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PIEZOELECTRIC TRANSDUCER WITH LONGITUDINAL POLARIZATION

Original Filed Feb. 13, 1958

FIG. 1
PRIOR ART

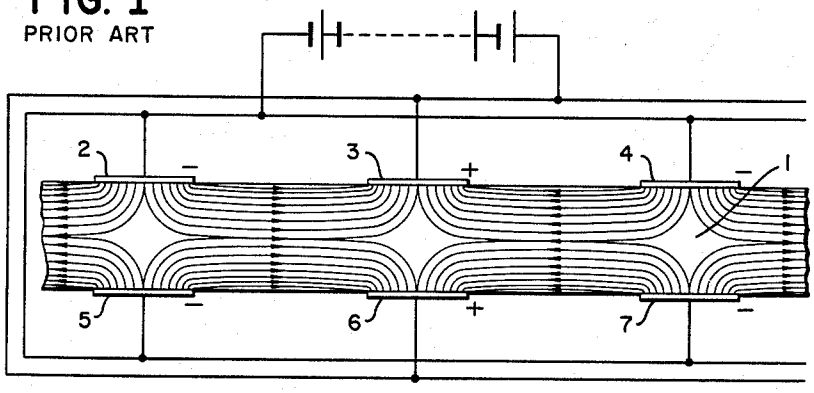
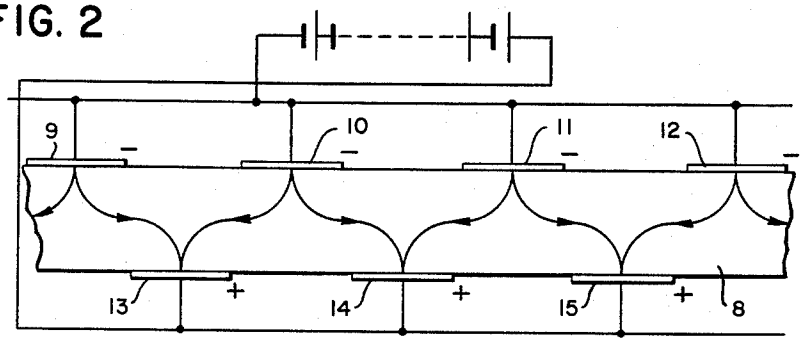


FIG. 2



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PIEZOELECTRIC TRANSDUCER WITH LONGITUDINAL POLARIZATION

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Original application Feb. 13, 1958, Ser. No. 715,044, now Patent No. 3,071,841, dated Jan. 8, 1963. Divided and this application Nov. 23, 1962, Ser. No. 247,780
3 Claims. (Cl. 310—9.8)

This application is a division of application Serial No. 715,044, filed February 13, 1958, now Patent No. 3,071,841, granted January 8, 1963.

The present invention relates to a method for the longitudinal pre-polarization of bodies consisting of at least one layer of homogeneous, polycrystalline, ceramic, piezo-electric material having remanent polarization properties, which pre-polarization occurs in a medium having a high breakdown-strength, the main faces of the layers being provided with a number of parallel electrodes located at right angles or substantially at right angles to the sense of polarization, while the polarization between adjacent pairs of electrodes is of opposite sense.

Such a method is known from U.S.A. patent specification 2,540,87. It has a limitation in that, due to the placement of the several electrodes, the bundle of lines of force produced during pre-polarization passes in part along the surface of the body beyond the material, which often causes arcing-over along the surface.

The method, according to the invention, in which this disadvantage occurs to a much lesser degree, consists in that one polarity of the polarization voltage is applied to the electrodes resting on one main face, and the other polarity is applied to the electrodes resting on the other main face between each two adjacent electrodes on the first-mentioned main face. In this manner advantage is taken from the fact that, as a result of said placement of the electrodes the whole bundle of lines of force passes through the material.

A further advantage of the method according to the invention over that according to said U.S.A. patent specification is, that for obtaining the same capacity, half the electrode surface is sufficient, while obtaining the same output voltage.

The invention is particularly advantageous when carrying out this method in pre-polarizing large numbers of such bodies simultaneously. As a matter of fact, in the aforesaid known method, the bodies are pre-polarized in a bath containing oil as a medium having a high breakdown-strength, a breakdown then rendering the bath unsuitable for a next polarization, so that large-scale production is not feasible. When using the method according to the invention this disadvantage occurs to a much lesser degree in large-scale pre-polarization, since, as mentioned above, the risk of arcing-over per se has already been reduced. In so far as arcing-over is still to be feared under these greatly improved conditions as may occur in practice, this can be met in a preferred form of the method according to the invention when using as a medium having a high breakdown-strength a gaseous medium, preferably a fluorochloromethane, for example CF_2Cl_2.

In order that the invention may be readily carried into effect, an example will now be described with reference to the accompanying drawing, in which

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FIG. 1 shows a member pre-polarized according to a known method, and

FIG. 2 shows a member pre-polarized with the aid of the method according to the invention.

In FIG. 1, the reference numeral **1** designates a body of ceramic, piezo-electric material, for example $BaTiO_3$, the main faces of which are provided with electrodes **2, 3, 4, 5, 6** and **7**. The electrodes **2, 3** and the electrodes **3, 4** on the upper main face each constitute a pair of electrodes, similarly the electrodes **5, 6** and **6, 7** respectively each constitute a pair of electrodes on the lower main face. In this known method, the pre-polarization is effected so as to be of opposite sense between adjacent pairs of electrodes (**2, 3** and **3, 4**). As a result of the placement of the several pairs of electrodes the bundle of lines of forces passes in part along the surface beyond the material, as represented schematically in FIG. 1. This often gives rise to arcing-over along the surface of the body.

FIG. 2 shows a body of ceramic, piezo-electric material the main faces of which are provided with electrodes **9, 10, 11, 12, 13, 14**, and **15**. The method according to the invention consists in that one polarity of the polarization voltage is applied to electrodes **9, 10, 11, 12** resting on the upper main face, while the other polarity is applied to the electrodes **13, 14** and **15** on the lower main face between the two upper adjacent electrodes on the upper main face. In this manner, the electrodes **9, 13** on the one hand and the electrodes **10, 13** on the other hand, constitute a pair of electrodes. As a result of this disposition of electrodes the whole bundle of lines of force passes through the material.

The electrodes **9, 10, 11, 12, 13, 14, 15** may be applied to the ceramic body by the normal techniques, such as described in the U.S.A. Patent 2,540,187 with respect to the electrodes **2, 3, 4, 5, 6, 7.**

What is claimed is:

1. An element for use in a piezoelectric transducer, comprising a ceramic, piezoelectric body, a plurality of spaced interconnected electrodes disposed on one of opposite faces of the body, and a plurality of spaced interconnected electrodes on the opposite face of said body, each of said latter electrodes lying between adjacent electrodes on the said one face, said body possessing alternating longitudinal polarization.

2. A piezoelectric element with longitudinal polarization comprising a ceramic, piezoelectric body, a plurality of spaced electrodes disposed on a first surface of said body, a second plurality of spaced electrodes on a second surface of said body opposite that of said first surface, each of said latter electrodes being disposed opposite a space between pairs of electrodes on said opposite surface, said body being polarized longitudinally in opposite directions between one electrode on one face and a pair of electrodes on the opposite face separated by a space opposite from said electrode.

3. A piezoelectric element as claimed in claim 2 in which the ceramic body is $BaTiO_3$.

References Cited in the file of this patent

UNITED STATES PATENTS

2,540,194	Ellett	Dec. 26, 1947
2,743,614	Mason	Apr. 17, 1956
2,953,755	Mattiat	Sept. 20, 1960