

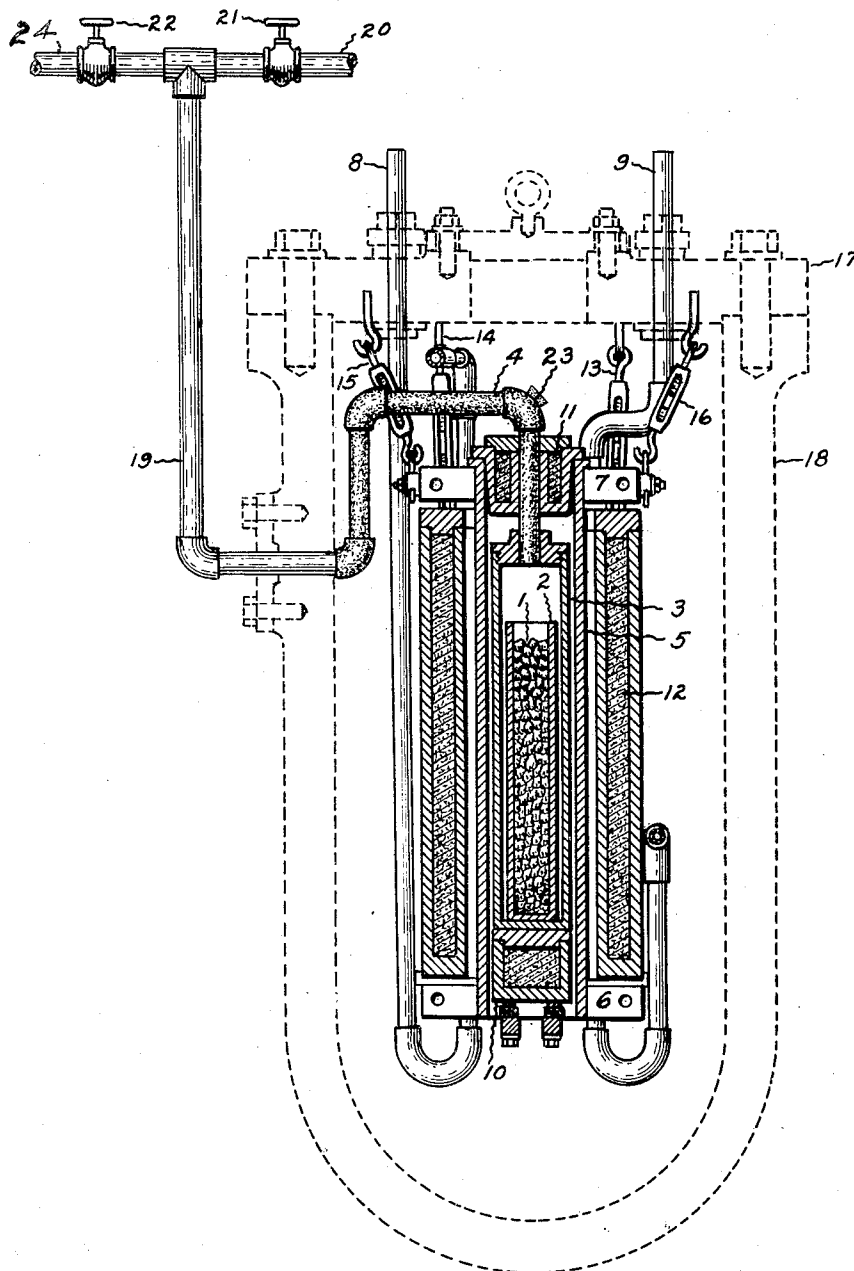
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P. K. DEVERS

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ELECTRIC FURNACE

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UNITED STATES PATENT OFFICE.

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ELECTRIC FURNACE.

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The present invention relates to a process and to an electric furnace particularly adapted for the preparation of vitreous silica, also commonly known as fused quartz, and it is an object of my invention to better the product and increase the length of life of the fusion apparatus.

As described in my prior Patent No. 1,536,821 of May 5, 1925, fragments or particles of quartz first are fused in a vacuum and the product of this fusion then is fabricated into objects of desired form by pressing, drawing, extrusion or the like. If material of a high quality is desired relatively high pressure is applied upon the vacuum-fused material while it is plastic to eliminate cavities occurring therein.

The vacuum fusion heretofore was carried out in an open graphite container, the required high temperature being produced by a graphite resistance heater which is spaced about the graphite container in which the fusion is carried out. A temperature of about 1750° C. is required to fuse quartz. This heater necessarily is heated to a higher temperature than the container or its contents. As a consequence the outer layer of the fusion reacted chemically with the graphite container and if the products of the reaction diffuse through the mass which may happen even before the quartz crystal pieces composing the charge begin to coalesce, further reduction may set in, leaving a coating around the various pieces after they have fused together. The quality of the material is deteriorated by this variation in composition and made unfit for certain purposes, particularly for high grade optical devices. I have found that this condition may be substantially avoided by drawing off products of reaction very rapidly as they are formed and in a certain specified manner as described hereinafter. As a consequence a high grade product free from striæ may be produced.

In carrying out my invention the quartz or silica is confined during the fusing process to a closed container, thus minimizing the effect of carbonaceous vapors on the silica fusion and also shielding the incandescent heater from the silica vapors arising from the fusion. Even though the carbonaceous vapors may react with the silica at the contact surfaces this reaction is not allowed to penetrate the mass.

My invention may be better understood by reference to the following description taken in connection with the accompanying drawing which shows in vertical section a furnace embodying my invention.

Referring to the drawing, the charge 1 of silica (ordinarily consisting of fragments of quartz crystals) is contained in a crucible 2 which is placed within a gas-tight receptacle 3. Both the crucible and the receptacle 3 may consist of suitable highly refractory material, such as graphite or molybdenum or tungsten. Into the cover of the receptacle 3 is inserted a graphite tube 4 through which gases may be exhausted. Surrounding the receptacle 3 is a tubular heater 5, ordinarily consisting of graphite. Electric contact is made at opposite ends of the heater 5 by the terminals 6 and 7 which may consist of copper. A cooling fluid may be supplied to these terminals by the pipes 8 and 9, part of the circulatory cooling system having been shown cut away to provide a more simplified drawing. The container 2 for the quartz fusion rests on a graphite cup 10 filled with powdered graphite and acting as heat screen. Surrounding the exhaust tube 4 and resting upon the upper end of the heater 5 is a second graphite screen 11. A cylindrical graphite screen 12 surrounds the heater 5.

This entire structure is supported by the suspension rods 13, 14, 15, 16 from the cover 17 of a steel casing 18, and therefore is maintained substantially out of direct thermal contact with the outer enclosure. This outer casing has been shown in dotted lines as it may be omitted in some cases when vacuum fusion only is desired. The cover 17 is bolted to the tank 18 which is made vacuum-tight as described in my prior Patent No. 1,536,821 and as moreover well understood in vacuum furnace practice. The water cooling tubes 8 and 9 are led through the cover 17, the joints being made vacuum-tight as indicated.

The graphite exhaust pipe 4 is joined to a metal pipe 19 which is connected in turn to an exhaust pump (not shown) by a valved pipe 24. If desired the pipe 19 also may be connected to a source of gas under pressure by a valved pipe 20. Preliminary to making a quartz fusion the valve 21 in the pipe 20 is closed and the vacuum valve 22 to the vacuum system is opened thereby withdraw-

ing gas from the fusion chamber. Due to the porosity of graphite, the gas in the space outside the housing 3 in the tank 18 is exhausted at the same time by the gas seeping from this space through the interstices in the graphite and through the joints between the graphite exhaust pipe and the receptacle 3. If it is desired to obtain a slug fused only in vacuum or a slug made in vacuum and then subjected to slight pressure, I may do away with the steel casing 18, and make the graphite vacuum system heavy walled. This system may then be suspended in the carbon tube furnace as well understood in furnace practice. Vacuum slugs such as are made in the usual way and later extruded into the form of tube, rod, ribbon and the like from a carbon tube furnace, may be made in this manner, or the bubbles in this slug may be appreciably reduced for certain purposes by applying a pressure of about 100 lbs. per sq. in. or even a greater pressure in the graphite vacuum system. The required pressure may be obtained by closing the vacuum valve 22 and admitting gas under pressure through the valved pipe 20.

When the vacuum-fused product is to be subjected to higher pressures, as described in my prior patent, the graphite walls of the container 3 and the pipe 4 may be made sufficiently thick-walled and tight at the joints to withstand the required pressure. Plugs may be inserted in holes provided somewhere in this system as indicated at 23. When a gas under pressure is admitted, these plugs are blown out and the pressures inside and outside the graphite container are equalized.

The following advantages are obtained by exhausting the immediate space about the quartz fusion by a conduit communicating with a closed receptacle surrounding the fusion: First, the gases evolved from the fusion which attack the carbon at incandescence are removed at a more rapid rate than would be the case if they were permitted to diffuse throughout the space within the outer enclosing envelope; secondly, the quartz fusion is protected from the carbon vapors from the highly incandescent heater, and in the third place the heater is protected from the chemical effect of silica vapors and hence its life is greatly prolonged.

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

1. An electric furnace comprising an enclosed charge-receiving receptacle consisting of graphite, means for evacuating said receptacle, a vacuum-tight outer envelope

wholly enclosing said receptacle, and a heater external to said receptacle and contained within said outer envelope.

2. An electric furnace comprising an enclosed charge-receiving receptacle consisting of porous refractory material, a conduit communicating therewith for evacuating said receptacle, means for electrically heating said receptacle, and a gas-tight enclosing envelope, the porosity of the wall of said receptacle and communicating conduit being sufficient to permit of the evacuation there-through of the space in the outer envelope.

3. An electric furnace comprising a mechanically sealed metal receptacle, a carbonaceous inner chamber which is closed but provides interstices for the slow passage of gas therethrough, a resistance heater external to said inner chamber but within said receptacle and a conduit consisting of carbonaceous material communicating with said inner chamber and extending to the exterior of said receptacle.

4. A vacuum furnace comprising a sealed container, a second container consisting of porous refractory material located within said first container, a crucible supported therein, a resistance heater surrounding said second container and means for exhausting gas directly from said second container, the porosity of said second container being sufficiently great to permit of the evacuation of the first container through said second container.

5. A furnace comprising a sealed outer container, an inner container, a charge-receiving receptacle therein, means for supporting said inner container spaced out of direct thermal contact with the outer container, a conduit provided with closures removable by internally applied pressure communicating with said inner container and means for heating said inner container.

6. An electric furnace comprising an outer metal container capable of being made vacuum-tight, an inner container consisting of carbonaceous material, means for suspending said inner container from the wall of the outer container, a gas exhaust pipe extending from the exterior through the space between said containers and communicating with the inner container, a radiant heater surrounding said carbonaceous container, a heat screen interposed between said heater and the outer container.

In witness whereof, I have hereunto set my hand this ninth day of July, 1925.

PHILIP K. DEVERS.