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APPARATUS FOR SPOT COATING CRYSTAL BLANKS

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FIG. 1

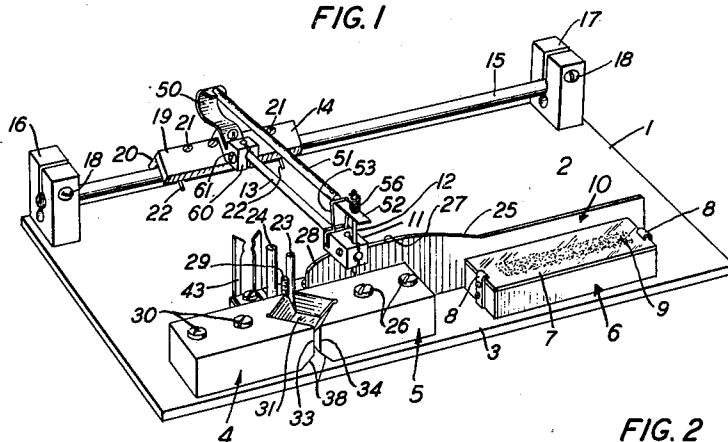


FIG. 2

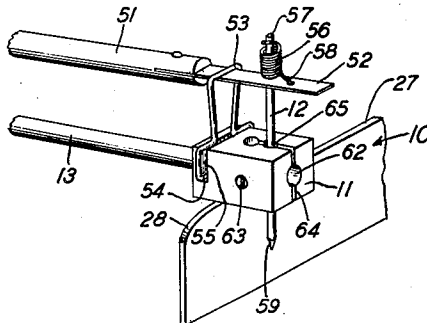


FIG. 3

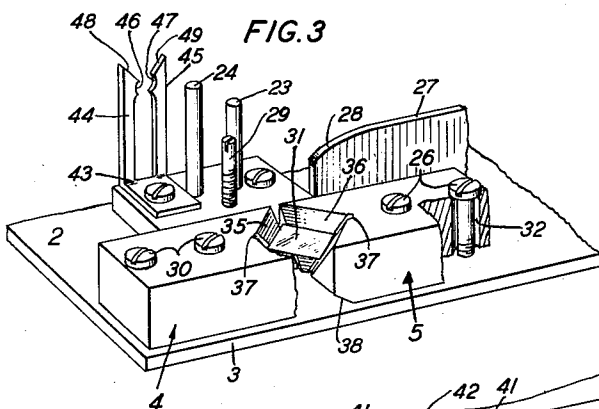
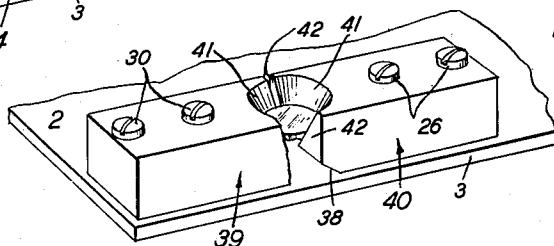


FIG. 4



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APPARATUS FOR SPOT COATING
CRYSTAL BLANKS

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8 Claims. (Cl. 91-47)

1

This invention relates to piezoelectric crystal manufacture, and particularly to means for applying uniform quantities of metallic paste to crystal blanks in accurately predetermined locations.

The device consists of a crystal blank holder, a paste supply plate, and a slidably traversable stylus which may be brought into automatic registry with the nodal point of the blank. The stylus is arranged to be pressed first against the paste supply plate, and then, after traversal to a properly aligned stop position, against a crystal blank, to apply a spot of paste thereto. The blank holder is arranged to accommodate crystals of different sizes without requiring adjustment, and the pressure between the blanks and the stylus is always uniform. Each crystal must be turned over to permit spotting on both sides at exactly opposite positions.

Two general types of mountings have been widely used for piezoelectric crystals. In one, knife edges, pressure pins or anvils are used to provide both mechanical support and electrical connections. In the other, these functions are performed by fine wires soldered to the crystal. The latter, or wire suspension type, is preferred for many applications because the adjustment of the frequency and frequency temperature characteristic is facilitated, while an improvement in precision is obtained of the order of two or three to one over the pressure supported types, due to elimination of variations in contact pressure and resistance.

The present disclosure is concerned with the manufacturing techniques and equipment for securing the wire leads to the plates in wire supported crystal units. Soldering directly to the surface of the crystal blanks is not satisfactory because of the weak joints obtained. It has been found, however, that a good connection may be secured by bonding a metallic layer to the crystal, and soldering the wire to that layer. In fixing the metallic layer to the crystal, the surface must first be cleaned thoroughly. A portion of "Hanovia" paste, or an equivalent mixture of finely divided silver and a soft glass such as lead borate, is applied to the desired location and partially dried by a preliminary low temperature heating. The plate is then heated in the presence of oxygen to a temperature as high as possible without changing the crystal structure, so

2

that glass melts and the glass and silver become well bonded to the crystal surface. After cooling, the silver spot is burnished and the wire soldered thereto. A still more satisfactory bond mechanically is obtained if the wire is first headed to about 10 mils diameter, so that a larger contact area is obtained.

When crystals are being produced in quantities, it is essential that uniform amounts of paste be applied to each blank, and in exactly the same position. Too large an amount of paste will exert a damping effect on the crystal, while the vibrational mode is adversely affected if the spot is not located exactly on a nodal line. The pressure with which the paste is applied to the blanks should be uniform, so that the quantities will be equal, and so that breakage may be minimized. Some of the crystals in regular use are of the order of only 0.3 millimeter in thickness, with a lateral dimension of the order of 3 millimeters, so that they possess very little rigidity, and are extremely fragile, as well as being difficult to handle because of their small size.

Manual application of the silver spots has not proved satisfactory. Experience indicates that the variations in pressure are too great, the positioning is not always exact, the spots are not of uniform shape, and production speed is too slow.

Automatic machinery for applying the paste spots has likewise been unsatisfactory. It has been difficult to accommodate different sizes and shapes of blanks, and breakage has been excessive. The alignment of the paste spots with the nodal points, the maintenance of uniform spot size and contact pressure, and the continuous control of paste consistency have not been adequately solved. The cost of manufacturing the machinery has been considerable, and there has been an undue amount of upkeep required.

The instant disclosure presents a simple holder which will accommodate a wide variety of sizes and shapes of crystals. The holder aligns the blank with the stylus exactly and insures that the pressure which the stylus exerts thereon will be uniform. The paste consistency is under continuous observation by the operator, and the paste may be frequently renewed to keep it uniform. Means are provided to hold the stylus head in disengaged position when the holder is to be moved.

3

The invention may be better understood by reference to the drawings in which:

Fig. 1 is a perspective view of the device;

Fig. 2 is a fragmentary detailed view illustrating the construction of the guiding head in which the stylus operates;

Fig. 3 is a fragmentary view partially in section of the crystal receptacle; and

Fig. 4 is a fragmentary view partially in section of another preferred embodiment of the crystal receptacle.

It is to be understood that the embodiments shown are illustrative only of the invention, and that other equivalent structures are deemed to be included within the scope of the appended claims. In operation, the stylus is drawn to the right of the device as shown in Fig. 1 and a crystal blank is placed horizontally in the crystal holder by the attendant. He then depresses the trigger plate to pick up a spot of fresh paste from the supply plate, releases the trigger, and draws the stylus and its supporting members to the left, under the vertical control of a cam, until the supporting members engage a guide mechanism. He next depresses the trigger plate, upon which a paste spot is automatically deposited on the nodal point of the crystal. The crystal plate is then turned over and the process is repeated to spot the other side. The plate is now ready for the other processes necessary to prepare for the attachment of the wire leads.

Referring now to Fig. 1 of the drawings, the device, indicated generally as 1, is shown as having a rectangular base plate 2. Along one side 3 of base plate 2 are mounted adjustably members 4 and 5, which together constitute the holder for the crystals. In line with the crystal holding members 4 and 5 along side 3 is fixed a block 6, on which is removably mounted a supply plate 7. Plate 7 may conveniently be an ordinary glass microscope slide. It is held by resilient arms 8, and has spread smoothly thereon a supply of the metallic paste 9. The paste layer 9 may be renewed at intervals determined by the operator. It should be moist, yet not too thin in consistency. A spreading blade is used to apply the paste from a mixing tank, and is preferably of such a form as to make the thickness of the layer uniform. These implements are not part of the present invention, and are not illustrated. An elongated cam 10 is fixed to the base plate 2 and extends upwardly therefrom immediately adjacent the crystal holding member 5 and block 6. Cam 10 partially controls the vertical movement of the stylus head 11, in which stylus 12 operates, during traversal between the pick-up and spotting positions, as will be more fully described below.

The stylus head 11 is carried by a transverse rod 13 fixed by means described later to a shoe 14. Shoe 14 is slidably mounted on a rod 15 held parallel to the side 3 of the base 2 by slotted support members 16 and 17. Screws 18 threadably engaged in the slotted members 16 and 17 may be tightened to secure rod 15 rigidly in place, or loosened to permit its removal.

The shoe 14 is elongated, so that the transverse rod 13 will extend normal to support rod 15 regardless of the position of the shoe therealong, but is rockable about the axis of rod 15. The shoe 14 may conveniently be formed of two rectangular plates 19 and 20 fixed normal to each other by means such as screws 21, and resting on rod 15 to give line contact between the rod and each of the plates. This permits normal wear to

4

occur without disturbing the angular relation between the support rod 15 and transverse rod 13. The shoe is held removably on rod 15 by a pair of spring arms 22. The stylus head 11 may be traversed, by sliding shoe 14 along rod 15, from a position over the paste supply plate 7 to a limiting position substantially centered between the crystal holding blocks 4 and 5, fixed longitudinally of the base plate 1 by stop rods 23 and 24. A preliminary adjustment of members 4 and 5, described hereafter, is made to secure exact vertical alinement of the centers of blanks to be seated therein with the axis of stylus 12 in the limiting position.

The cam 10 operates to keep the level of stylus head 11 uniform during its traverse adjacent paste supply plate 7, and at substantially the same height above the plate 7 as it will be above a crystal blank at the opposite end of its traverse. As the head 11 is shifted toward stop rod 23, it is raised by the curved lifting surface 25 so that the stylus 12 may clear the block 5 and the adjusting screws 25. The lifting surface 25 merges into a horizontal surface 27 adjacent block 5, and then into a descending curve 28 as it approaches the crystal blank seat, described hereafter in detail. The descending curve 28 delivers head 11 over the lower stop rod 23 to encounter the higher stop rod 24, which will prevent further traversal. The assembly is then lowered between the stop rods 23 and 24 as vertical guides until the transverse rod 13 engages vertically adjustable stop screw 29. At this point the stylus 12 will be centered over the crystal seat formed between blocks 4 and 5.

Exact preliminary adjustment of the seat relative to the stylus is obtained by first loosening the adjusting screws 26 and 30 in blocks 5 and 4, respectively. The blocks are then shifted until the stylus aligns exactly with a vertical line through the nodal point of a test blank 31 seated between them, and the screws tightened to maintain this relation permanently. The bores 32 through which screws 26 and 30 pass are large enough to permit ample adjustment of the blocks 4 and 5 for proper alinement. This construction is seen to best advantage in Fig. 3.

The crystal holding members 4 and 5 are rectangular blocks having their adjacent ends 33 and 34 cooperatively recessed at 35 and 36. These portions are so shaped that when ends 33 and 34 are in contact they define a recess having the shape of an inverted pyramid having a square base, with one diagonal parallel to the long side 3 of the base, and the other diagonal normal thereto. The recess is carefully machined, and finished with a smooth surface. The corners of the pyramidal depression are cut out at 37 to provide clearance for the corners of the blank 31. Similar clearance is provided for the opposite diagonal corners by spacing block 4 somewhat from block 5. This separation also permits the entry of the tips of a pair of conventional forceps or tweezers, not shown, to seat or remove a blank. Such entry is facilitated by cutting away the adjacent lower front corners of the blocks at 38. Normally, however, the blank is held by opposite edges between the tweezer tips, and dropped from above into the seat, where it positions itself by gravity action.

With such an inverted pyramidal seat, a wide range of sizes of square crystal blank may be seated, and yet the nodal point, which is found at the intersection of the lines between diagonally opposite corners in crystals of the type for

5

which this invention was made, will be always along a single vertical line. Since this line will coincide with the position of the stylus 12 when rod 13 is dropped between the stop rods 23 and 24, the silver paste will always be applied in exactly the right location. The seat described will level the blanks automatically, as long as reasonable care is used in placing them therein. If slightly rectangular blanks are to be processed, the operator must use care to center them accurately in the seat. If a quantity is to be produced, it may be preferable to replace the seat shown in Figs. 1 and 2 by one having the seat defined by an inverted pyramid having a rectangular base. In such case it would be preferable to align the rectangular axes, rather than the diagonals, with the long side of the base. This embodiment is not shown in the drawings.

For round crystals, an inverted conical seat may be used. It possesses the same flexibility in accommodating different sizes of blanks, and the same characteristic of automatically leveling the blanks, as in the other embodiments. As illustrated in the partially broken away view of Fig. 4, blocks 39 and 40 are substituted for 4 and 5 of Figs. 1 and 3. Blocks 39 and 40 are cooperatively recessed to define in each, half of an inverted conical recess 41 having its vertical axis coincident with one of the adjacent block ends 42. The block ends are undercut at 38 as in the embodiment of Figs. 1 and 3, and spaced apart slightly to permit manipulation of the crystal blanks by tweezers when necessary.

If it is desired to move the entire device 1, the stylus head 11 and transverse rod 13 may be secured against shock and vibration by use of a locking mechanism 43, seen best in Fig. 3. It comprises resilient vertically extending spaced strips 44 and 45 secured adjacent stop rod 24, and arranged to receive transverse rod 13 therebetween. The rod 13 is then held against vertical and horizontal movement between locking ears 46 and 47 projecting in opposition from the strips 44 and 45, respectively. The shoe 14 may be traversed into locking position by first locking it on rod 15 until the transverse rod 13 is able to clear the highest stop rod 24. Mutually inclined guiding surfaces 48 and 49 are formed on strips 44 and 45 to direct the rod 13 between the ears 46 and 47, where the rod will be held by the resilience of strips 44 and 45.

Returning now to the construction of the shoe 14 and the parts associated therewith in supporting the stylus; a spring leaf 50 is secured to shoe 14 and bent over toward the stylus head to act as a support for an upper transverse rod 51. Opposite spring 50, a short trigger plate 52 is secured to rod 51. Spring leaf 50 continuously urges rod 51 arcuately away from rod 13, but the rod is restrained by a stirrup 53 extending over trigger plate 52 and pivotally connected to stylus head 11. The stirrup may be preformed as shown in Fig. 2 of resilient wire and stressed to maintain pivotal engagement of the ends 54 within bores, not visible in the drawings formed in head 11 and communicating with stirrup-positioning grooves 55. The stirrup is shaped to limit the upward movement of the rod 51 and trigger plate 52, while permitting the latter to be depressed freely toward the stylus head 11. During such depression, the stirrup acts as a vertical guide for the trigger plate, which is bored to permit the free movement therethrough of the vertically disposed stylus 12. The stylus is connected to the plate 50 only by an encircling coil spring 56,

6

the upper end 57 of which is secured to the stylus; and the lower end 58 of which is secured to the trigger plate 52.

When the trigger plate 52 is depressed by the operator, the stylus is carried downward until it encounters resistance in the form either of the paste supply plate 7 or the crystal blank 31. Further depression of the trigger will result in increasing the application pressure of the stylus point 59 against the paste supply plate or crystal blank only by the amount of the tension in the spring 56. Adjustment of the screw stop 29 may be made to make the vertical spacing between the head 11 and the crystal blank 31 substantially equal to that between the head and the supply plate 7. This insures substantially uniform contact pressure each time the stylus is used, and assists in maintaining correct stylus alinement for all sizes of crystal blanks. By properly selecting the spring tension, breakage of crystal blanks resulting from excessive pressure is eliminated. The uniform contact pressure thus obtained between the tapered and rounded stylus point 59 and the paste supply plate or blank assists in insuring that equal amounts of the metallic paste will be applied in each spotting operation.

Alinement of the stylus and blank is also obtained through two additional adjustments. A split block 60 secured to shoe 14 is bored to receive the transverse rod 13. An adjusting screw 61 permits rod 13 to be rotated to bring stylus 12 into precisely vertical position, after which the screw 61 is tightened. As a preliminary, the stylus position is controlled longitudinally of rod 13 by moving head 11. Head 11 is bored at 62 to receive the rod 13, and is fixed relative thereto by a set screw 63.

In addition to being bored at 62, head 11 is cut vertically by a slot 64. Slot 64 is cut through bore 65 in which the stylus 12 operates. The combination of horizontal bore 62, vertical bore 65, and the vertical slot 64 intersecting both of them, gives four contact areas within the stylus near the surfaces of the head. This distributed bearing area minimizes the tendency of a straight bore to wear out-of-round at the corners, and so permit movement of the stylus in non-vertical paths. Such wear as does occur may be compensated for by forcing the split portion together.

After spotting one side, the blank is turned over and spotted on the opposite side. The self-aligning character of the seat and the cooperating guides for the stylus insure that the spots will be applied exactly opposite each other in proper position.

The invention as described has proved to be very satisfactory in operation, producing accurately spotted crystals with a breakage rate one-tenth that of previous machine processes, and at good production rates, while the cost of maintenance has been very greatly reduced.

What is claimed is:

1. In apparatus for spotting crystals, a supply plate for spotting material, a support for crystal blanks to be spotted, a spotting stylus, a carriage and track for traversing said stylus between said supply plate and said support, means for holding said carriage in position for spotting a blank held in said support, and a downwardly tapering depression formed in said support and constituting a seat adapted to center accurately crystals of different sizes, means for aligning the vertical axis of said depression with the center line of said

stylus in spotting position, and means for insuring substantially uniform contact pressure between said stylus and said supply plate, and between said stylus and a blank held in said support.

2. A device for spotting crystal blanks, comprising a base, an elongated supporting member secured to said base, a shoe frictionally engaged with said elongated supporting member and slidable thereon, a pair of transverse members secured to said shoe, a stylus head having a stylus vertically movable therein carried by said transverse members, resilient means for controlling the vertical position of said stylus within said head, a cam secured to said base and arranged to be engaged by said stylus head, a slide arranged to have a layer of metallic paste applied thereto and positioned to be engaged by said stylus at one end of the traverse of said shoe along said elongated support member, a crystal blank support disposed adjacent said supply, means formed in said crystal blank support for accurately predetermining the position to be occupied by a blank therein, a stop means arranged to be engaged by one of said transverse members and to align said stylus with the exact center of said crystal blank, and means for determining the vertical position of said stylus head when said stop means is engaged by one of said transverse members.

3. In a device for applying metallic paste spots to crystal blanks, a base, a holder adapted to receive and center crystal blanks of different sizes, a paste supply plate, and a support rod mounted on said base, a stylus head assembly, comprising a shoe slidable laterally on said rod, an upper and a lower support arm fixed to said shoe, a stylus head secured to said lower support arm, a stylus vertically movable through said head and aligned transversely of said base with the center of said holder, a resilient trigger member fixed to said upper support arm and apertured to permit free movement of said stylus therethrough, a resilient connection between said trigger member and said stylus, a lateral stop positioned to align said stylus longitudinally with the center of a crystal blank disposed in said holder, and a cam arranged to raise said head assembly during traversal between said supply plate and said lateral stop.

4. A device for processing crystal blanks, comprising a base having thereon a holder arranged to receive and center blanks of various sizes, a block, a paste supply plate removably mounted on said block, a support rod fixed substantially parallel to a line between said holder and said block, an elongated shoe slidably mounted on said support rod, a pair of transverse rods secured to said shoe, a stylus head carried by one of said transverse rods, a resilient trigger fixed to the other of said transverse rods, a stylus disposed through said head and said trigger, resilient means for connecting said stylus to said trigger, a cam arranged to control the position of said stylus head vertically during sliding of said shoe along said support rod, and stop members arranged to align said head exactly over said holder.

5. The combination, in a device for processing crystal blanks, of a base, a support rod mounted on said base, an elongated shoe slidably mounted on said support rod, upper and lower transverse head-supporting rods carried by said shoe, a stylus head fixed to the lower of said stylus head-supporting rods, a vertical stylus disposed slidably within said head, a resilient trigger fixed to the

upper of said stylus head-supporting rods and slidably surrounding said stylus, a resilient connection between said trigger and said stylus, a cam arranged to control the vertical movement of said head during traversal of said shoe along said support rod, a paste supply plate, an adjustably positioned crystal blank holder, and stop means arranged to limit traversal in one direction of said stylus head in exact position relative to said crystal blank holder to align said stylus with a desired point on said blank.

6. In a device for processing crystal blanks, a base, an adjustably positioned blank holder comprising a pair of blocks having depressions formed therein cooperating to define an inverted pyramidal seat, a paste supply plate, a cam extending between said paste supply plate and said blank holder, a support rod disposed above said base, a shoe slidably mounted thereon, transverse head support rods associated with said shoe, a bored head block fixed to one of said transverse head support rods, an apertured leaf spring trigger member secured to the other of said transverse head support rods, a stylus extending vertically through and slidable in said apertured trigger member and said bored head block, resilient means connecting said trigger member to said stylus, means for urging one of said transverse head support rods arcuately away from the other of said transverse head support rods, means for limiting arcuate separation of said rods while permitting depression of said trigger member, and stop means for limiting traverse of said shoe in one direction to a position in which said stylus and a desired portion of said crystal blank holder are exactly aligned.

7. In a device for processing crystal blanks, a base, an adjustably positioned blank holder comprising a pair of blocks having depressions formed therein cooperating to define an inverted conical seat, a paste supply plate, a cam extending between said paste supply plate and said blank holder, a support rod disposed above said base, a shoe slidably mounted thereon, transverse head support rods associated with said shoe, a bored head block fixed to one of said transverse head support rods, an apertured leaf spring trigger member secured to the other of said transverse head support rods, a stylus extending vertically through and slidable in said apertured trigger member and said bored head block, resilient means connecting said trigger member to said stylus, means for urging one of said transverse head support rods arcuately away from the other of said transverse head support rods, means for limiting arcuate separation of said rods while permitting depression of said trigger member, and stop means for limiting traverse of said shoe in one direction to a position in which said stylus and a desired portion of said crystal blank holder are exactly aligned.

8. In a device for processing crystal blanks, a base, an adjustably positioned blank holder comprising a pair of blocks having depressions formed therein cooperating to define an inverted conical seat, a paste supply plate, a cam extending between said paste supply plate and said blank holder, a support rod disposed above said base, a shoe slidably mounted thereon, transverse head support rods associated with said shoe, a bored head block fixed to one of said transverse head support rods, an apertured leaf spring trigger member secured to the other of said transverse head support rods, a stylus extending vertically through and slidable in said apertured trigger

member and said bored head block, resilient means connecting said trigger member to said stylus, means for urging one of said transverse head support rods arcuately away from the other of said transverse head support rods, means for limiting arcuate separation of said rods while permitting depression of said trigger member, stop means for limiting traverse of said shoe in one direction to a position in which said stylus and a desired portion of said crystal blank holder are exactly alined, and resilient means for holding said stylus head in a locking position.

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