April 20, 1926. 1,581,829

E. R. BERRY

QUARTZ WORKING

Filed March 29, 1921

Fig. 1.

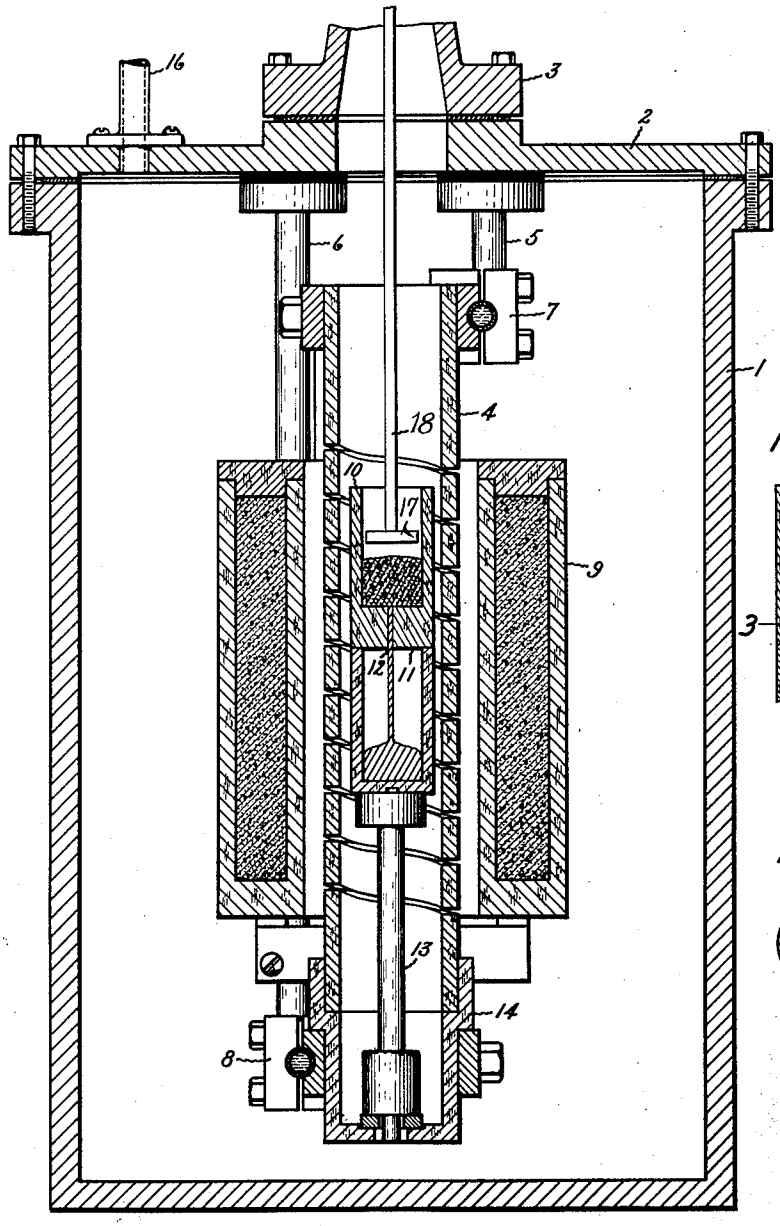


Fig. 2.

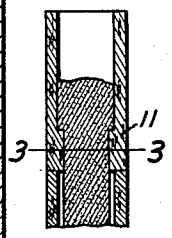
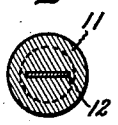


Fig. 3.



Inventor
Edward R. Berry
By Albert G. Davis
His Attorney

Patented Apr. 20, 1926.

1,581,829

UNITED STATES PATENT OFFICE.

EDWARD R. BERRY, OF MALDEN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

QUARTZ WORKING.

Application filed March 29, 1921. Serial No. 456,577.

To all whom it may concern:

Be it known that I, EDWARD R. BERRY, a citizen of the United States, residing at Malden, in the county of Middlesex, State of Massachusetts, have invented certain new and useful Improvements in Quartz Working, of which the following is a specification.

The present invention relates to the production of substantially bubble-free silica glass or vitreous quartz.

One of the difficulties encountered in the working of silica is the cracking of quartz crystal during heating, and the consequent presence of air bubbles in the fused material, these bubbles frequently being so numerous and so small as to give the silica a milky or cloudy appearance.

In accordance with my invention, substantially bubble-free silica is produced by extruding silica while plastic through a contracted opening, preferably a narrow elongated slit. As a result of the molten silica being spread out into a thin ribbon, the entrapped air bubbles are substantially entirely eliminated. The extruded silica then is caused to coalesce in a vacuum forming clear homogeneous slugs.

The accompanying drawing illustrates in Fig. 1 in vertical section an apparatus suitable for carrying out my invention; Figs. 2 and 3, respectively, are detail views of the extrusion duct being respectively vertical and horizontal sections.

The furnace shown in Fig. 1 is particularly adapted to carry out a fusion at reduced gaseous pressure. I wish it to be understood, however, that the benefits of my invention are not entirely dependent upon the practice of the process in a vacuum although benefits are derived by the use of a vacuum.

Referring to Fig. 1 of the drawing, the furnace here shown comprises a tank 1 having a cover 2 bolted thereto with a gas-tight joint. The cover may be provided with an extension 3 indicated in part broken away. A heater 4 consisting of graphite or other suitable material is suspended from the cover by the conductors 5, 6. These conductors are suitably insulated from each other and from the cover as indicated and are connected to external terminals (not shown). Preferably they are made tubular and serve also to convey a cooling fluid to the terminal clamps 7, 8. A heat screen 9 preferably surrounds the heater. Located in the heating space within the heater 4 is a container, 10 which has two compartments separated by a transverse wall 11 containing a duct 12, as best shown in Figs. 2 and 3. The duct 12 may have various shapes but preferably it is constituted of an elongated narrow slit, as indicated. For example, the duct 11 may be $\frac{1}{2}''$ in length and $\frac{1}{16}''$ in width. The container 10 is supported by a pedestal 13 resting on the terminal cap 14 of the heater 4. The container consists of material inert with respect to molten silica, as for example graphite.

In accordance with my invention a quantity of pure silica, as for example quartz crystal, is placed in the upper compartment of the receptacle 10, and the interior of the furnace is exhausted of air through the tube 16. A heating current is conveyed to the resistor 4 to bring the silica to a plastic state. When quartz crystal is used, it cracks into many pieces at about 550° C., but subsequent coalescence of these pieces will trap little gas in so far as the gases within the container have been removed. As it is not possible to entirely remove the gas some bubbles will be trapped in the mass when the pieces of quartz coalesce as a glassy mass at about 1650° C. To bring the silica glass to thin liquidity would require a temperature of about 2000° C. with large accompanying losses of silica by vaporization. Instead of attempting to remove gas bubbles by heating the silica glass to sufficient liquidity to cause the gas bubbles to rise, I prefer to heat the silica to a plastic state only, say, up to 1750° C. and cause the plastic mass to flow through the slit 12 into the lower container. In some cases, especially when an opening of very constricted dimensions is used, I may assist the flow of the silica glass by mechanical pressure transmitted through a piston 17 consisting of graphite or other suitable material. The use of a piston is not necessary in all cases. The stem 18 passes through a suitable bushing in the cover extension 3. The material issuing from the constricted opening is substantially free from bubbles. It is probable that the elimination of bubbles is due to the high surface tension of the plastic silica which by virtue of the large surface exposed

and the proximity of the gas cavities to the surface cause the walls of the cavities or bubbles to collapse.

The material may be collected in the lower chamber, caused to coalesce as indicated, and utilized in the form of slugs in subsequent operations, or the silica may be used directly in ribbon form.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The method of freeing silica from gas bubbles which consists in extruding the silica in a plastic state in a vacuum through an opening sufficiently restricted to cause bubbles to break through the surface of the silica, and thereupon causing said extruded silica to coalesce in a vacuum.

2. The method of freeing silica from entrapped cavities which consists in extruding the silica in a plastic state through a slit of such narrowness that the surface tension of the silica causes the cavities to collapse.

3. The method of producing clear vitreous quartz which consists in melting crystalline quartz in an attenuated atmosphere, removing bubbles therefrom by passing the quartz while heated to a temperature of about 1750° C. through a restricted opening, and causing the extruded silica to recoalesce.

4. An apparatus for freeing silica from entrapped air which consists of the combination of two containers communicating with each other by a narrow slit, heating means for causing quartz in one container to become sufficiently plastic to pass through said slit into the other container, and means for maintaining a vacuum about said container.

5. The process of producing vitreous silica substantially free from bubbles which consists in fusing crystalline quartz in a vacuum, forcing the fusion while plastic through a restricted duct in a vacuum, and causing the extruded silica to coalesce in the form of slugs.

6. The step in the process of making clear silica ware which consists in forcing under pressure plastic silica containing entrapped bubbles through a duct of such small dimensions that the bubbles in said silica are largely eliminated.

7. The step in the process of making clear silica ware which consists in spreading plastic silica containing gas bubbles into thin ribbons thereby eliminating a substantial number of said bubbles and thereupon causing said ribbon to coalesce in a vacuum.

In witness whereof, I have hereunto set my hand this 25th day of March, 1921.

EDWARD R. BERRY.