

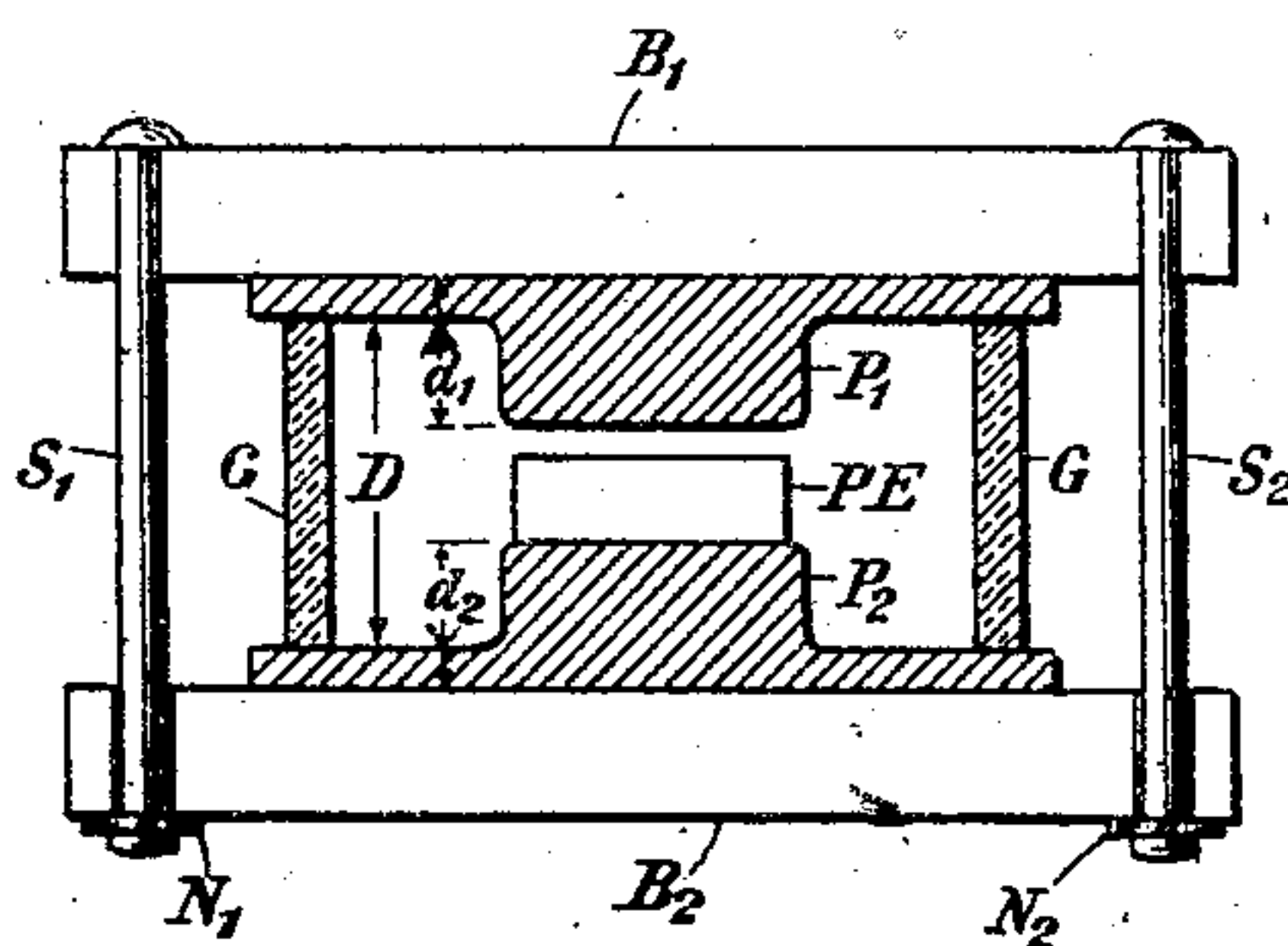
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MOUNTING FOR PIEZO ELECTRIC DEVICES

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MOUNTING FOR PIEZO-ELECTRIC DEVICES

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This invention relates to mountings for piezo-electric crystals or devices, and particularly to arrangements in such mountings for avoiding or greatly reducing the undesirable effects on the free vibratory period of the piezo-electric member caused by variations in the surrounding thermal conditions.

A piezo-electric device comprises a crystal of piezo-electric character which may be set into vibration between two conductive electrodes. When such a piezo-electric crystal is placed between the two conductive electrodes in such a way that a gap exists between one or both of the surfaces of the piezo-electric crystal and the corresponding conductive electrodes, so that the piezo-electric crystal may freely vibrate therebetween, the vibratory period of the piezo-electric crystal may be varied by changing the size of the gap between the piezo-electric crystal and the corresponding conductive electrodes. In experimenting with such a crystal, it has been found that as the size of the gap changed, the frequency of vibration of the piezo-electric crystal also changed within reasonable limits.

Heretofore, such a piezo-electric crystal was mounted between two metallic conductive plates or electrodes in some suitable mounting in such a way that the gap above mentioned was provided to permit the free vibration of the piezo-electric crystal. The size of the gap was found to be dependent upon the rigidity of some insulating material such as hard rubber, bakelite, etc., used for the base of the mounting. Moreover, in the mountings heretofore used, the external thermal variations brought about expansions and contractions of the elements of the mounting, causing uncontrollable changes in the size of the gap existing between the piezo-electric crystal and its corresponding conductive plates or electrodes. Due to such changes in the external thermal conditions, the piezo-electric crystal continually assumed a different vibratory period.

One of the principal objects of this invention is the provision of means in some form of a mounting for a piezo-electric device wherein the undesirable effects of temperature variation on the free vibratory period of the

piezo-electric crystal contained therein are avoided or substantially reduced.

While this invention will be pointed out with particularity in the appended claims, the invention, itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing, showing a cross-sectional view of a mounting for a piezo-electric device and the enclosed piezo-electric crystal, which drawing is shown herein merely for the purpose of illustration.

Referring to the drawing, two bases, the upper and lower bases are designated by the reference characters B_1 and B_2 , respectively. These bases may be of any material whatsoever, but these are preferably of some insulating material such as hard rubber, bakelite, porcelain, glass, etc. Cemented or otherwise suitably fastened to the bases B_1 and B_2 are two electrodes P_1 and P_2 , respectively, these electrodes forming the means for the transmission or reception of electric current to or from a piezo-electric crystal PE mounted between these electrodes. It will be understood that these electrodes P_1 and P_2 may be of any material whatsoever but that they are preferably of some conductive material such as brass, steel, nickel, etc. The device of piezo-electric character PE is so placed between the conductive electrodes P_1 and P_2 that a gap of, for example, air, exists between one or both of the surfaces of the piezo-electric device PE and the adjacent conductive electrodes P_1 and P_2 . This gap permits the free vibration of the piezo-electric device at a characteristic frequency. Yet, by changing the size of this gap, the vibratory period of the piezo-electric device PE may be effectively changed.

In order to separate the electrodes P_1 and P_2 from each other by some predetermined distance, a tube or cylinder G is employed, this tube or cylinder being preferably coaxial with the piezo-electric device PE and also coaxial with the adjacent conductive electrodes P_1 and P_2 . This tube or cylinder G may be of any material whatsoever, but it is preferably of some such insulating mate-

rial as glass, porcelain, etc. The thickness
 and general lateral proportions of the tube
 or cylinder are of such size that the capacity
 between the electrodes P_1 and P_2 , due to the
 presence of this tube or cylinder, is substan-
 tially negligible as compared to the capacity
 between the electrodes P_1 and P_2 through
 the piezo-electric device PE and the adja-
 cent gap. The length and general longitu-
 dinal dimensions of the tube or cylinder G are
 so proportioned with respect to the longi-
 tudinal proportions of the conductive elec-
 trodes P_1 and P_2 , and the linear coefficients
 of thermal expansion of the tube or cylinder
 G and the conductive electrodes P_1 and P_2
 are so chosen, that any change in the longi-
 tudinal dimensions of the conductive elec-
 trodes P_1 and P_2 due to any variation in the
 external temperature conditions, will be
 equal and opposite to the change taking place
 in the longitudinal dimensions of the tube or
 cylinder G. In other words, a change in the
 longitudinal dimensions of the conductive
 electrodes P_1 and P_2 due to an external tem-
 perature variation, will be substantially
 equal and opposite to the change in the longi-
 tudinal dimension of the tube or cylinder
 G due to the same external temperature va-
 riation. Assuming that d_1 and d_2 represent,
 respectively, the effective longitudinal di-
 mensions of the conductive electrodes P_1 and
 P_2 , respectively, and that D represents the
 longitudinal dimension of the tube or cylin-
 der G, and furthermore, assuming that K_1
 and K_2 represent, respectively, the linear co-
 efficients of thermal expansion of the con-
 ductive electrodes P_1 and P_2 and of the tube
 or cylinder G, then the relationship above
 mentioned may be expressed algebraically as
 follows:

$$(d_1 + d_2) \times K_1 = D \times K_2$$

As the external temperature rises, the dis-
 tance between the conductive electrodes P_1
 and P_2 will decrease, and vice versa. Fur-
 thermore, as the external temperature rises,
 the longitudinal dimension of the tube or
 cylinder G will increase, and vice versa. The
 general physical proportions of the tube or
 cylinder G and conductive electrodes P_1 and
 P_2 are so chosen that the products of any
 changes in their longitudinal dimensions and
 their corresponding linear coefficients of
 thermal expansion will be substantially
 equal. Yet, it will be understood that these
 products may be varied so as to bear some
 fixed relationship to each other to bring
 about any desired change in the size of the
 gap existing between the piezo-electric de-
 vice PE and the adjacent conductive elec-
 trodes P_1 and P_2 , when a change takes place
 in the external thermal conditions, all of
 which is within the scope of this invention.

While this invention has been shown and
 described in one particular embodiment
 merely for the purpose of illustration, it will

be understood that the general principles of
 this invention may be embodied in other and
 widely varied organizations without depart-
 ing from the spirit of the invention and the
 scope of the appended claims.

What is claimed is:

1. A mounting for a piezo-electric device
 which shall be substantially free from exter-
 nal thermal variations, comprising two me-
 tallic electrodes disposed so that the piezo-
 electric device may freely vibrate therebe-
 tween and so that there will be a longitudinal
 movement of the faces of said electrodes due
 to external thermal variations, and a tube
 surrounding the piezo-electric device and co-
 axial therewith maintaining the metallic elec-
 trodes a fixed distance apart, said tube pro-
 ducing a longitudinal movement due to said
 external thermal variations equal to that of
 the faces of said metallic electrodes.

2. Piezo-electric apparatus comprising two
 metallic electrodes affected by temperature,
 a piezo-electric device located between said
 electrodes, an air-gap being provided between
 said device and one of said electrodes, and a
 cylinder coaxial with the piezo-electric de-
 vice and separating the metallic electrodes by
 a definite distance, said cylinder being so pro-
 portioned that any external thermal varia-
 tion may produce a linear movement of the
 faces of the metallic electrodes substantially
 equal and opposite to the linear movement of
 the cylinder separating the faces of the me-
 tallic electrodes.

3. Piezo-electric apparatus comprising two
 metallic electrodes, a piezo-electric device so
 placed therebetween that a gap is provided
 to permit the free vibration of the piezo-elec-
 tric device, a cylinder coaxial with the piezo-
 electric device separating the metallic elec-
 trodes by a predetermined distance during
 normal external conditions, the product of
 the sum of the projecting lengths of said me-
 tallic electrodes and their coefficient of ther-
 mal expansion bearing a fixed relationship
 to the corresponding product of the length of
 the cylinder and its coefficient of thermal ex-
 pansion.

4. Piezo-electric apparatus comprising a
 pair of bases of insulating material, a pair of
 metallic electrodes permanently fixed, respec-
 tively, to said bases, a piezo-electric device
 placed between said metallic electrodes, said
 metallic electrodes being spaced so that a gap
 exists between the piezo-electric device and
 the surface of one of the adjacent metallic
 electrodes so that the piezo-electric device
 may assume a characteristic frequency and
 freely vibrate at that characteristic fre-
 quency, and a tube of refractory material sur-
 rounding the metallic electrodes and the
 piezo-electric device and separating the said
 metallic electrodes by some predetermined
 distance, the tube and the metallic electrodes
 being so chosen and so proportioned that

said predetermined distance between said metallic electrodes will remain constant during any change in the external thermal conditions.

distance between said metallic electrodes, thereby maintaining the size of the air gap constant.

In testimony whereof, I have signed my name to this specification this 21st day of September, 1926.

RUSSELL S. OHL.

5 5. The combination of a pair of metallic electrodes, and a hollow cylinder so arranged as to maintain the metallic electrodes a predetermined distance apart, said cylinder being so proportioned that the effective distance
10 between said metallic electrodes will be substantially independent of temperature variations.

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15 6. The combination of a pair of metallic electrodes which are affected by temperature variations and dielectric means having a predetermined coefficient of thermal expansion for maintaining said metallic electrodes a predetermined distance apart and so that
20 the spacing of said electrodes will be substantially unaffected by said temperature variations.

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25 7. A mounting for a piezo-electric device comprising a pair of electrodes spaced a predetermined distance apart so that a gap exists when the piezo-electric device is placed
therebetween, both of said electrodes changing in their lengths with temperature variations and tending to correspondingly change the size of said gap, and means of dielectric
30 character having a predetermined coefficient of thermal expansion for maintaining said distance independent of variations in the condition of the surrounding medium.

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35 8. Piezo-electric apparatus comprising two metallic electrodes, a piezo-electric device located between said electrodes, a gap being provided due to the spacing of the electrodes which is greater than the thickness of said piezo-electric device so that the
40 piezo-electric device may vibrate freely therebetween, a cylinder of dielectric material coaxial with the piezo-electric device separating the metallic electrodes by a predetermined distance, the product of the sum
45 of the projecting lengths of the metallic electrodes and their coefficient of thermal expansion equalling the corresponding product of the length of said cylinder and its coefficient of thermal expansion.

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50 9. Piezo-electric apparatus comprising a pair of metallic electrodes both affected by temperature, a piezo-electric device located between said electrodes, said metallic electrodes being placed so that a gap exists between said metallic electrodes and the piezo-electric device permitting the free vibration
55 of the piezo-electric device, a cylinder coaxial with the piezo-electric device and separating said metallic electrodes by a fixed and predetermined distance, said cylinder being of such a longitudinal dimension and of such a material that any change in the thermal conditions
60 tending to produce a change in its longitudinal dimension will be substantially balanced by a corresponding change in the

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