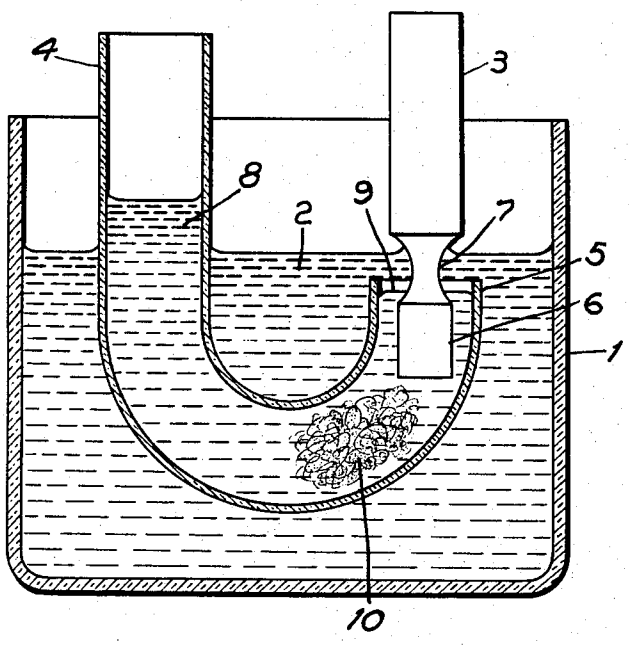
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METHOD OF SHAPING A CRYSTAL BY ACID CUTTING

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METHOD OF SHAPING A CRYSTAL BY ACID CUTTING

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ABSTRACT OF THE DISCLOSURE

This is a method of shaping a solid crystal object. A container is filled with an acid which is capable of etching the crystal object. A U-shaped tube is placed in the container and one end is immersed in the acid. An inert liquid which is heavier than the acid is poured into the other end of the tube creating an interface between the two liquids at the immersed end of the tube. The object is submerged a predetermined distance into the immersed end of the tube so that the crystal can be cut at the interface between the two liquids.

This invention relates to a device for cutting metallic crystals and more particularly to a device for the chemical cutting of crystals.

Devices for cutting crystals without introducing dislocations are ordinarily rather complex especially if flat surfaces are desired and even the simplified versions known to the art have been difficult to adjust and operate. One such device is the electrolytic cutter wherein the crystal is immersed in a receptacle containing an electrolyte which is disposed between two insulating liquid layers, the insulating layers and the electrolyte being immiscible and the bottom insulating layer being heavier than the electrolyte. The crystal sample to be cut forms an anode and an annular cathode surrounds the crystal at the interface of the electrolyte and the top insulating layer. The anode and the cathode are then connected to a source of current and during the electrolytic action that takes place, the metal is displaced and forms a viscous layer which is heavier than the electrolyte. However, the disadvantage of this method is that the viscous layer which is the salt formed by the reaction of the electrolyte with the crystal, tends to accumulate within the electrolyte and in time converts the acid phase to an inert phase thus interfering with the cutting operation.

Another method of cutting crystals is the spark erosion method which is purely electrical without the use of chemical materials.

Still another method is the purely chemical method using a wet string crystal cutter wherein the thread or string is disposed around the crystal to be cut at the place where the cut is to be made and acid is wicked up through the thread, and the chemical reaction between the acid and the crystal with constant tension on the string results in the cutting of the crystal. However, the difficulty of this method is that it is difficult, even impossible, to maintain the string in a straight path so that a wavy and irregular cut generally results.

An object of this invention is to provide a device for purely chemical cutting of crystals without string thereon and wherein the cut is generally straight and regular within close tolerances.

A feature of this invention is a method of shaping a solid object comprising immersing the solid object in a corrosive liquid capable of chemically reacting with said solid object, and surrounding the immersed metallic object with an inert fluid leaving a portion of the solid object in contact with the corrosive liquid. The solid object can be a crystal, such as quartz or metal, or any other

material which can be cut by this method. The corrosive liquid may be an acid or any liquid substance that will react with the solid object immersed therein.

The above-mentioned and other features and objects of this invention will become more apparent by reference to the following description taken in conjunction with the sole figure of this invention.

With reference to the figure, there is shown a container **1** which has therein an acid **2** capable of reacting with a metal sample or crystal **3** which is suspended within the acid **2** by means not shown. A U-shaped tube **4** is immersed in the acid **2** with the end **5** thereof surrounding the immersed portion **6** of the crystal **3**. There is thus left a portion **7** of the crystal **3** exposed to the action of the acid **2**. An inert liquid **8**, which is heavier than the acid **2**, is poured into the U-tube **4** until it reaches the level **9** at the other end **5** of the U-tube. A buffer material **10** which may be glass wool, is disposed within the U-tube **4** directly below the end portion **6** of the crystal **3** so that when the crystal is cut through at the area **7** and the cut off piece **6** falls, it will first strike the glass wool **10** and not be injured by the wall of the U-tube.

If we consider a metallic sample **3** to be a copper crystal which is to be cut, then the acid **2** would consist of two parts concentrated nitric acid plus three parts water. The inert fluid **8** could be 20 parts of tetrachloroethylene and one part of linoleic acid. In the case of copper crystals, it was found that a large amount of acid phase was necessary (300 ml.) for a ½ inch diameter crystal. If less acid is used, the acid phase gets too dense as copper nitrate accumulates resulting eventually in an inversion of the two phases. By restricting the inert phase to a small container, such as the U-tube **4**, most of the space within the container **1** can be occupied by acid. Another advantage of the U-tube is that the heavy copper nitrate solution as it is formed can flow over the lip of the narrow U-tube at the end **5** and down into the bottom of the container **1**, thus removing the spent acid from the cutting region. This insures that the acid phase and the inert phase is not intermixed. Also, the hydrostatic force exerted by the inert liquid **8** allows for easy correction of the meniscus level and maintains an upward pressure on the meniscus thus insuring that the copper nitrate formed will not penetrate into the inert liquid but will spill over on the side of the U-tube into the bottom of the container. This then provides for greater and more accurate control of the cutting process. The height of the meniscus can be adjusted by adjusting the level of the heavy inert liquid in the U-tube, the inert liquid being heavier than the acid. Another advantage of this device is the adjustability of the surface tension of the inert liquid at the interface with an acid and the crystal by the use of linoleic acid. This is effected by the linoleic acid causing the inert liquid to wet the copper surface and thus prevents the meniscus from extending lower than the level shown in the figure. Furthermore, narrowness of the meniscus due to the small diameter of the U-tube allows the copper nitrate to spill over more readily. Any inert fluid can be used which is inert and heavier than the cutting fluid or acid and any acid can be used which is suitable for cutting.

The cutting fluid can be any corrosive liquid which will react with the immersed object to be shaped, such as an acid. The object may be any solid, such as metallic or quartz crystals, which will react with the cutting fluid.

While we have described above the principles of our invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of our invention as set forth in the objects thereof and in the accompanying claims.

We claim:

1. A method of shaping a solid crystal object from a group consisting of copper and quartz in a container comprising the steps of:

filling said container with a liquid acid, said acid being capable of etching said crystal object;

placing a U-shaped tube in said container, one end of said tube being immersed in said acid;

pouring an inert liquid into the other end of said tube, said inert liquid being heavier than said acid whereby an interface is created between said two liquids in the immersed end of said tube;

submerging said object into the immersed end of said tube to a predetermined distance;

and cutting said crystal in said interface between said two liquids.

2. A method of shaping a solid crystal object according to claim 1 wherein said acid is of two parts concentrated nitric acid and three parts water.

3. A method of shaping a solid crystal object according to claim 1 wherein said inert liquid is of 20 parts tetrachloroethylene and 1 part linoleic acid.

References Cited

UNITED STATES PATENTS

2,952,528 9/1960 Corneilson ---------- 156—17

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