

March 10, 1964

S. I. SLAWSON

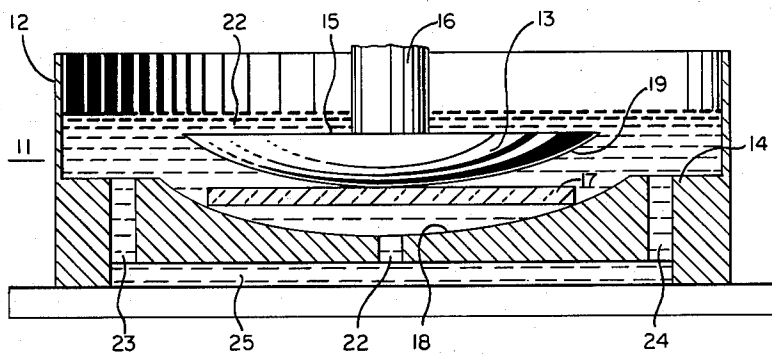
3,124,623

METHOD OF SHAPING CRYSTAL BLANKS

Filed Jan. 18, 1961

2 Sheets-Sheet 1

FIG. 1



INVENTOR
STEWART I. SLAWSON

C.E. Vantrappen, Agent

BY

Richard C. Reed

ATTORNEY

March 10, 1964

S. I. SLAWSON

3,124,623

METHOD OF SHAPING CRYSTAL BLANKS

Filed Jan. 18, 1961

2 Sheets-Sheet 2

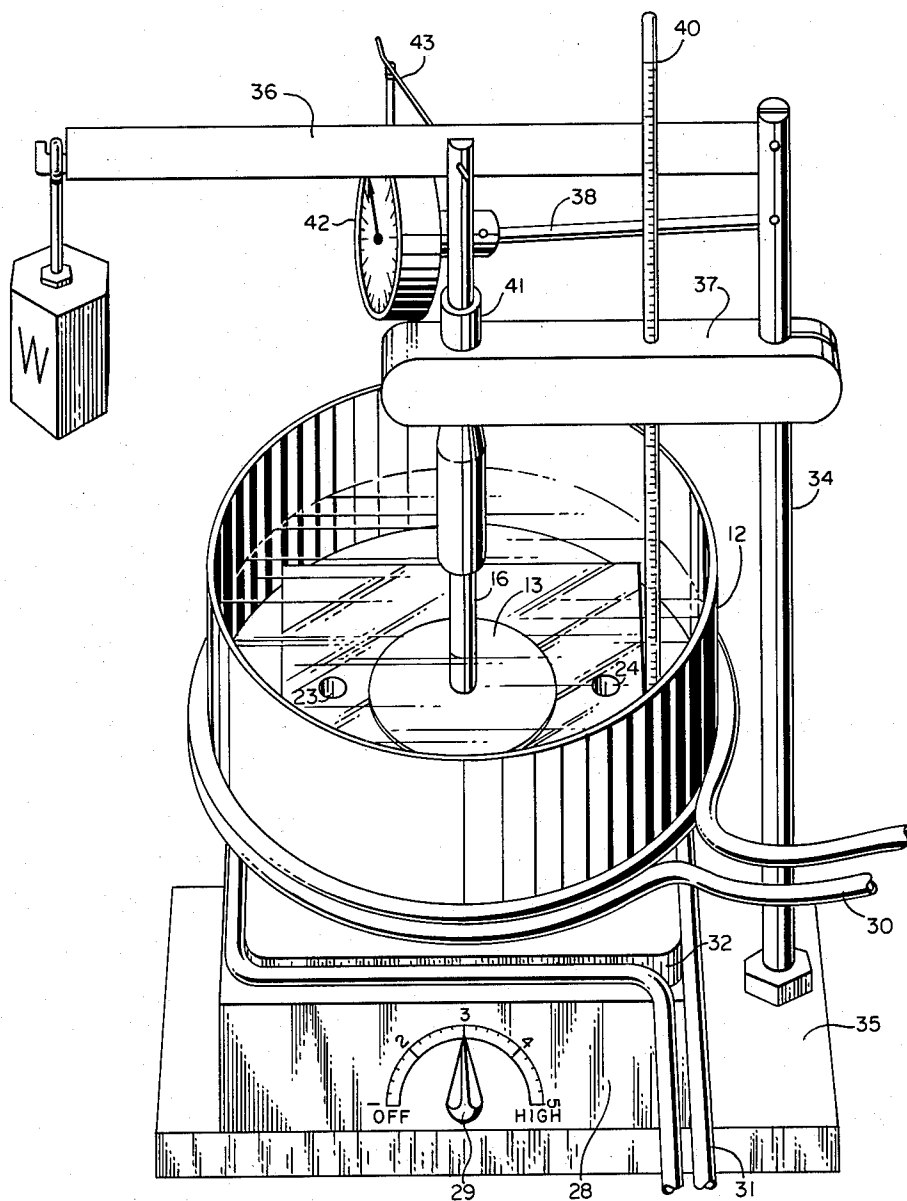


FIG. 2

INVENTOR
STEWART I. SLAWSON
C. E. Vautour, Jr., Agent

BY *Richard C. Reed*

ATTORNEY

1

3,124,623

METHOD OF SHAPING CRYSTAL BLANKS

Stewart I. Slawson, 1108 Mary Baldwin Drive,
Alexandria, Va.

Filed Jan. 18, 1961, Ser. No. 83,595

5 Claims. (Cl. 264—1)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates in general to a method for shaping crystal blanks and in particular to a method for shaping crystal blanks in which opposing faces are shaped concurrently.

The use of grinding methods to shape lenses for spectacles, telescopes and other optical devices is well-known in the optical art, particularly where a simple curvature is obtained after many grinding steps. Such methods, however, are lengthy, tedious and costly as well as critically detailed, requiring the use of skilled workmen and special machinery. Grinding processes shaped the exterior surfaces of crystals but do not, of course, produce curvatures of an entire surface as a unit.

It is often desired to have crystals e.g. salt crystals, shaped such that their faces are substantially parallel in a convex-concave curvature. Crystals so shaped could be used, for example, in optical filters, in devices such as light modulators where it is desired to actuate a switch in response to small changes in light intensity, in underwater sound transducers to provide a high level of signal strength in signals arriving from many directions, and in other such applications where a curved crystal surface will provide results superior to those obtained through use of a plane surface.

Accordingly, it is an object of the present invention to provide a unique method for shaping crystal blanks.

It is another object of the present invention to provide a method by which crystal blanks may be shaped quickly and with a minimum amount of attention by the person operating the device.

It is a further object of the present invention to provide a method for shaping crystal blanks in which heat and pressure are utilized in sequence to produce substantially smooth curved crystal surfaces.

It is still another object of the present invention to provide a method for shaping crystals, e.g. salt crystals, wherein the crystal to be shaped is introduced into a die in the form of a solid. That is, a change is produced in a crystal blank in contrast to the forming of a crystal to a predetermined contour.

Various other objects and advantages will appear from the following description of one embodiment of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In accordance with the broad concept of this invention there is provided a method for shaping an originally flat crystal blank so that the opposite faces of the blank are concavo-convex and have few if any surface irregularities.

In FIG. 1, die 11 is shown including a container 12, a punch 13 and a matrix 14. Positioned on the upper surface 15 of the punch is a shaft 16 through which a desired pressure is applied on a crystal blank 17 inserted between surface 18 of the matrix and surface 19 of the punch. Before pressure is applied, a fluid 22 is poured into the container until the crystal blank 17 is completely or substantially completely submerged therein. Passage 22 is provided to furnish an exit for the fluid under crystal 17 when pressure is applied to the upper surface thereof. Passages 23 and 24 are provided to permit escape of

2

fluid from under matrix 14, such fluid flowing through open area 25 from passage 22.

Referring to FIG. 2, container 12 is shown on a hot plate 28 having conventional heat control means 29. Cooling coils 30 and 31 surround, respectively, the base of container 12 and the upper perimeter 32 of hot plate 28. The cooling coils are connected at one end to a conventional cold water tap, not shown, and at the other end empty into a conventional receptacle, also not shown.

Post 34 is securely attached to a base 35 and supports arms 36 and 37 which extend over container 12, and arm 38 which extends to one side thereof. Thermometer 40 and collar 41 are supported by arm 37 while weight W is supported by arm 36 and pressure gauge 42 by arm 38. The pressure exerted through shaft 16 by weight W is indicated on gauge 42 through movement of links 43. Weight W may be varied by the addition or removal of increments of weight, not shown, or the desired pressure may be obtained through other conventional means for applying force such as compressed gas, tension, etc. also not shown.

Although the apparatus used to apply the method of this invention has been specifically detailed, it will be appreciated that other means than those shown may be substituted to obtain the desired effects, and that such other means are within the knowledge of persons of ordinary skill in the art. For example, the matrix and punch may have a variety of outer form so long as the mating surfaces are curved to produce the shape desired in the formed crystal blank. Also, temperature and pressure may be measured in a variety of other ways, as well as applied in a variety of ways.

The method of shaping comprises several steps which will now be discussed. After assembling the components of apparatus shown in FIG. 2, the blank to be shaped is centered on the matrix in the container and a solvent prepared in sufficient quantity to completely cover the blank. This solvent is one in which the blank is only slightly soluble; for a blank of Z-cut ammonium dihydrogen phosphate, an appropriate solvent would be propylene glycol.

Next, the punch is lowered into contact with the upper surface of the blank, the thermometer, weight and pressure gauge are positioned, and the inlets to the cooling coils are attached to a cold water tap. The hot plate is then turned on and as the matrix, blank and punch rise in temperature, solvent is added so as to completely or substantially completely submerge the blank. Pressure is applied after a predetermined critical temperature is reached, and the pressure is gradually increased thereafter until the crystal blank becomes plastic and deforms to take the shape of the die.

Upon the blank conforming to the shape of the die, the heat is cut off and both the container and hot plate are cooled by passing cold water through the cooling coils. Pressure is then released and the blank removed, ready for surface polishing or cutting to adapt it for use.

In one embodiment of the method, the steps included placing a blank of salt crystal, specifically a disc of Z-cut ammonium dihydrogen phosphate, in a die which was heated and immersed in propylene glycol as the temperature rose. The disc was 0.063 inch thick and 2 1/4 inches in diameter; a maximum temperature of 111° C. was reached to obtain the deforming and weights totalling 6.61 kilograms were then applied. It is noted that although the process of deforming under increasing heat and pressure is well known in the art, and that crystals of some substances have been deformed through such application, there is no known teaching of deforming crystals of the degree of difficulty to deform as such salt crystals as ammonium dihydrogen phosphate, and in particular there is no known teaching of the method of the

present invention to deform salt crystals. Other solvents such as higher alcohols or polyhydric alcohols may be used within the concept of the invention, the pivotal characteristic of any such solvent being that the crystal to be deformed is only slightly soluble in the solvent.

There is thus provided a method for shaping crystal blanks quickly and with a minimum amount of attention of the operator wherein the shaped blank is a unitary alteration of the original blank. The shaped blank is ready for finished grinding and polishing in a relatively short time, and unusual contours such as elliptical sections may be obtained as readily as regular contours such as a sector of a sphere.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A method of shaping a substantially flat ammonium dihydrogen phosphate crystal blank, which is at least slightly soluble in a solvent, into a concavo-convex blank, by the use of a die and a crystal solvent which comprises substantially immersing said blank in said solvent, applying heat to said solvent, and applying pressure to said blank after said blank has been heated so as to produce concavo-convex surfaces on said blank.

2. A method of shaping a substantially flat Z-cut ammonium dihydrogen phosphate crystal blank, which is at least slightly soluble in a solvent retained in a matrix, into a concavo-convex blank having substantially parallel surfaces by the use of a punch which comprises substantially immersing said blank in the solvent retained in said matrix, heating the matrix, solvent and blank simultaneously, applying pressure to said blank through said punch after said blank has been heated to a predetermined temperature, and exiting said solvent from the center portion of said matrix during the application of pressure so as to produce said concavo-convex surfaces on said blank.

3. A method of manufacturing an ammonium dihydrogen phosphate crystal blank having substantially parallel concavo-convex surfaces comprising the steps of immersing a die in a solvent in which the crystal blank is only slight-

ly soluble, positioning the crystal blank in said die, heating the die and crystal blank, applying pressure to the crystal blank after being heated to a predetermined temperature, and cooling the die and blank upon the blank conforming to the shape of the die.

4. A method of shaping a substantially flat Z-cut ammonium dihydrogen phosphate crystal blank, which is at least slightly soluble in a solvent retained in a matrix, into a concavo-convex blank, by the use of a punch which comprises substantially immersing said blank in the solvent retained in said matrix, heating the matrix, solvent, and blank simultaneously, applying pressure to said blank through said punch after said blank has been heated to a predetermined temperature so as to produce concavo-convex surfaces on said blank which are substantially parallel, and cooling said matrix, punch, and blank upon the blank conforming to the shape of the die.

5. A method of shaping a substantially flat ammonium dihydrogen phosphate crystal blank which is at least slightly soluble in a solvent, into a concavo-convex blank having substantially parallel faces, by the use of a die and a crystal solvent which comprises positioning the crystal in the matrix of said die, increasing the temperature of the die and the crystal, adding said solvent so as to increasingly immerse the crystal in the solvent while the temperature is increasing, applying gradually increasing pressure through the punch of said die when the temperature has reached a predetermined value, exiting said solvent from the lower center portion of said matrix during the application of pressure, and cooling the die and crystal upon the crystal conforming to the shape of the die.

References Cited in the file of this patent

UNITED STATES PATENTS

2,298,429	Smith	Oct. 13, 1942
2,304,217	Tillyer	Dec. 8, 1942
2,330,837	Mullen	Oct. 5, 1943
2,333,131	Tillyer et al.	Nov. 2, 1943
2,390,567	Williams	Dec. 11, 1945
2,408,540	Williams	Oct. 1, 1946
2,446,041	Blanchard	July 27, 1948
3,058,160	Mocker et al.	Oct. 16, 1962