July 3, 1951 I. I. FRIEDMAN ET AL 2,558,745

METHOD OF SELECTION OF ORIENTED SEED PLATES FOR QUARTZ SYNTHESIS

Filed April 6, 1948

FIG. 1

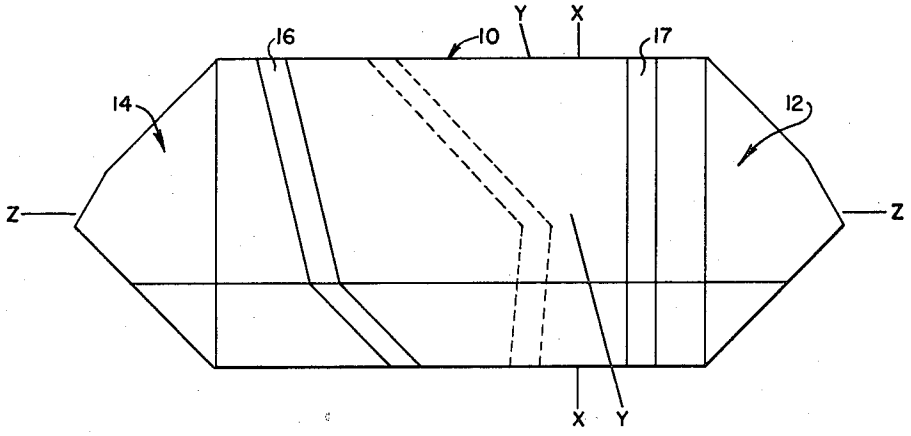


FIG. 2

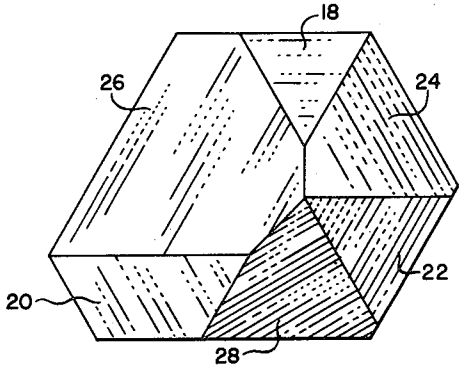
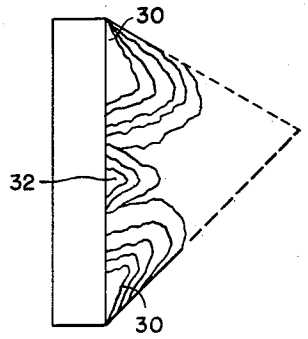


FIG. 3



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Patented July 3, 1951 2,558,745

UNITED STATES PATENT OFFICE

2,558,745

METHOD OF SELECTION OF ORIENTED SEED PLATES FOR QUARTZ SYNTHESIS

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Application April 6, 1948, Serial No. 19,394

1 Claim. (Cl. 171—327)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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This invention relates to a method of preparation of seed crystals for the production of crystals from crystallizing solution. In particular the invention relates to a method of cutting a seed crystal from bar stock of a quartz crystal so that the rate of crystal growth is increased and at a maximum.

The applicants have found that cutting a seed plate at a particular angle to the longitudinal axis of a crystal will not necessarily produce a seed plate which will promote the most rapid crystal growth from solution. This is true where the crystal is of the type which grows asymmetrical caps.

It is therefore the general object of the invention to provide a method of orientation of the cutting of seed plates from crystal bar stock of crystals which develop asymmetrical terminal caps.

It is also an object of the invention to provide a method of orienting the cutting of seed plates from crystal bar stock of crystals which develop asymmetrical caps of major and minor rhombohedral surfaces in which (method) the cut is made substantially parallel to a minor rhombohedral surface of the cap.

Other objects of the invention, such as efficiency in production etc., will be apparent from the following description and from the drawings hereto appended which are merely illustrative of the method as applied to a quartz crystal.

In these drawings:

Figure 1 represents an elevational view of a quartz crystal showing the various orientations of seeds to be cut from the bar stock of the crystal.

Figure 2 is an end view of the crystal in Figure 1. This view shows the relative positioning of the major and minor rhombs of the cap.

Figure 3 is a diagrammatic sketch illustrating the process of crystallization on the surface of a minor rhomb.

The applicants' invention resides in orienting or locating the cut to be made in the crystal bar stock so that a maximum number of plates are obtained with a minimum of wastage of material. The cuts are made in a plane which is substantially parallel to the surface of a minor rhomb of the cap. The process involves a series of mechanical steps which are related to each other and which cooperate to produce the desired seed plate.

In order that a clearer understanding may be had of the applicants' invention further reference is now made to Figure 1 of the drawings,

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wherein 10 represents generally a crystal of quartz. The X, Y and Z axes of the crystal are indicated; the Z axis being the intersection of a vertical plane through the longitudinal axis of the crystal with a horizontal plane YY through the said axis. The X axis is the intersection of a transverse vertical plane XX through the crystal with the vertical ZZ plane and the Y axis is the intersection of planes XX and YY. These planes are all mutually perpendicular. It is customary in the art to place the Z axis along the longitudinal or optical axis of the crystal and the X and Y axes as here described. It is also customary in the art to designate a "Z" cut seed plate as one which is cut transversely of the crystal parallel to the Y axis and at right angles to the Z axis so that the crystal growing faces of the seed plate will be at right angles to Z axis as shown at 17. The caps of the crystals are shown generally at 12 and 14. The orientation of a seed plate to be cut according to the applicants' invention is shown at 16. This plate is cut approximately parallel to the surface of rhomb 18 (Figure 2). It is further customary in the art to use as seed crystals, small, completely grown crystals.

In Figure 2 of the drawings there is shown an end elevation of the cap of a quartz crystal. There is a rhomb for each lateral crystal face. These rhombs comprise two groups of three each, viz, 18, 20 and 22 and 24, 26 and 28. The 18, 20 and 22 group are the minor rhombs and the 24, 26 and 28 group are the major rhombs. These rhombs are all substantially triangular in shape. Each is based on a lateral face of the crystal and the apices tend to approach a common point inwardly in the direction of the Z axis.

The applicants found that the minor rhombs grow more rapidly than the major rhombs. The reason for this is probably that the residual valence of the molecules located in the surfaces at the base angles of the rhombs is greater than at other points along the base line of the rhomb because at these angles there are three surfaces meeting at a point, viz, two lateral faces of the crystal and the crystallizing surface. This residual valence attracts clusters of ions as they come out of solution. Thus rhombs build up relatively rapidly at these base angles. This is shown at 30 in Figure 3 where the growth of the crystal at the base angles is shown relatively greater with reference to the growth 32 along the base line. The base line of the minor rhombs is of shorter length than that of the major rhombs.

Along those base lines there are only two meeting surfaces, viz, the lateral face of the crystal and the crystallizing surface. The residual valence of the molecules located along this line is therefore less than that of the molecules located at the base angles and the ions coming out of solution are attracted to the base line to a lesser degree than to the base angles. Furthermore, it is believed that the growth of crystallization along the plane of a minor rhomb is more rapid because the lattice structure of the crystalline material is such that the residual valence on this plane is the most attractive to the material in solution, i. e. the surface energy for the heterogeneous reaction is greatest normal to the minor rhomb plane. The rate of crystallization on the surface of a minor rhomb is therefore greater than that on the surface of a major rhomb. The applicants have found that these relative rates are to each other substantially as 2:1, and that seed plates cut from the crystal bar stock substantially parallel to the surface of a minor rhomb, i. e. within $\pm 5°$ of parallelism, grow much more rapidly in a crystallizing solution than seed plates cut at other angles. This is the "nub" of the applicants' invention.

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

What is claimed is:

A seed plate for promoting rapid crystalline growth of quartz in a crystallizing solution, consisting of a plate cut from a quartz crystal bar at an angle to the optical axis and parallel to one of the minor rhombs of the cap of the crystal bar.

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