still wet a very thin metallic foil, such as gold leaf, having the property of forming with the recrystallized surface of the body material and said particles a molecular and intimate bond.

12. In a piezo-electric device the combination of a body of soluble piezo-electric crystalline material and a metallic foil electrode secured to a surface of said body, the electrode material having the property of adhering without the use of adhesive material to a dry surface of said body to which it was applied while wet with its solvent, causing an intimate and molecular bond throughout the electroded surface.

13. In a piezo-electric device the combination of a body of piezo-electric Rochelle salt and a metallic foil electrode secured to a surface of said body, the electrode material having the property of adhering without the use of adhesive material to a dry Rochelle salt surface to which it was applied while water moistened, causing an intimate and molecular bond throughout the electroded surface.

14. In a piezo-electric device the combination of a body of soluble piezo-electric crystalline material and a composite electrode attached to a surface thereof, the electrode comprising a finely divided colloidal conducting material and a very thin metallic foil, the foil being the outermost layer, and both the finely divided colloidal conducting material and the foil being secured to said surface and to each other without the use of an adhesive cement, by virtue of the inherent property of the foil to adhere to the dry surface to which it was applied while wet.

15. In a piezo-electric device the combination of a body of piezo-electric Rochelle salt and a composite electrode attached to a surface thereof, the electrode comprising a finely divided colloidal conducting material and a very thin metallic foil, the foil being the outermost layer, and both the finely divided colloidal conducting material and the foil being secured to said surface and to each other without the use of an adhesive cement, by virtue of the inherent property of the foil to adhere to the dry Rochelle salt surface to which it was applied while wet.

RAYMOND W. TIBBETTS.