UNITED STATES PATENT OFFICE.

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PRODUCING QUARTZ-GLASS FREE FROM AIR-BUBBLES.

No. 805,302. Specification of Letters Patent. Patented Nov. 21, 1905.

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To all whom it may concern:

Be it known that I, RICHARD KÜCH, a subject of the German Emperor, and a resident of Hanau, Germany, have invented certain new and useful Improvements in Producing Quartz-Glass Free from Air-Bubbles, of which the following is a specification.

As is well known, quartz-glass is melted rock-crystal. It is comparatively easy to melt rock-crystal, as it is only necessary to heat the raw material in vessels of carbon or iridium up to a temperature of over 1,700° centigrade either in an electric furnace or in a furnace with an oxyhydrogen-blowpipe. The quartz-glass so produced contains, however, numerous large air-bubbles, even if all other impurities are avoided. These air-bubbles arise from two causes—first, the rock-crystal is employed in a coarsely-pulverized state, so that during the melting process the air between the several pieces or corns is inclosed by the melting mass, and it is very hard to make this air rise in the liquid mass even by long-continued heating up to a very high temperature, and it is most probable that this air cannot be extracted at all in a practical manner; second, during the heating without special precautions the rock-crystal is apt to burst into numerous pieces, so that later on during the melting process not only the quantity, but also the size, of the air-bubbles formed in the mass in the manner indicated above will be further increased. Shenstone has endeavored to avoid the formation of the numerous and large air-bubbles in the quartz-glass by suddenly chilling with cold water the pieces that have remained intact during the heating up to about 1,000° centigrade. Such chilled pieces look white, like milk, since they have been divided into exceedingly small particles, without, however, losing their external cohesion. These chilled pieces can be at once exposed to the flame of an oxyhydrogen-blowpipe and changed into glass; but this glass is not clear at all, since it contains an endless number of very small air-bubbles.

During my experiments I have discovered three important facts, viz: First, during a very slow heating of pieces of rock-crystal in the size of from a hazelnut up to a walnut a great many of these pieces will remain intact and do not burst; second, pieces of rock-crystal heated up to a temperature of over 600° centigrade will burst more violently into smaller pieces if they are then cooled; third, those pieces of rock-crystal which have not burst during their heating up to a temperature of over 600° centigrade or show, at any rate, but insignificant cracks or crazes can be at once put to the highest temperature without further bursting, care being taken that they are not cooled meanwhile. These three facts have led me to invent a new method of producing quartz-glass free from air-bubbles.

This method is as follows: A convenient quantity of pieces of rock-crystal in the size of from a hazelnut up to a walnut is placed in a crucible or other similar vessel and heated very slowly up to a temperature exceeding 600° centigrade. Afterward with the aid of a suitable heated implement or tool (such as a pair of tongs or the like) a piece is extracted from the glowing contents of the crucible or vessel and at once exposed to the temperature required for the vitrification, care being taken to avoid every cooling. This vitrification may be effected in two manners—either the piece is exposed direct to the flame of an oxyhydrogen-blowpipe and kept in this position until its vitrification is accomplished, after which it is removed, or the piece is thrown into a vessel of a suitable material, (carbon, iridium, or the like,) which is heated up to the temperature necessary for the vitrification in a furnace with an oxyhydrogen-blowpipe or in an electric furnace. In both cases a piece of quartz-glass free from air-bubbles is obtained. Now a second piece is extracted from the glowing contents of the crucible or other vessel and treated in the same manner. The uniting of the vitrified pieces by melting them together successively to form the mass may be effected in different ways. If the vitrification is effected directly with the flame of an oxyhydrogen-blowpipe, the pieces may be melted together in the following manners: Two workmen having their own blowpipes work together, one extracting a piece of rock-crystal from the glowing contents of the crucible or vessel and exposing it at once to his blowpipe until its vitrification is effected, then giving it off at once to the other workman, who places it on the piece or rod of melted quartz-glass which he is keeping before his blowpipe, so as to cause the piece to unite with the other piece of the rod by melting. The first workman then extracts a fresh piece from the crucible or vessel, and both

workmen repeat the described operations. A single workman may perform alone the whole work by extracting a piece of rock-crystal from the glowing crucible or vessel and holding it to his blowpipe until the vitrification is accomplished. Then he keeps the vitrified piece of glass still in the flame and extracts from the crucible or vessel a second piece of rock-crystal, heated up to a temperature of 600° centigrade, which he applies to the piece of quartz-glass and causes it to melt and unite therewith, and after this he extracts a fresh piece of heated rock-crystal from the crucible or vessel and repeats the operation. Again the several pieces of heated rock-crystal are extracted one after another from the glowing contents of the crucible or vessel, exposed to the flame of the blowpipe, and turned into quartz-glass in the manner described, after which the several vitrified pieces are stored separately. Later on the uniting of these vitrified pieces may be accomplished either by the aid of the flame of an oxyhydrogen-blowpipe or in a furnace, in either case the separate vitrified pieces being successively added to the mass after the preceding piece or pieces have completely melted and united. In this manner the formation of air-bubbles in the quartz-glass is avoided, which otherwise would not be possible if several pieces or the whole mass were to be added to the contents or thrown into the vessel, respectively, at a time.

The new method thus presents three essential features, viz.: first, the slow heating of the rock-crystal up to a temperature exceeding 600° centigrade; second, the sudden change from this temperature to that required for the vitrification, and, third, the successive addition of the glowing pieces to the melting mass.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The method substantially as herein described of producing quartz-glass free from air-bubbles, which consists in slowly heating pieces of rock-crystal to a temperature exceeding 600° centigrade, then bringing the pieces to the temperature of vitrification and uniting the pieces by melting.

2. The method substantially as herein described of producing quartz-glass free from air-bubbles, which consists in slowly heating pieces of rock-crystal to a temperature exceeding 600° centigrade, then bringing the pieces successively to the temperature of vitrification, and successively uniting the vitrified pieces together by melting.

3. The method substantially as herein described of producing quartz-glass free from air-bubbles, which consists in slowly heating pieces of rock-crystal to a temperature exceeding 600° centigrade in a crucible or the like, successively withdrawing the heated pieces and bringing them to the temperature of vitrification, and successively uniting the vitrified pieces by melting.

4. The method substantially as herein described of producing quartz-glass free from air-bubbles, which consists in slowly heating pieces of rock-crystal to a temperature exceeding 600° centigrade in a crucible or the like, successively withdrawing the pieces by means of a heated tool and bringing the pieces to the temperature of vitrification, and successively uniting the vitrified pieces by melting.

5. The method substantially as herein described of producing quartz-glass free from air-bubbles, which consists in slowly heating pieces of rock-crystal to a temperature exceeding 600° centigrade in a crucible or the like, successively withdrawing the heated pieces by means of a heated tool and bringing the pieces to the temperature of vitrification by exposing them to the flame of an oxyhydrogen-blowpipe, and successively uniting the vitrified pieces by melting.

6. The method substantially as herein described of producing quartz-glass free from air-bubbles, which consists in slowly heating pieces of rock-crystal to a temperature exceeding 600° centigrade, bringing the heated pieces to the temperature of vitrification by exposing to the flame of an oxyhydrogen-blowpipe, storing the several vitrified pieces, and finally uniting the vitrified pieces by heating them and adding them successively to the melting mass.

7. The method substantially as herein described of producing quartz-glass free from air-bubbles, which consists in slowly heating pieces of rock-crystal to a temperature exceeding 600° centigrade in a crucible, successively withdrawing the pieces by means of a heated tool and bringing the pieces to the temperature of vitrification by exposing to the flame of an oxyhydrogen-blowpipe, storing the several vitrified pieces, and finally uniting the vitrified pieces by heating and successively melting them together to form the mass.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

RICHARD KÜCH.

Witnesses:
FRANZ HASSLACHER,
ERWIN DIPPEL.