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METHOD AND APPARATUS FOR SHAPING CRYSTAL BODIES

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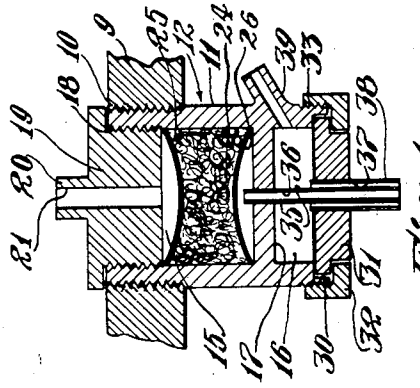


Fig. 4

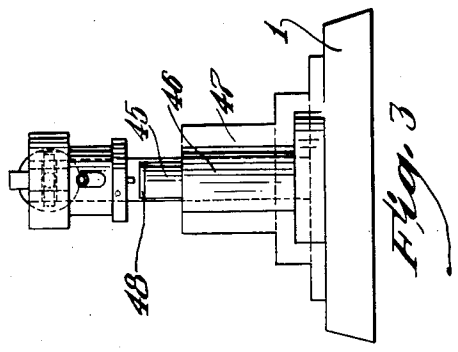


Fig. 3

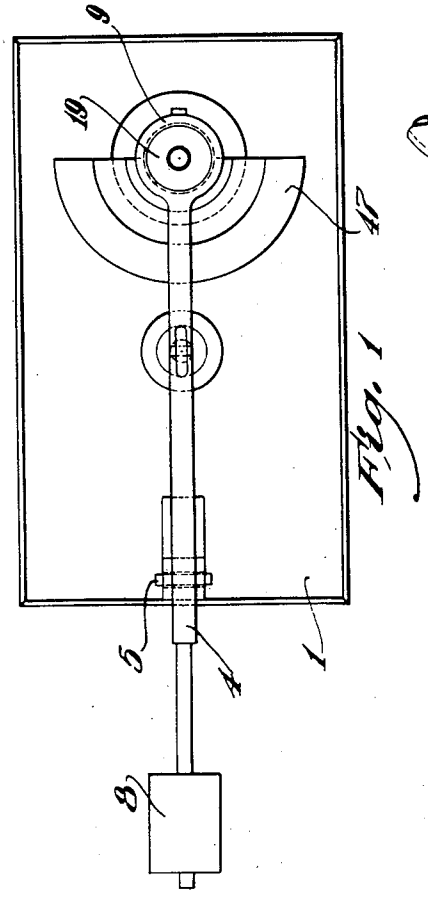


Fig. 1

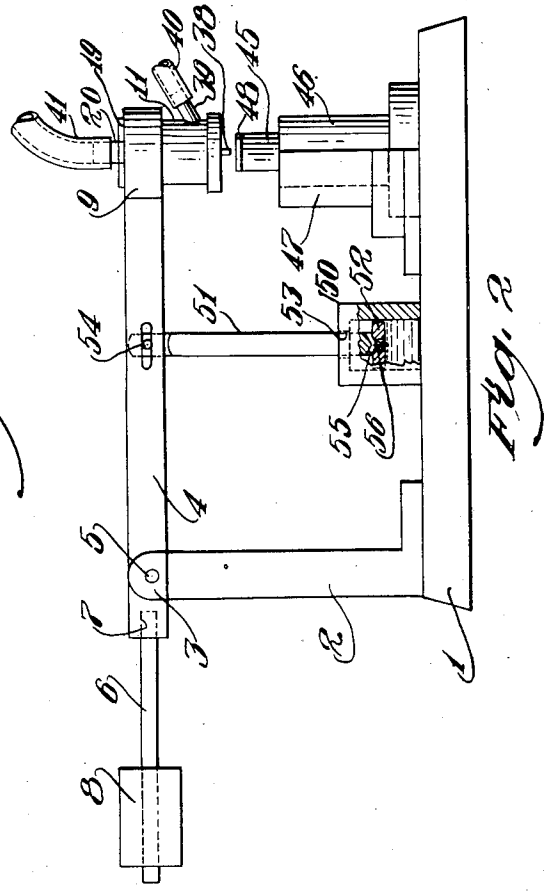


Fig. 2

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METHOD AND APPARATUS FOR SHAPING CRYSTAL BODIES

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10 Claims. (Cl. 171—327)

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This invention relates to the art of piezo-electric crystals or other fragile bodies of soluble materials and more particularly to a method and apparatus for forming holes or configurations in or otherwise shaping said bodies as the need may arise.

In the fabrication of fragile soluble bodies, as for example Rochelle salts, when used for their piezo-electric or optical properties, it is often necessary to provide holes through or partially through said bodies or to form them into intricate and varied shapes and configurations.

The primary object of the invention is to provide a method and apparatus which will accomplish the above necessary objects and in an efficient, accurate and economical manner. Another object of my invention is to provide a method of accomplishing the above objects which is simple to perform and an apparatus which is easy to operate requiring the services of a relatively unskilled operator.

In one aspect the invention involves the method of shaping or selectively removing portions of such a body in a localized area which comprises directing against the body a stream of solvent for the material and concomitantly drawing the solvent away from the body before it has spread beyond said area.

In another aspect the invention involves a method of forming a hole of predetermined cross-sectional area which comprises directing against such a body a stream of solvent for the material and concomitantly drawing the solvent away from the body before it has spread beyond said area. After establishing the stream of solvent it is advanced relative to the body at a rate equal to the rate at which the depth of the hole is formed.

In a further aspect the invention involves apparatus comprising delivery means for directing against such a body a stream of solvent for the material, an exhaust conduit for the solvent adjacent the delivery end of the delivery means, and suction means associated with said exhaust conduit for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area. The delivery means may comprise a delivery conduit and the exhaust conduit may be coaxial with said delivery conduit. Preferably the exhaust conduit comprises a jacket circumposed about the delivery end of the delivery conduit and suction means are associated with said jacket. In a preferred aspect the apparatus has means for lowering said delivery conduit and jacket at a rate equal to the rate at which the depth of the hole is formed. In a preferred aspect the apparatus may comprise a casing having a filter charmber and a suction chamber, means communicating with the filter chamber for supplying said chamber with a solvent for the material, a filter within the filter chamber, a delivery conduit communicating with the filter chamber for directing against such body a stream of solvent, an exhaust conduit for the solvent coaxial with the delivery conduit for communicating with the suction chamber, and suction means communicating with the suction chamber for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area. A filter is disposed within the delivery chamber.

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For the purpose of illustration a typical embodiment of the invention is shown in the accompanying drawings in which,

Fig. 1 is a plan view of a typical embodiment;

Fig. 2 is a side elevation with parts broken away;

Fig. 3 is an end elevation; and

Fig. 4 is a cross section of the operating head.

Referring to Figs. 1 and 2 the numeral 1 designates a base. An L-shaped post is fixedly mounted at one end of the top surface of the base 1 and is provided with a bifurcated end 3 for pivotally supporting an arm 4 by suitable means as a pintle 5. An arm extension 6 is fixedly received in a recess 7 formed in one end of the arm 4 and supports a counterweight 8 slidably mounted thereon. The arm 4 is formed at its opposite end with an interiorly threaded annular portion 9 to receive the upper exteriorly threaded portion of a cylindrical casing 11, as shown in Fig. 4, the casing constituting part of the operating head 12.

The cylindrical casing is internally divided into a filter chamber 15 and a suction chamber 16 by a partition 17. The wall of the filter chamber 15 is provided at its outer end with threads 18 to receive a bushing 19, the top of the bushing being formed with a nipple 20 communicating with an axial bore 21 of the bushing. A filter pad 24, preferably of flocculent cotton fiber is supported within the filter chamber 15 by screens 25 and 26.

The wall of the suction chamber 16 is provided at its outer end with an annular recess 30 to receive a plug 31. An inwardly flanged lock nut 32 is threaded onto the exteriorly threaded portion 33 of the cylindrical casing 11 and tightly retains the plug 31 within the recess 30 as shown in Fig. 4.

A delivery conduit 35 having one end disposed

in the filter chamber 16 below the screen 26 extends axially through an opening 36 formed in the partition 17, thence through the suction chamber 16 and thence out of said chamber through an axial bore 37 formed in the plug 31, the edges of the opening 36 in the partition being tightly sealed about the delivery conduit by suitable means as a weld. An exhaust conduit or jacket 38 is circumposed in spaced relation about that portion of the delivery conduit which extends through the bore 37 and exteriorly of the suction chamber, and is fixedly secured to the plug 31 within the bore 37 by suitable means as a weld. It is to be understood that while in the typical embodiment shown in Fig. 4 the exterior ends of the jacket 38 and delivery conduit 35 are flush, the invention is not to be so limited.

The wall of the suction chamber is provided with an outlet nipple 39 to which may be attached a hose 40 as indicated in Fig. 2, the opposite end of the hose 40 being connected to a suitable suction pump (not shown) of any well-known design. In a similar manner, a hose 41 is attached to the nipple 20 of bushing 19, the opposite end of the hose being connected to a source of supply of suitable solvent under control by a valve (not shown).

At the opposite end of the base 1 and in cooperative relation to the operating head 12 is an anvil 45 supported on a cylindrical block 46, the lower end of which block is flanged and rests on the base 1. A semi-cylindrical stepped member 47 is fixed to the base 1 so as to provide a stop or positioning gauge for centering the block 46 with the anvil 45 properly positioned with respect to the exterior ends of the delivery conduit 35 and jacket 38. A crystal body 48 rests upon the top surface of the anvil 45.

A cylindrical housing 50 is fixedly mounted to the base 1 intermediate the post 2 and stepped member 47. A piston rod 51 secured at one end to a piston 52 within the cylindrical housing extends upwardly through an opening 53 formed in the top wall of the housing and is attached at its opposite end to the arm 4 by a pin and slot connection 54 as shown in Fig. 2. Adjacent the piston 52 the piston rod 51 is formed with inlet passages 55 which communicate with a ball check valve 56 provided in the piston. The cylindrical housing 50 is filled with any suitable hydraulic fluid, preferably oil, to the height indicated in Fig. 2.

In operation, the vacuum pump is started, thus creating a suction of air at the exterior end of the jacket and about the delivery end of the delivery conduit. The solvent supply is also turned on; the operating head 12 is gently lowered manually or automatically as by a cam (not shown) until the exterior ends of the jacket 38 and delivery conduit 35 are in contact or nearly in contact with the body of the crystal at the location where it is desired to form a hole of predetermined cross-sectional area. At this point the control of the lowering of the operating head 12 is assumed by the dashpot, the rate of this lowering being determined by the mechanical resistance of the dashpot.

The solvent passes through the filter 24 to remove any foreign particles in the solvent and thence flows through the delivery conduit 35 to direct a stream of solvent, against the crystal body. As the stream of solvent emerges from the delivery conduit, it is exposed to the current of air created by the suction and is sucked away from the crystal body up into the jacket 38 before it has spread beyond the predetermined cross-sectional area. The solvent passes from the jacket 38 into the suction chamber 16 and thence is carried away through the nipple outlet 39 and hose 40. The passage of the solvent from out of the delivery conduit into the jacket causes the surface of the crystal body to be dissolved thereby to begin to form a hole.

While the source of supply of the solvent may be under pressure, preferably the pressure is very slight, and it is to be understood that the apparatus will operate with no head at all, for when the exterior ends of the delivery conduit and jacket are in contact or nearly in contact with the surface of a crystal a partial vacuum is formed at said exterior ends causing the solvent to flow through the delivery conduit.

In the illustrated embodiment the jacket 38 has preferably been described as the exhaust conduit and the conduit 35 as the delivery conduit, but it is to be understood that the functions of the two conduits may be interchanged, that is, the jacket may serve as the delivery conduit for the flow of solvent to the crystal and the vacuum may be applied to the conduit 35 causing it to serve as the exhaust conduit.

The ball check valve 56 and passages 55 are to permit free flow of the hydraulic fluid in the dashpot when the head is raised. The downward resistance of the dashpot may be controlled by any of the methods in common practice. From the foregoing it is evident that means are thus provided for controlling the rate of forming the depth of the hole as well as providing means whereby the delivery conduit and jacket are lowered at a rate preferably equal to the rate at which the depth of the hole is formed thereby to avoid breakage of the crystal body due to pressure of the operating head on the crystal body.

After the hole has been formed to the desired depth, the operating head is swung upwardly by hand or automatically as by a cam out of the hole and the crystal body removed from the anvil. When the delivery conduit 35 and jacket 38 are not in contact with the crystal, any solvent flowing through the conduit 35 is sucked away through the jacket 38.

While the foregoing description of the manner of operation refers to the forming of a hole in a crystal, it is to be understood that approximately the same procedure may be followed in etching, forming configurations in or otherwise shaping a soluble body in desired localized areas, the difference being only in the extent of time during which any one selected area of the crystal is exposed to the above described passage of the solvent.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. In the art of piezo-electric crystals and other fragile bodies of soluble material, the method of shaping or selectively removing portions of the body in a localized area which comprises continuously directing against such a body a stream of solvent for the material at a predetermined rate and continuously drawing the solvent away from the body at approximately the same rate to prevent it from spreading beyond said area.

2. In the art of piezo-electric crystals and other fragile bodies of soluble material, the method of forming a hole of predetermined cross-sectional

area which comprises continuously directing against such a body a stream of solvent for the material at a predetermined rate and continuously drawing the solvent away from the body at approximately the same rate to prevent it from spreading beyond said area.

3. In the art of piezo-electric crystals and other fragile bodies of soluble material, the method of forming a hole of predetermined cross-sectional area which comprises establishing and continuously directing against such a body a stream of solvent for the material at a predetermined rate and continuously drawing the solvent away from the body at approximately the same rate to prevent it from spreading beyond said area, and advancing said stream of solvent relative to the body at a rate equal to the rate at which the depth of the hole is formed.

4. Apparatus for forming a hole of predetermined cross-sectional area in a piezo-electric crystal or other fragile body of soluble material comprising delivery means for directing against such a body a stream of solvent for the material, an exhaust conduit for the solvent adjacent the delivery end of the delivery means, and suction means associated with said exhaust conduit for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area.

5. Apparatus for forming a hole of predetermined cross-sectional area in a piezo-electric crystal or other fragile body of soluble material comprising a delivery conduit for directing against such a body a stream of solvent for the material, an exhaust conduit for the solvent coaxial with the delivery conduit, and suction means associated with said exhaust conduit for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area.

6. Apparatus for forming a hole of predetermined cross-sectional area in a piezo-electric crystal or other fragile body of soluble material comprising a delivery conduit for directing against such a body a stream of solvent for the material, a jacket circumposed about the delivery end of the delivery conduit, and suction means associated with said jacket for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area.

7. Apparatus for forming a hole of predetermined cross-sectional area in a piezo-electric crystal or other fragile body of soluble material comprising a delivery conduit for directing against such a body a stream of solvent for the material, an exhaust conduit for the solvent adjacent the delivery end of the delivery conduit, suction means associated with said exhaust conduit for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area, and means for lowering said delivery and exhaust conduits at a rate equal to the rate at which the depth of the hole is formed.

8. Apparatus for forming a hole of predetermined cross-sectional area in a piezo-electric crystal or other fragile body of soluble material comprising a delivery conduit for directing against such a body a stream of solvent for the material, an exhaust conduit for the solvent coaxial with the delivery conduit, suction means associated with said exhaust conduit for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area, and means for lowering said delivery and exhaust conduits at a rate equal to the rate at which the depth of the hole is formed.

9. Apparatus for forming a hole of predetermined cross-sectional area in a piezo-electric crystal or other fragile body of soluble material comprising a delivery conduit for directing against such a body a stream of solvent for the material, a jacket circumposed about the delivery end of the delivery conduit, suction means associated with said jacket for concomitantly drawing the solvent away from the body before it is spread beyond the predetermined area, and means for lowering said delivery conduit and jacket at a rate equal to the rate at which the depth of the hole is formed.

10. Apparatus for forming a hole of predetermined cross-sectional area in a piezo-electric crystal or other fragile body of soluble material comprising a casing having a filter chamber and a suction chamber, means communicating with the filter chamber for supplying the chamber with a solvent for the material, a filter within the filter chamber, a delivery conduit communicating with the filter chamber for directing against such a body a stream of the solvent, an exhaust conduit for the solvent coaxial with the delivery conduit and communicating with the suction chamber, and suction means communicating with the suction chamber for concomitantly drawing the solvent away from the body before it has spread beyond the predetermined area.

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