

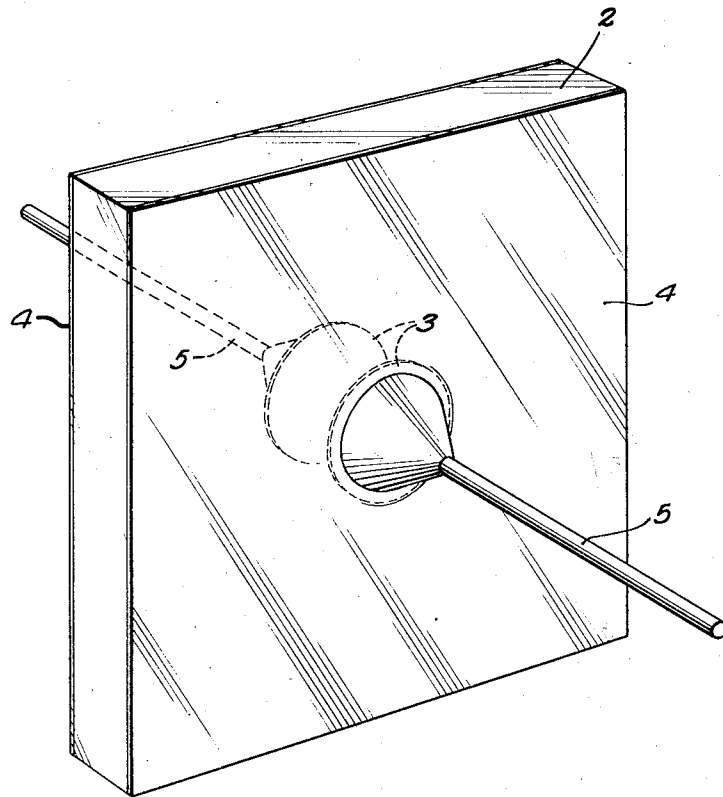
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METHOD OF MAKING PIEZOELECTRIC CRYSTALS

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METHOD OF MAKING PIEZOELECTRIC CRYSTALS

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This invention relates to a method of making piezoelectric crystals and more particularly to a method of spotting piezoelectric crystals to provide anchors by which lead wires may be securely attached to the crystals.

In the manufacture of electric communication apparatus, it is sometimes desirable to employ piezoelectric crystals as frequency control devices. Where it is necessary to establish direct contact with these crystals, it is sometimes the practice to plate the sides of the crystals with a metallic compound and then to attach conducting lead wires to either side of the crystals at the nodal point thereof. These wires also serve to support the crystals.

In assembling these crystals and in the course of later use, the crystals may be subjected to considerable vibration and to mechanical shocks which may place a severe strain on the bonds between the crystals and the supporting lead wires. Occasionally these lead wires may part from the crystal and thus render the crystal unsuitable for use. In order to provide a better anchor for these lead wires than is afforded by the plated crystal surface, it has sometimes been the practice to provide either side of the crystal with a spot of a metallic paste which may contain varying amounts of lead, tin, silver, bismuth and lead borate, among other ingredients. Such a spot, when fired, does provide a better surface for the lead wires to be soldered to than does an ordinary plated surface. However, for some uses, this method has been found inadequate to provide anchors for the lead wires which will withstand the severe mechanical shocks and vibrations which may be encountered. Often, upon examination of defective crystals, it will be found that the spot itself has separated, the upper layer adhering to the end of the lead wire while the lower layer adheres to the surface of the crystal.

An object of the present invention is to provide an efficient and effective method of spotting piezoelectric crystals to provide secure anchors by which lead wires may be attached to the crystals.

In accordance with one embodiment of this invention, a spot of conducting material containing a vitrifiable binder may be applied to either side of a quartz crystal. The spot is dried and pressed under high pressure. The crystal is then baked at a high temperature to vitrify the binder.

Other objects and advantages of this invention will be apparent from the following detailed description taken in conjunction with the single

figure which is an enlarged perspective view of a spotted crystal having lead wires attached to either side.

In accordance with this invention, a quartz crystal 2, as shown in the drawing, may be etched in a bath of a suitable etching material, such as hydrofluoric acid, to roughen slightly the surface of the crystal. The etched crystal is then rinsed and dried and a small spot 3 of a suitable bonding compound containing conducting particles and a vitrifiable binder may be applied to each side of the crystal and preferably at the nodal points of the crystal. This bonding compound may contain, for example, lead, tin, silver and bismuth particles, among other materials, and a vitrifiable binder such as lead borate, as described.

The spotted crystal is then dried on a hot plate, which may have a surface temperature between 500° F. and 700° F., for approximately one minute. This drying time may be made longer or shorter as may be required to dry the surface of the spot. However, the crystal should be removed from the drying plate while the spot is still in a semi-liquid form; that is, before the conducting particles and the vitrifiable binder, e. g. lead borate, have segregated into layers. The crystal is then transferred to a suitable pressure device whereby pressure on the order of 4500 pounds per square inch is applied to the spots to compact the materials therein and to prevent segregation of these materials.

The crystal is then returned to the hot plate to dry for approximately thirty minutes, the hot plate being heated to the same surface temperature as before. In this way, substantially all moisture is removed from the spot. Then the crystal is placed in an oven and the spot fired for a sufficient time and at a sufficient temperature to vitrify the binder. With lead borate, a firing time of thirty minutes at a temperature of from 970° F. to 990° F. gives satisfactory results. With materials other than lead borate, higher or lower firing temperatures may be required. The purpose of the baking is primarily to vitrify the binding material which forms thereafter a glass-like bond for the metallic components of the spot. With suitable compacting apparatus, it would, of course, be feasible to apply sufficient heat to the crystal in the compacting apparatus to complete the drying or to vitrify the binder.

After the crystals have been spotted on both sides and the spot baked to the desired degree, a thin plating 4 of silver, or other conducting material, is applied to either side of the crystal to

serve as an electrode therefor. Lead wires 5 may then be soldered to the spots 3 on either side of the crystal to provide a mechanical support for the crystal and to serve as electrical conductors.

While but one embodiment of this invention has been shown and described, it will be understood that many changes and modifications may be made therein without departing from the spirit and scope of the present invention.

What is claimed is:

1. A method of spotting a piezoelectric crystal comprising applying a spot of a bonding compound to a side thereof, pressing said spot, and heating said crystal sufficiently to fuse said spot.

2. A method of spotting a piezoelectric crystal comprising applying a spot of a vitrifiable bonding paste to a side thereof, heating said crystal to dry the surface of said spot, pressing said spot to compact the materials therein, and heating said crystal sufficiently to vitrify said spot.

3. A method of spotting a piezoelectric crystal comprising applying a spot of vitrifiable bonding paste to a side thereof, pressing said spot, and heating said crystal at a temperature from 970° F. to 990° F. to vitrify said spot.

4. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing lead borate as a binder to a side thereof, heating said crystal to dry the surface of said spot, pressing said spot to compact the materials therein, and heating said crystal at a temperature from 970° F. to 990° F. to fuse said spot.

5. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing a vitrifiable bonding material to a side thereof, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, and heating said crystal sufficiently to vitrify said spot.

6. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing lead borate as a binder to a side thereof, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, and heating said crystal at a temperature from 970° F. to 990° F. to fuse said spot.

7. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing lead borate as a binder to a side thereof, heating said crystal to dry the surface of said spot, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, and heating said crystal at a temperature from 970° F. to 990° F. to vitrify said spot.

8. A method of spotting a piezoelectric crystal comprising applying a spot of vitrifiable bonding compound to a side thereof, heating said crystal to dry the surface of said spot, pressing said spot to compact the materials therein, heating said crystal sufficiently to dry said spot and baking said crystal sufficiently to vitrify said spot.

9. A method of spotting a piezoelectric crystal comprising the steps of applying a spot of vitrifiable bonding compound to a side thereof, heating said crystal at a temperature from 500° F. to 700° F. to dry the surface of said spot, pressing said spot to compact the materials therein, and baking said crystal sufficiently to vitrify the spot.

10. A method of spotting a piezoelectric crystal comprising the steps of applying a spot of a

metallic compound containing lead borate as a binder to a side thereof, heating said crystal at a temperature from 500° F. to 700° F. to dry the surface of said spot, pressing said spot to compact the materials therein, and baking said crystal at a temperature on the order of 970° F. to 990° F. to fuse said spot.

11. A method of spotting a piezoelectric crystal comprising applying a spot of bonding compound to a side thereof, pressing said spot sufficiently to avoid segregation of the components of the bonding compound, and heating said crystal sufficiently to fuse said spot.

12. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing lead borate as a binder to a side thereof, heating said crystal at a temperature on the order of 500° F. to 700° F. to dry the surface of said spot, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, drying said spot by heating said crystal at a temperature on the order of 500° F. to 700° F., and baking said crystal at a temperature on the order of 970° F. to 990° F. to fuse said spot.

13. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing lead borate as a binder to a side thereof, heating said crystal at a temperature on the order of 500° F. to 700° F. to dry the surface of said spot, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, drying said spot by heating said crystal at a temperature on the order of 500° F. to 700° F., and baking for approximately thirty minutes at a temperature on the order of 970° F. to 990° F. to fuse said spot.

14. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing lead borate as a binder to a side thereof, heating said crystal for approximately thirty minutes at a temperature on the order of 500° F. to 700° F. to dry the surface of said spot, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, drying said spot by heating said crystal at a temperature on the order of 500° F. to 700° F., and baking said crystal at a temperature on the order of 970° F. to 990° F. to fuse said spot.

15. A method of spotting a piezoelectric crystal comprising applying a spot of a metallic paste containing lead borate as a binder to a side thereof, heating said crystal for approximately thirty minutes at a temperature on the order of 500° F. to 700° F. to dry the surface of said spot, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, drying said spot by heating said crystal at a temperature on the order of 500° F. to 700° F., and baking said crystal for approximately thirty minutes at a temperature on the order of 970° F. to 990° F. to fuse said spot.

16. A method of forming a bonding surface on a quartz crystal, comprising applying a metallic bonding compound containing a vitrifiable binder to a side thereof, compacting said compound, and heating sufficiently to vitrify the binder.

17. A method of forming a bonding surface on a quartz crystal comprising applying a bonding compound containing conducting material and a vitrifiable binder to a side thereof, compacting said compound, and heating sufficiently to vitrify the binder.

18. A method of spotting a piezoelectric crystal comprising applying a bonding compound containing conducting material and a vitrifiable binder to a side thereof, heating said crystal sufficiently to dry the surface of said spot, pressing said spot to compact the materials therein, heating said crystal sufficiently to dry said spot, and baking said crystal sufficiently to vitrify said spot.

19. A method of spotting a piezoelectric crystal comprising the steps of applying a bonding compound containing conducting material and a vitrifiable binder to a side thereof, heating said crystal at a temperature from 500° F. to 700° F. to dry the surface of said spot, pressing said spot to compact the materials therein, and baking said crystal sufficiently to vitrify the spot.

20. A method of spotting a piezoelectric crystal comprising applying a bonding compound containing conducting material and a vitrifiable binder to a side thereof, heating said crystal for approximately thirty minutes at a temperature on the order of 500° F. to 700° F. to dry the surface of said spot, pressing said spot at a pressure on the order of 4500 pounds per square inch to compact the materials therein, drying said spot by heating said crystal at a temperature on the order of 500° F. to 700° F., and baking said crystal for approximately thirty minutes at a temperature on the order of 970° F. to 990° F. to fuse said spot.

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