

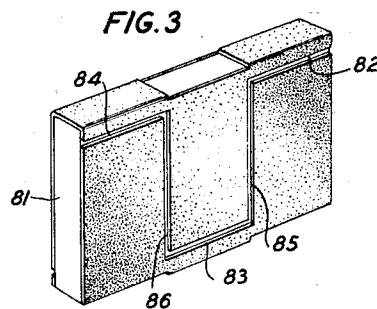
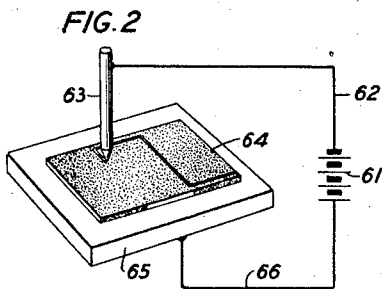
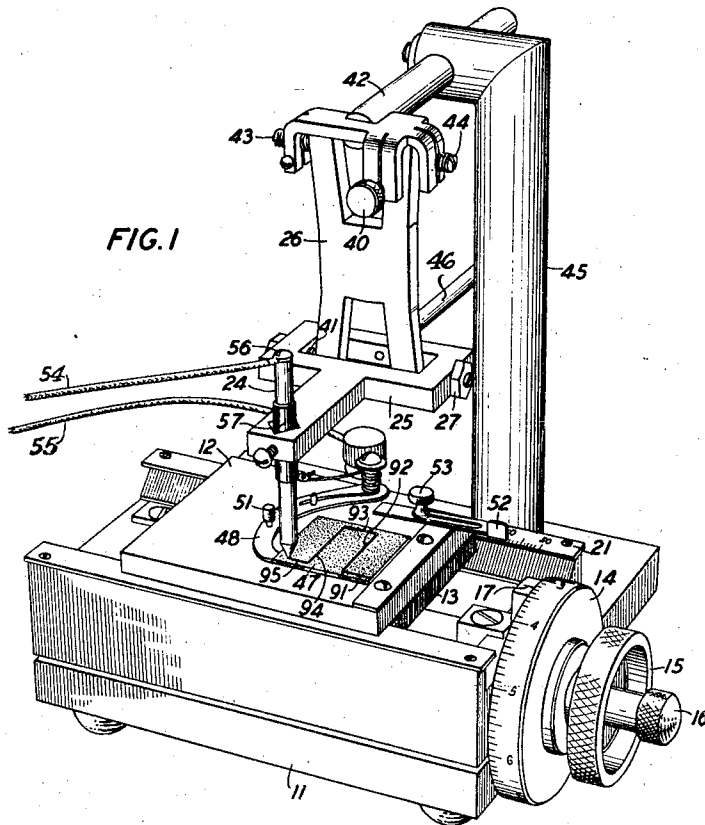
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ELECTRICAL CUTTING DEVICE

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## ELECTRICAL CUTTING DEVICE

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This invention relates to an electrical cutting device and particularly to a device for cutting and removing predetermined portions of the metallic coatings of objects such, for example, as the metallic electrode coatings of piezoelectric crystal plates.

An object of the invention is to facilitate the removal of predetermined portions of the metallic coatings of objects.

Another object of the invention is to facilitate the production of piezoelectric crystal plates.

A more specific object of the invention is to facilitate the removal of predetermined, narrowly defined portions of the metallic electrode coatings of piezoelectric crystal plates without damage to the remainder of the coating or to the crystal itself.

Piezoelectric crystal plates are, as is well known, commonly used as elements in electrical circuits where a constant frequency is essential, and are of increasing importance as elements in electrical filters and other networks. When these plates are used in such electrical circuits it is necessary, of course, that some means be provided whereby the plates may be electrically connected to the other elements of the circuit. It is common practice to provide, for this purpose, metallic electrode coatings on the surfaces of the crystal plates, these coatings being electrically conductive with respect to the surfaces to which they are applied. The external conductors of the circuit may then be conductively connected to the proper electrode coatings by suitable means.

In connection with the preparation of certain types of piezoelectric crystal plates, for example, the so-called "harmonic crystals" described in Patent 2,185,599 issued January 2, 1940, to W. P. Mason, entitled "Piezoelectric apparatus," it is desirable to divide the metallic coatings into a plurality of electrically distinct portions or patches; this may be accomplished conveniently by removing or erasing narrow portions of the coating in a series of narrow, definite, straight lines, certain of which lines may extend in a direction at right angles to the direction of others of said lines. The device of the present invention is particularly adaptable to the removal of the metallic coatings in such a manner.

In accordance with a specific embodiment of the invention, a stylus is movably supported over a work supporting table, a circuit for supplying current to the conductive stylus including as series elements the stylus, a potential source and the table, this circuit being completed through the metallic coating of the crystal when the crys-

tal is positioned on the table. It will be understood that the coating extends over both major surfaces of the crystal and over certain or all of the edges thereby affording the necessary completing link for the circuit. As the point of the stylus is moved over the face of the crystal the metallic coating contacted by the point of the stylus is burned away.

A feature of the invention is means for supporting the cutting stylus with respect to the crystal plate that a relative movement between the two may be attained that is effective to bring about removal of the electrode coating in a series of straight, narrow, well-defined lines certain of which lines are in a direction at right angles to others of said lines.

A complete understanding of the arrangement and operation of the device contemplated by the invention as well as appreciation of the various valuable features thereof may be had by consideration of the subsequent detailed description in connection with the drawing in which:

Fig. 1 is a perspective view of a device for removing predetermined portions of a metallic coating which embodies features of the present invention;

Fig. 2 is a schematic of the electrical circuit involved in the device of Fig. 1; and

Fig. 3 is a perspective, enlarged view of a third harmonic crystal, the coating of which has been divided into electrically distinct portions by use of the device of Fig. 1.

Referring now to the drawing, there is illustrated in Fig. 1 a machine which embodies features of the present invention, including a base 11 on which is mounted the work supporting table 12. The table 12 is supported on a carriage 13 which is driven by a micrometer screw in a horizontal direction parallel to the front edge of base 11. Knobs 14, 15 and 16 are provided for rotating the driving screw, knob 14 being provided with an index scale which, in conjunction with marker 17, indicates the extent of movement of the work-table. A second index scale 21 is also provided for this same purpose.

Stylus 24 is supported by a straight line link mechanism which includes a T-shaped member 25 and an H-shaped member 26, member 25 being rotatably mounted on member 26 by pivots 27 and 41 and member 26 being rotatably mounted on horizontal arm 42 by pivots 43 and 44. Horizontal arm 42 is supported by vertical arm 45 which, in turn, is mounted on base 11. Pivots 27, 41, 43 and 44 are so adjusted as to permit free relative movement of members 25 and 26 and

yet to prevent any "back-lash" of the members. Forward movement of member 26 may be limited by adjustment of thumb screw 40.

Stylus 24 may be of any suitable conducting material such as carbon or metal. The tip may be tungsten carbide, for example, it having been found by applicant that a tip of this material resists wear and does not burn away readily.

A counter-balancing arm 46 is mounted on the rear edge of T-shaped member 25 and serves to so balance the assembly that, while the point of stylus 24 is held in contact with the crystal during the normal relative movements of the stylus and crystal the pressure of the stylus on the crystal is very light at all times; if desired, weights of desired magnitude may be placed on arm 46.

Crystal plate 47 is shown mounted on work-table 12 being held in proper position by spring biased arm 48, a knob 51 being provided on arm 48 in order to facilitate movement thereof. A second arm 52 is slidably mounted on work-table 12 being held in desired position by thumb screw 53. After arm 48 has been set in desired position, the end of arm 52 may be brought into contact with the edge of arm 48 in order to prevent, by a camming action, further movement of arm 48.

Conductors 54 and 55 are provided for connecting the source of potential to the machine, conductor 54 being connected directly to stylus 24 by bolt 56 and conductor 55 being connected to the base of the machine and therethrough to work-table 12. Stylus 24 is electrically insulated from member 25 and the rest of the machine by a wrapping 57 of suitable insulating material.

The electrical circuit involved is illustrated schematically in Fig. 2 where we have a circuit from one side of potential source 61 through conductor 62 to stylus 24, through the stylus to the conductive coating of crystal plate 64 and from the coated plate to work-table 65, through conductor 66 to the other side of potential source 61. While potential source 61 has been shown as a battery, other sources of potential may be utilized, for example, potential may be supplied at a low alternating current voltage by means of a transformer.

In order to further illustrate the invention, let us assume that the machine of Fig. 1 is to be used in order to divide the metallic coating of a crystal plate as shown in Fig. 3. As shown in Fig. 3, the coating on the front surface of crystal plate 81 has been divided into two electrically distinct portions by cutting a thin line across the coating, this line comprising three straight portions 82, 83 and 84 extending in one direction, joined by two straight portions 85 and 86 extending in a direction at right angles thereto. Referring again now to Fig. 1, we will see how a line of this nature may be cut. Work-table 12 is first so positioned by rotation of micrometer screw adjusting knob 14 that the point of stylus 24 is just at the start of portion 81 of the desired line. Knob 14 is now rotated in the direction effective to cause horizontal movement of table 12 to the right, the table preferably being moved at the approximate rate of one inch per second. As plate 47 is moved along under the stylus point the metallic coating is burned away in a thin distinct line. As the end of portion 81 of the desired line is reached, motion of the table is stopped and stylus 24 is then moved by the finger towards the rear of the machine in a direction at right angles to the direction of the table movement in order to cut portion 82 of the desired line, stylus 24 also being moved at the

approximate rate of one inch per second. Rotation of H-shaped member 26 about pivots 43 and 44 permits stylus 24 to be moved in the manner described; T-shaped member 25 is enabled to retain a substantially horizontal position during this movement, however, due to its pivotal connection (27 and 41) to member 26. Member 25 is precisely counter-balanced by arm 46, and additional weights if necessary, so that the point of stylus 24 rests lightly on plate 47 during the movement of table 12 and the movement of the stylus itself. Upon completion of portion 82 of the line, the motion of stylus 24 is stopped and, while the stylus is held in position at the end of portion 82, knob 14 is again rotated in a direction to cause further horizontal movement of table 12 in the same direction as first moved in order to cut portion 83 of the desired line. As portion 83 is completed movement of the table is stopped and stylus 24 is then pushed with the finger in a direction opposite to that of the first movement of the stylus in order to cut portion 84 of the desired line. As the end of portion 84 of the desired line is reached stylus 24 is stopped and held in position, and knob 14 is again rotated to cause further horizontal movement of table 12 in the same direction as first moved in order to cut portion 85 of the desired line.

Applicant is uncertain at this time just what takes place at the point of contact between the metallic coating and the point of the stylus but believes that the coating is burned away although there is some reason to suspect that an arcing process is involved rather than a burning process. Regardless of the exact process involved, the fact remains that the coating is removed in a thin, well-defined line and that the crystal itself is not damaged in any way.

It will be clear from the above description that the device is effective in "drawing" precise straight lines on the coating of a piezoelectric crystal, certain of which lines are in a direction at right angles to the direction of the other lines. This has been found a particularly difficult task to perform with apparatus and methods used heretofore, for example, abrasive wheels. Moreover, the delicate structure of the crystal is not affected by the process; in the instance of methods used heretofore, for example, the acid etching method, the crystal has been found to be frequently damaged thereby. The drawing of straight accurate lines is facilitated by the particular mounting means provided for the stylus and the work-table whereby relative movements of the stylus and the crystal in a precise accurate manner may be obtained. Actual tests have shown that as many as ten distinct, well-defined lines per millimeter can be drawn on the coating of a crystal by the device of the present invention.

While a specific embodiment of the invention has been selected for illustration and detailed description, the invention is not, of course, limited in its application to the embodiment disclosed. The embodiment described should be taken as illustrative of the invention and not as restrictive thereof.

What is claimed is:

1. A device for electrically removing predetermined portions of electrically conductive material from an article coated therewith, comprising a base, an article supporting member movable laterally in a fixed path on said base, a conductive stylus, a straight line link mechanism for supporting said stylus above said article support-

ing member whereby said stylus is also movable laterally in a fixed path, the path of movement of said stylus being at right angles to the path of movement of said article supporting member, said straight line link mechanism including an H-shaped member and a T-shaped member, a standard supported on said base, means for rotatably supporting one end of said H-shaped member on said standard, means for rotatably supporting the wider end of said T-shaped member on the other end of said H-shaped member, and means for mounting said stylus on the narrower end of said T-shaped member.

2. A device for electrically removing predetermined portions of electrically conductive material from an article coated therewith, comprising a base, an article supporting member movable laterally in a fixed path on said base, a conductive stylus, a straight line link mechanism for

supporting said stylus above said article supporting member whereby said stylus is also movable laterally in a fixed path, the path of movement of said stylus being at right angles to the path of movement of said article supporting member, said straight line link mechanism including an H-shaped member and a T-shaped member, a standard supported on said base, means for rotatably supporting one end of said H-shaped member on said standard, means for rotatably supporting the wider end of said T-shaped member on the other end of said H-shaped member, means for mounting said stylus on the narrower end of said T-shaped member, and means mounted on said wider end of said T-shaped member for counterbalancing the weight of said stylus.

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