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TRANSDUCER CONSTRUCTION AND METHOD

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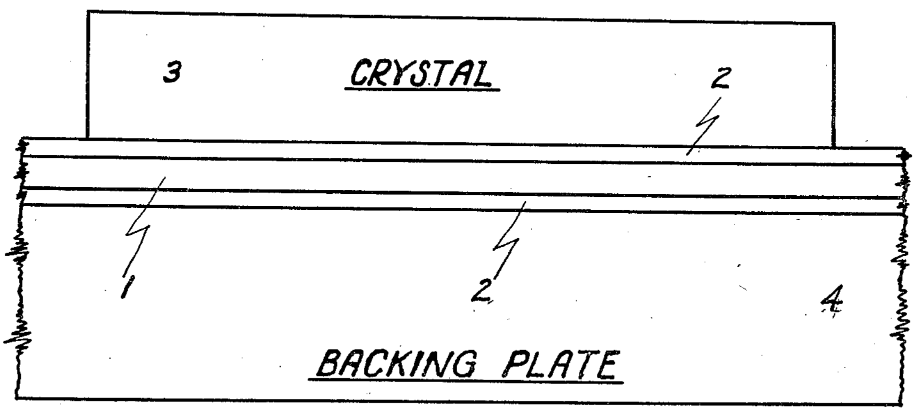

FIG. 1

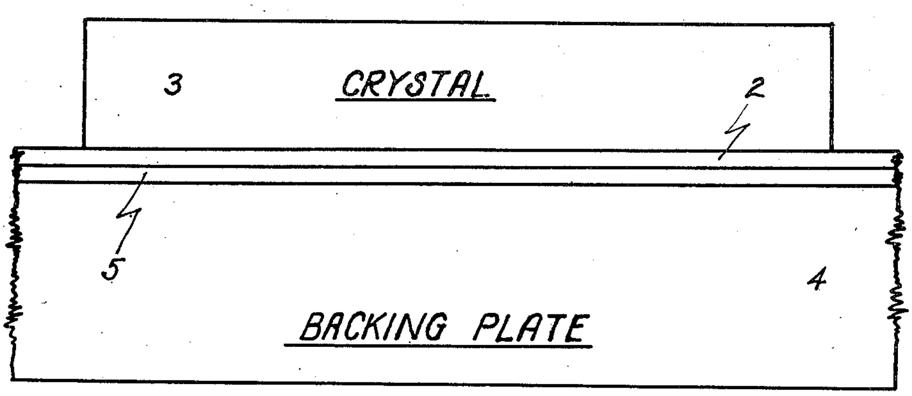

FIG. 2

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TRANSDUCER CONSTRUCTION AND METHOD

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This invention relates to a crystal transducer mounting and method.

In the past, considerable difficulty has been met in providing a proper bonding surface for Rochelle salt or other piezo-electric crystals when the same are bonded to a metal plate and used to convert electrical to sound energy and vice versa. Not only is it desirable to have a flat backing surface to which the crystals may be attached, but it is equally important that the surface be one capable of insuring a fast bond between the plate and the crystals. Likewise, good practice requires that the electrical characteristics of the bond be such as to insulate, insofar as possible, the crystals from the backing plate and to reduce the distributed capacity between the two.

Past practice has generally involved gluing a layer of some insulating material to the backing plate and subsequently gluing the crystals to this layer of material. The result in many cases, when the insulating material possessed the proper electrical characteristics, was that it did not provide the necessary elasticity to transmit the vibrations of the crystals to the backing plate; and when the necessary stiffness was present, reduction of capacity and proper insulation were not accomplished.

The old method also involved the use of two glued joints, which joints were found, in practice, to be the weakest points in transducer construction, in addition to providing an important source of energy dissipation. It also produced undesirable discontinuities in the mechanical impedance between the plate and crystals.

One of the objects of my invention is a method of overcoming the above objections by providing a vitreous enamel layer on the backing plate, to which the crystals are cemented.

Another of the objects of my invention is a crystal transducer having a layer of vitreous enamel between the crystals and backing plate.

A further object of my invention is to provide a more satisfactory surface for cementing crystals to backing plates.

A still further object of my invention is to provide an insulating layer between crystals and backing plates in transducers.

An even further object of my invention is a device and method for reducing the distributed capacity between transducer crystals and the adjacent backing plate.

Yet another object of my invention is a construction and method for mounting transducer crystals on backing plates which utilizes a single cemented joint.

And still another object of my invention is a

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transducer and method of construction in which the crystals are attached to the backing plate by means of a bond having substantially the characteristics of the backing plate so as to eliminate discontinuities in the mechanical impedance between the two.

Another object is the provision of a mounting of the crystal which will be economical to manufacture, reliable in operation and which possesses all of the qualities of ruggedness and dependability in service.

Other objects and features will become apparent upon a careful consideration of the following detailed description when taken together with the accompanying drawings, the figures of which are designed for the sole purpose of illustration and not as a definition of the limits of the invention, reference for the latter purpose being had to the appended claims.

In the drawings:

Figure 1 represents the mounting of the prior art.

Figure 2 illustrates the mounting of this invention.

In Figure 1, the prior art shows that the backing plate **4** has a layer of glue **2** upon which is placed a layer of insulating material **1**. Another layer of glue **2** is placed upon the insulating material and on this the crystal **3** is mounted. Obviously, the two layers of glue and the insulating material are weak spots in this prior art, and the elimination of one or more of them results in an improved mounting.

In Figure 2, this invention consists in the placing of the vitreous enamel **5** on the backing plate **4** as the layer of insulating material. The insulating material and the backing plate are integral, thus giving a stronger and a lower loss mounting for the crystal. The single layer of glue **2** is placed upon the vitreous enamel and on this rests the crystal **3**.

It is elementary in transducer construction that a relatively elastic plate, ordinarily of metal, is provided as a seat for the crystals. This plate, to which the crystals are attached, is securely mounted in the transducer housing and energy is transmitted, by movement of the crystals, to the surrounding medium, which may be air, water, oil, etc. Since the primary purpose of the plate is to provide inertia for the system to insure the transmission of the energy to the medium, it is necessary that the joint between the crystals and plate be as nearly elastic as the plate as possible. In other words, insofar as possible, discontinuities in the mechanical impedance must be avoided.

I have found that a layer of vitreous enamel bonded to the plate serves as an excellent joint between the crystals and plate. It overcomes the difficulties outlined above because insofar as its elastic qualities are concerned, it substantially resembles the backing plate. It prevents the undesirable dissipation of energy occurring at the joint and functions much as though the crystals were attached directly to the plate; except that it provides the necessary insulation and reduction of capacity required.

For this purpose, I find that of the known vitreous enamels, including those products sold under the trade-names of "Steatite" and "Isolanite," porcelain enamel serves very well. Because of this, I have chosen to limit my specific description to porcelain enamel; but it is to be clearly understood that I intend to claim the broader classifications, including vitreous enamels and low loss porcelains.

I have found that either of two methods of processing the backing plate with porcelain enamel may be utilized. These are conventionally known as the "wet" and "dry" porcelainizing processes. Both will be described herein, but it is to be understood that either furnishes the desired bond.

In the dry process, the backing plate, which may be steel, cast iron, meehanite or other satisfactory material, is first thoroughly cleaned of all surface dirt. This is preferably done by sand blasting to insure the cleanest possible surface. The plate is then sprayed with a ground or primer coat which serves as a bond between the metal and the subsequent porcelain coats. The ground coat is allowed to dry completely and the plate is then heated until it reaches a temperature of about 1600° F. For this purpose, a muffle-type furnace has been found to be very useful. After the plate reaches 1600° F., it is removed and powdered porcelain is sprinkled onto the surface by means of vibrating sieves and this powdered porcelain immediately fuses onto the metal when it contacts the heated surface. It is important that the powdered porcelain be applied immediately after the plate is brought from the furnace because the porcelain will not adhere to the surface after the temperature has dropped to about 1200° F. If this should happen, the plate must be returned to the furnace and the process repeated.

As a matter of fact, I have found that owing to the rapid loss of heat, two or more applications of porcelain are necessary to insure a completely opaque coating.

As the porcelain contacts the hot surface, it slowly melts and flows into a solid glassy coating which, when completely cold, is as durable and hard as ordinary glass and ready for use.

It should also be noted that the powdered porcelain is composed of the well-known ceramic chemicals, including borax, sodium nitrate, zinc oxide, sodium carbonate, feldspar, flourspar, lead oxide, cryolite, antimony compounds and other related compounds. It is made by smelting these compounds together into a fluid state which fluid is directed to run into a tank of cold water where it is immediately quenched and shatters into minute particles. These particles are then dried and milled to a fineness of 150 mesh.

The alternative or "wet" process consists in annealing the plate for approximately ½ hour at a temperature of approximately 1500° F. The sandblast process is then used to thoroughly clean the plate and remove all rust, scale, etc. A black enamel porcelain coat, composed of milled glass, Valendar clay, black oxide, sodium nitrate, gum tragacanth, and water, is then sprayed onto the plate. It is then heated in an oven to dry out the water and brushed to break open any bubble formation. In the next step, a second coat of porcelain is sprayed on and this is fired at about 1300° F. for approximately 1 hour. Three more similar coats are applied but each successive coat is fired at a temperature 20° less than the preceding one.

The thickness of the layer of porcelain enamel which I have found desirable is from 1/64'' to 1/32''. This may be varied, particularly depending upon the amount by which it is desired to reduce the electrical capacity between the plate and crystals. The layer as it comes from the last heating step should be slightly thicker than is finally desired.

The porcelain layer is then lapped, preferably by hand, by means of a piece of heavy glass using carborundum, provided with a suitable liquid containing no water (benzine, carbon tetrachloride, for example), as an abrasive. The layer is lapped down to give a truly flat surface and the desired thickness. Perfect smoothness is not an advantage as small variations and discontinuities serve to made a stronger bond.

The surface is then thoroughly cleaned and several thick coats of a Bakelite cement (such as "Bakelite cement 6052" or "Vulcalock") are sprayed or brushed on. Each coat is allowed to dry to a sticky consistency before the next is applied. A similar coat is applied to the joining surface of the crystals which has been milled while the crystals were held in place by a jig. This coat is allowed to dry in a similar manner after which one additional coat is brushed on to either the porcelain or crystal surface. The crystals, preferably still mounted in the jig, are then positioned on the plate and pressure is applied by means of a press or weight to force the crystals against the plate. This pressure need not be great, 5 to 10 pounds per square inch being sufficient, if maintained for 15 to 30 minutes, or sufficient time to allow plastic flow between the two partially dried layers of cement.

The above described process produces an excellent bond for the crystals and one which will withstand hard usage whether or not the transducer is used in air or water. This, I believe, is due primarily to the fact that one joint is eliminated and the single remaining joint is made between the crystal and the porcelain surface, which, in addition to being as flat as a metal surface, is considerably more effective in producing a bond because of its roughened and slightly porous surface.

The discontinuities in mechanical impedance caused by ordinary bonds are eliminated and the unit acts substantially as though the crystals were cemented directly to the backing plate. Also reduction of capacity between plate and crystals is accomplished and a high resistance is introduced between the two elements.

Having described my invention, I claim:

1. A crystal-type transducer comprising a backing plate, a layer of vitreous enamel bonded to one face of said plate, and a piezo-electric crystal bonded to said layer of vitreous enamel.

2. A crystal-type transducer comprising, a backing plate, a layer of vitreous enamel bonded to one face of said plate, and a piezo-electric crystal cemented to said layer of vitreous enamel.

3. A crystal-type transducer comprising a back-

ing plate, a layer of porcelain enamel bonded to one face of said plate, and a piezo-electric crystal cemented to said layer of porcelain enamel.

4. A crystal-type transducer comprising a backing plate, a layer of porcelain enamel bonded to one face of said plate, and a piezo-electric crystal bonded to said layer of porcelain enamel.

5. A method of attaching a piezo-electric crystal to a backing element to make a transducer, comprising, enameling at least one surface of said element, lapping said enameled surface, and cementing said crystal thereupon.

6. A piezo-electric crystal mounting comprising a backing plate, a layer of insulating material fused onto a surface of said plate, and means bonding the crystal to the insulating material.

7. The method of attaching a piezo-electric crystal to the surface of a metallic backing element comprising the steps of heating said backing element to a temperature of about 1600° F., sprinkling at least one layer of a powdered fritted enamel on one surface of said heated element, fusing said applied layer on said surface, lapping said enameled surface to a true, flat surface, cleansing the lapped surface, applying a coating of an adhesive cement to said lapped surface and to a surface of said piezo-electric crystal and pressing the cemented surface into contact with the cemented surface on said backing element to firmly bond said piezo-electric crystal thereto.

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