

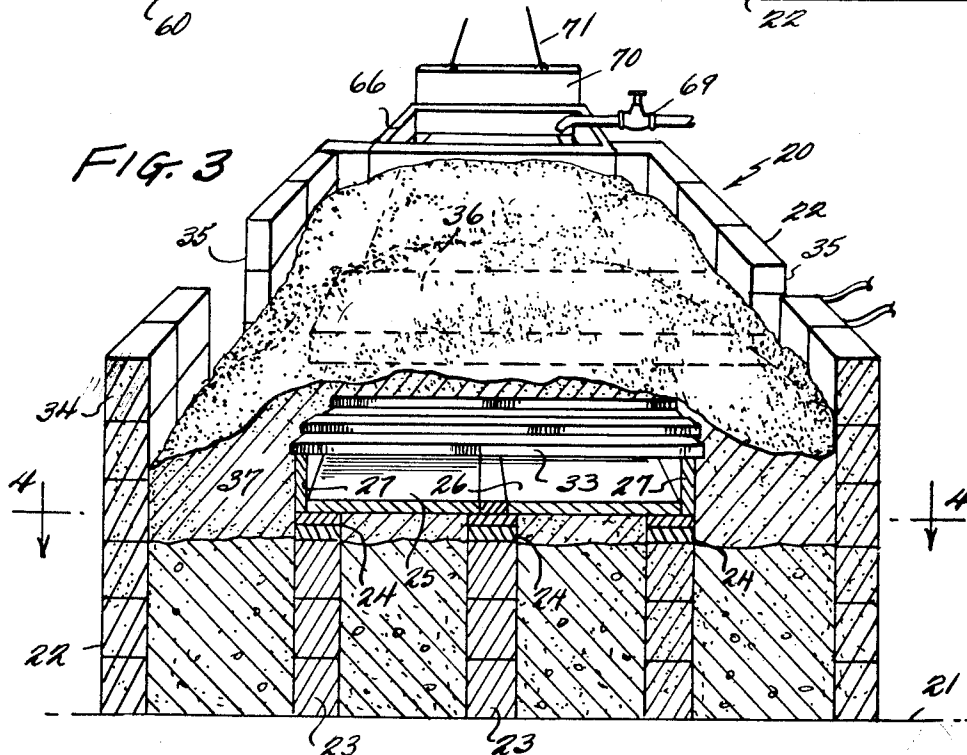
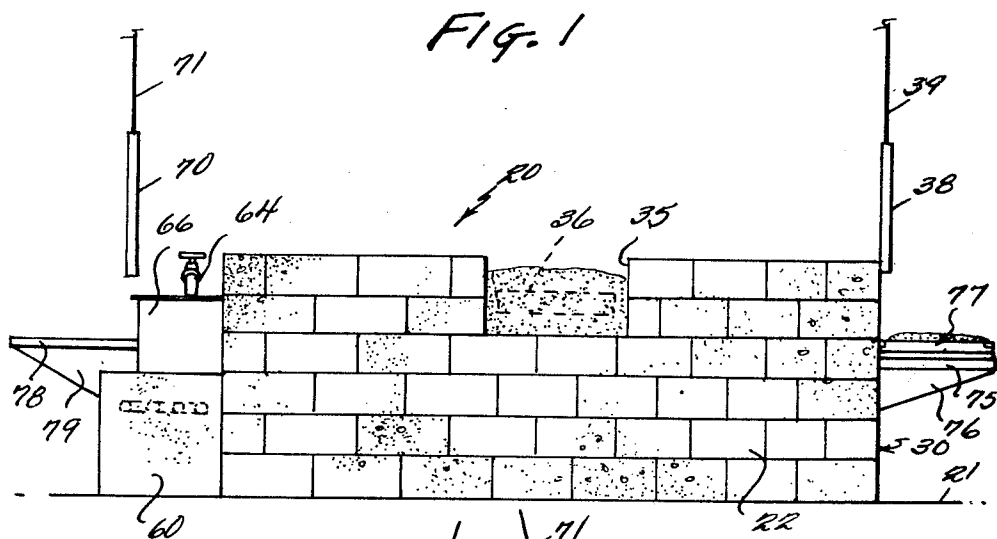
July 28, 1964

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APPARATUS FOR PRODUCING QUARTZ

3,142,717

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5 Sheets-Sheet 1



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FIG. 2

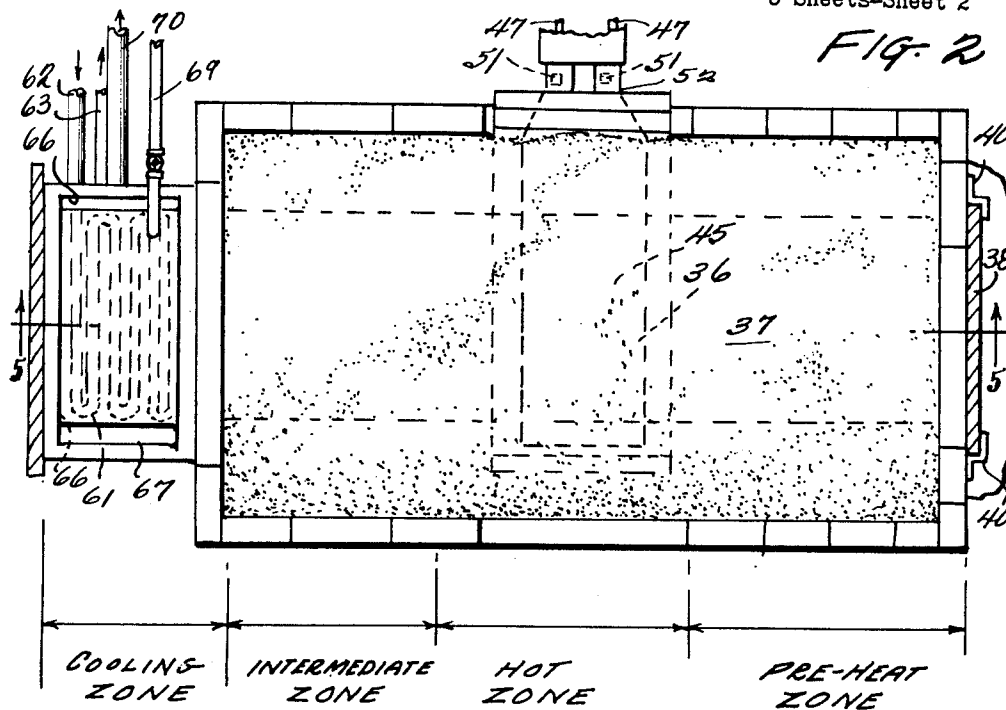
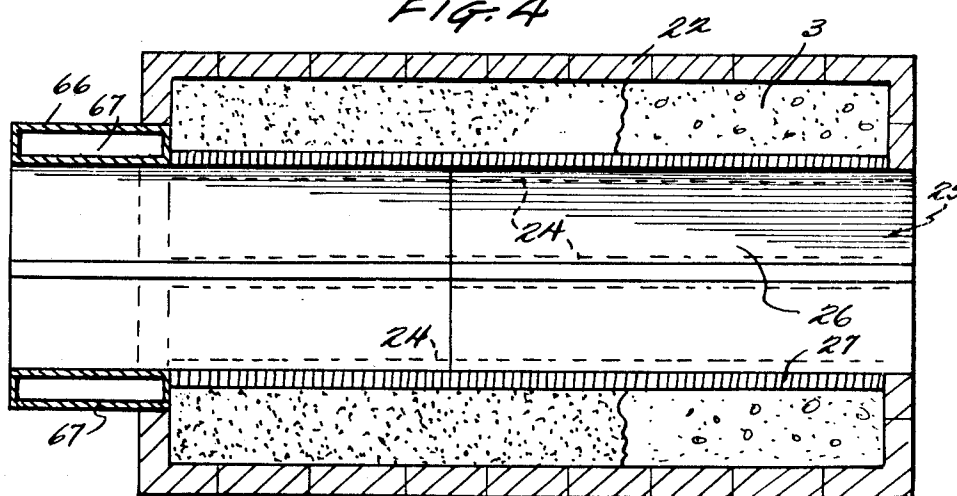


FIG. 4



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FIG. 5

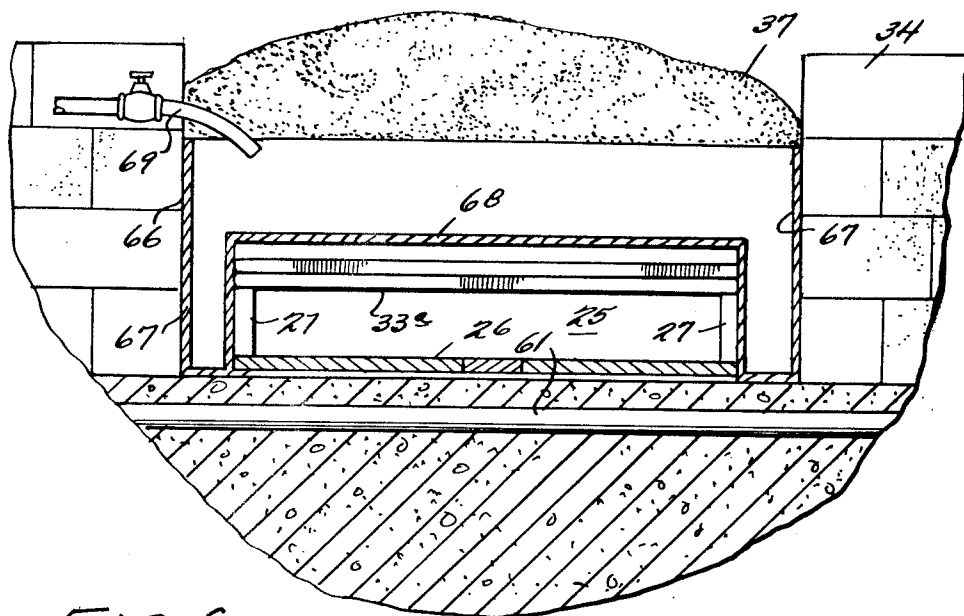
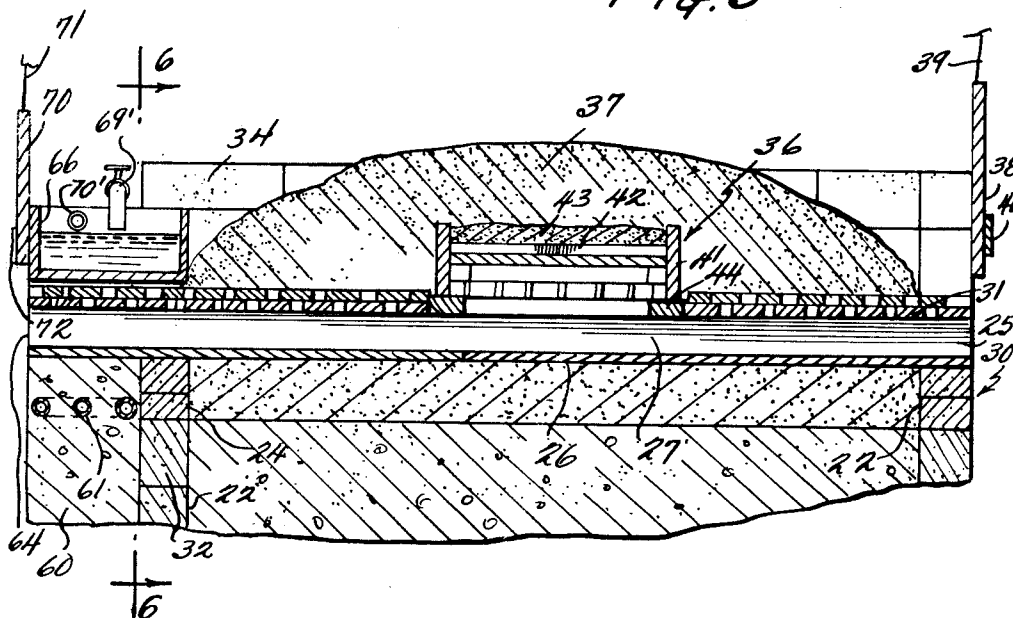


FIG. 6

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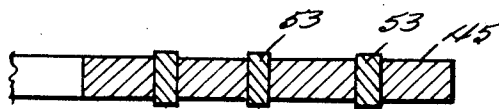
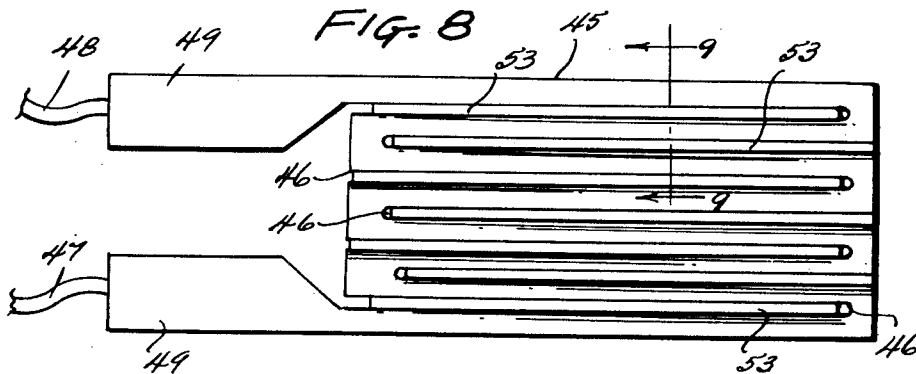
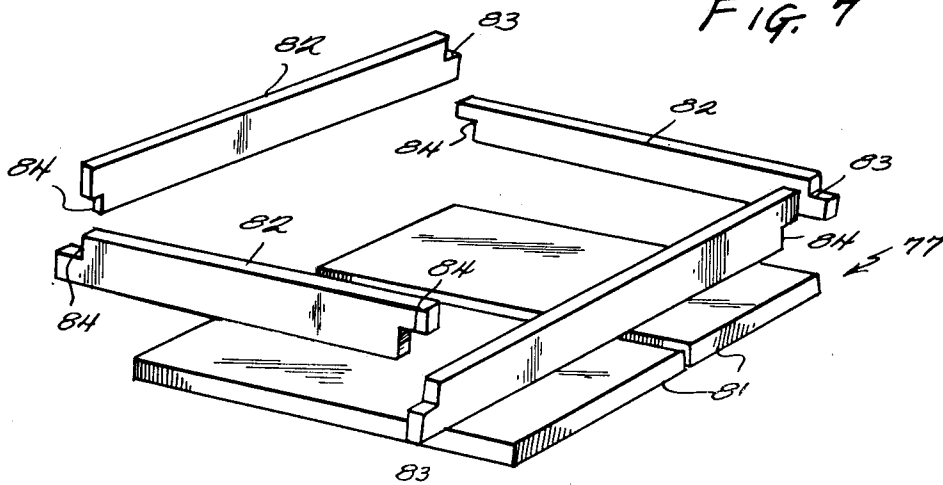


FIG. 9

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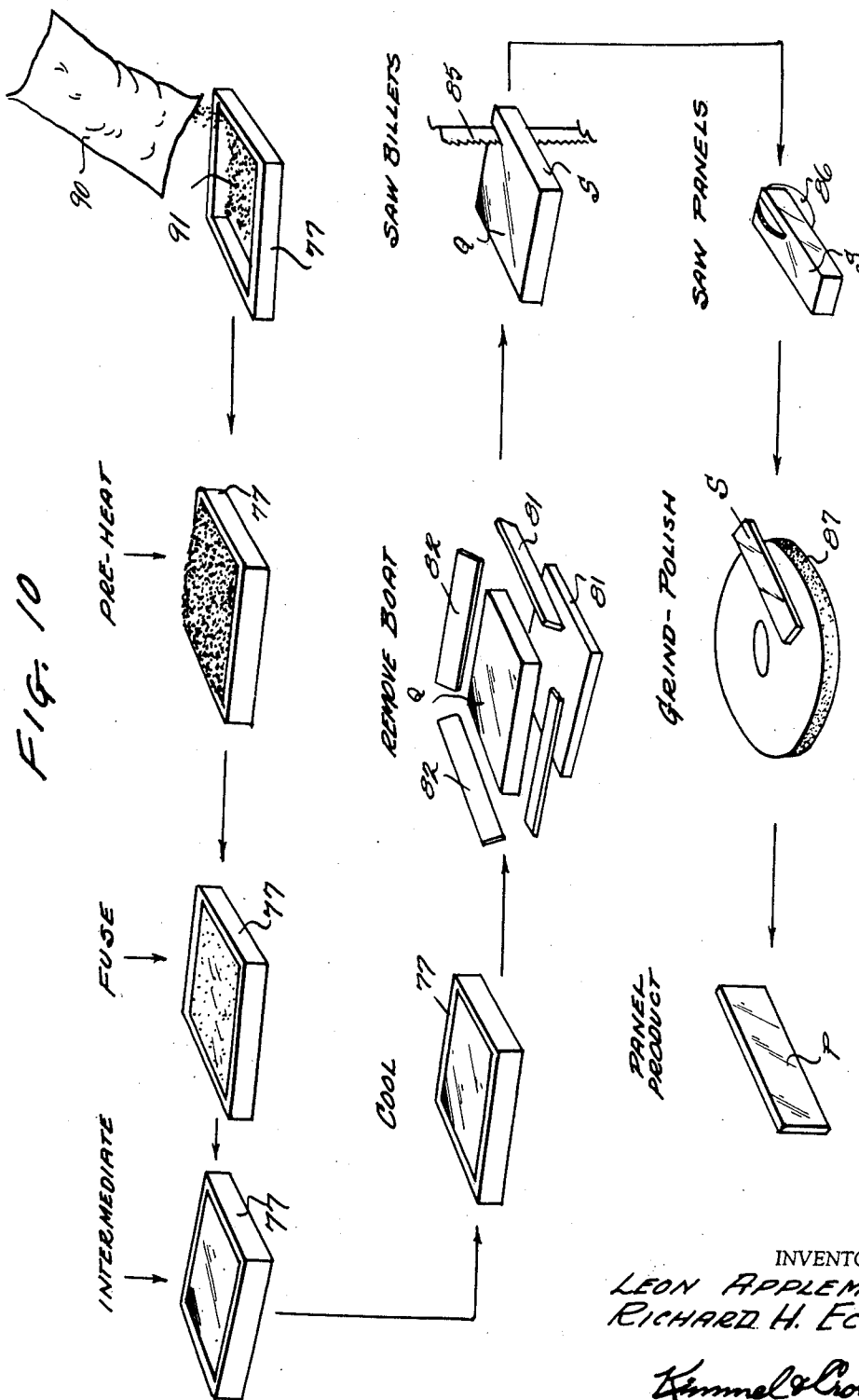
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APPARATUS FOR PRODUCING QUARTZ

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2 Claims. (Cl. 13-6)

This invention relates to an apparatus for producing quartz, and more particularly quartz billets or panes of high quality suitable particularly for the diffusion of radiant heat in cooking processes, although obviously quartz produced by this method may be employed for other purposes.

A primary object of the invention is the provision of an apparatus for producing quartz of a high degree of purity characterized by substantially the complete fusing of the sand employed and the absence of deformation of the fused billet during processing, characterized by the absence of elongated air pockets such as customarily found in blown, drawn or rolled silica.

A further object of the invention resides in the provision of an improved furnace for the fusion of high purity quartz characterized by simplicity of construction and resistance to the high fusion temperatures necessary to achieve the desired result.

A more specific object of the invention resides in the provision of an improved knocked down type tray or boat from which the billets may be removed after fusion with a minimum of effort and difficulty.

Still other objects reside in the combinations of parts, arrangements of elements, and features of construction of the apparatus, all as will be more fully pointed out hereinafter and disclosed in the accompanying drawings wherein there is shown a preferred embodiment of the furnace of the instant invention.

In the drawings:

FIGURE 1 is a side elevational view of the furnace.

FIGURE 2 is a top plan view of the furnace as shown in FIG. 1.

FIGURE 3 is a perspective view, partially broken away and partially in section, taken from the feeding end of the furnace.

FIGURE 4 is a sectional view taken substantially along the line 4-4 of FIG. 3 as viewed in the direction indicated by the arrows.

FIGURE 5 is a sectional view taken substantially along the line 5-5 of FIG. 2 as viewed in the direction indicated by the arrows.

FIGURE 6 is an enlarged sectional view taken substantially along the line 6-6 of FIG. 5 as viewed in the direction indicated by the arrows.

FIGURE 7 is an exploded perspective view of one of the boats comprising an element of the instant invention.

FIGURE 8 is a plan view of a heating element removed from the furnace.

FIGURE 9 is an enlarged sectional view taken substantially along the line 9-9 of FIG. 8 as viewed in the direction indicated by the arrows, and

FIGURE 10 is a diagrammatic view showing the several steps in the utilization of the disclosed apparatus.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings in detail, and more particularly to the furnace structure per se as disclosed in FIGS. 1 to 6, inclusive, there is generally indicated at 20 a furnace which is positioned on a suitable base 21, preferably in the form of a concrete floor. A suitable wall is formed of cinder blocks, as indicated at 22, and may be of any desired dimensions, although preferably of rectangular shape and about 4 feet high with an 8 foot width and a 12 foot 6 inch length. Longitudinally extending cinder block piers 23 are provided centrally of

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the box of enclosure. The piers are preferably approximately 3 feet 3 inches in height. The enclosure is then filled with a mixture of cinder concrete, which is firmly tamped every six inches of depth to level with the top of the piers. After the mixture is dried two layers of "alundum" brick are positioned on top of the piers, as shown at 24 (FIG. 3) to bring the piers level with the top of the walls. The remainder of the box is then filled with silica sand.

A longitudinally extending graphite tunnel extends the full length of the furnace, as generally indicated at 25, and includes a floor 26 and side walls 27 made of pure graphite slabs. The bottom of the tunnel is approximately 35 inches, in width, and the side walls approximately 6 inches high. The opposite ends of the tunnel are open to permit the introduction and removal of the silica to be fused, in a manner to be more fully described hereinafter.

The tunnel 25 is divided arbitrarily into four zones, the preheat zone, which is adjacent the input end wall 30, the heating zone, the intermediate zone, and the cooling zone. These four zones will be described more fully hereinafter. The tunnel 25 is roofed as at 31 over the pre-heat zone by alternate spaced slabs of graphite 32, in two layers, the slabs of the lower layer being spaced apart, and the slabs of the upper layer being loosely laid over the spaces. The intermediate zone is also roofed with graphite slabs as indicated at 33a (see FIG. 5). After the tunnel has been formed of graphite, the side walls 22 of the enclosure are built up as indicated at 34, openings being left in the wall 30, as well as the rear wall 31, at the input and outlet openings of the tunnel 25. Openings 35 are also left in the opposite side walls for the reception of a transversely extending heating element, generally indicated at 36, and to be more fully described hereinafter. After the heating element 36 has been suitably positioned over the hot zone of the furnace, and between the pre-heating and intermediate zones, the entire top of the tunnel and heating element are covered with loose sand, as indicated at 37, providing insulation at the top of the pre-heating, hot, and intermediate zones.

The input opening of tunnel 25 is adapted to be closed by suitable graphite slab 38, which is suspended from cables 39, which are suitably mounted in pulleys or the like from the ceiling to facilitate raising and lowering of the same. Guides 40 may be provided if desired to insure the complete closure of the open end of the tunnel by the slab during the process, which will be more fully described hereinafter.

The heating unit 36 is comprised of transversely extending side walls 41, which are also constructed of graphite, and between which is positioned a barrier or horizontally disposed partition 42 also of graphite. The barrier 42 is positioned below the tops of the side walls 41, and the space above the barrier 42 is filled completely with lampblack 43, to provide added heat insulation.

The partition 42 defining the bottom of the carbon black filled box is approximately 3 inches above the open roof of the tunnel.

Alundum bricks 44 positioned across the roof of the tunnel 25 at the opposite ends of the hot zone serve as supports for graphite electrodes 45 which are positioned approximately one inch above the bottom of the roof as defined by the graphite slabs 33. Electrodes 45 are formed as shown in FIG. 8 with a series of spaced cuts 46 extending from opposite ends thereof, and are supplied with current through wires 47 and 48 at opposite ends thereof. The electrodes are connected in open delta connection to a source of power, which is preferably 120 volt, three phase, 1000 amp. power. The terminal ends

49 of the electrodes are supported, as best shown in FIG. 2, on suitable graphite blocks, and are held in position by steel weights 50, which may weigh approximately 150 pounds. The copper feed wires 47 and 48 are connected to the source of power through 4 inch graphite blocks 51, which are contained in water cooled copper blocks 52, to prevent oxidation of the copper wires.

The slots 46 formed in the electrodes 45 are preferably filled with mica spacers 53, as best shown in FIG. 9, which serve as insulators.

The heating element is positioned substantially centrally of the enclosure formed by the cinder blocks, and defines the hot zone of the furnace, the pre-heat zone being on one side thereof and the intermediate zone on the other side. The cooling zone is formed on the outside of the enclosure, and is comprised of a "firecrete" block 60, in which are embedded copper cooling coils 61, the coils being provided with an external inlet 62 and outlet 63, as best shown in FIG. 2. The lower portion of the tunnel wall comprised of an extension of the slab 26 extends over the "firecrete" cement block 60 to the outlet opening 64 (see FIG. 5). A water tank 66 of generally inverted U-shaped configuration, as best shown in FIG. 6, includes side leg portions 67 which extend downwardly adjacent the sides 27 of the tunnel, and an upper portion having a bottom wall 68 which overlies the top of the tunnel. The tank 66 is normally kept filled with water, by means of a water inlet 69, and is provided with an overflow pipe 70'. The purpose of the cooling zone and its function will be more fully described hereinafter in conjunction with the method of the instant invention.

A closure slab 70 is provided adjacent the end 64 of the tunnel, and is suitably supported as by means of a cable or wire 71 in guide 72 in a manner similar to that of the previously discussed closure plate 38, the arrangement being such that both ends of the tunnel may be closed during the fusing process.

The openings 35 in the side walls of the rectangle at the opposite ends of the heating element 36 are provided to permit the introduction of wires to the electrodes from one side, and on the opposite side merely to provide an access opening.

As best shown in FIG. 1, a supporting tray 75 is positioned adjacent the inlet end of tunnel 25, and is supported on braces 76 and is adapted for the reception of a boat or tray 77 into which the sand is initially positioned in the process or method of the instant invention, as will be more fully described hereinafter. The filled boat 77 may be conveyed to the shelf 75 either manually or by means of any suitable automatic conveyer (not shown).

A second shelf 78 is mounted on braces 79 at the opposite or outlet end of the furnace, and is supported on braces or brackets 79. The boat 77 containing the fused quartz upon the completion of the process may be removed from the tray or shelf 78 in any desired manual or mechanical manner, or the boats may be removed, in a manner to be more fully described hereinafter, and the fused quartz blocks after cooling may be transferred to any desired locality for further processing.

A boat constructed in accordance with the instant invention is generally indicated at 77 in FIG. 7 and includes a pair of graphite slabs 81 forming the base or bottom, and four spaced side wall members 82, each of which is provided with an upper cut-out portion 83, and a lower cut-out portion 84, the arrangement being such that adjacent portions 83 and 84 interengage to form corner structures which provide a loosely interfitted rectangular box adapted to be passed through the furnace during the process of the instant invention.

Having described the furnace structure in detail, the use of the instant invention may be best understood by reference to FIG. 10 of the accompanying drawing. A boat 77 is first filled with the raw material of the process of the instant invention, which comprises pure white silica sand. One type of such sand is that furnished by the

Wedron Silica Company and known as Number 1 washed and dried sand, Grade 4030, shipped in 100 pound bags. As shown in FIG. 10, the bag is indicated at 90, and the sand at 91. Analysis of this sand discloses that it comprises 99.77% silica, the remaining ingredients varying,

but only the silica being of importance to the instant process. After a boat is filled it is positioned as indicated on the shelf 75, and pushed manually or by any suitable mechanical means, into the pre-heating chamber. Since the lengths of the boats are substantially equal to the width of each zone, the introduction of a second boat to the pre-heating chamber will pass the first boat into the hot or fusing chamber, and a further boat will cause the first boat to pass to the intermediate chamber and still another boat will cause the passage of the first boat to the cooling chamber as indicated in the schematic flow diagram of FIG. 10. It will thus be seen that there is provided a semi-continuous process for fusing quartz. In the initial starting of the furnace, assuming that the furnace is cold, three boats are loaded into the tunnel 25, with the second and third boats being filled with the sand comprising the raw material of the instant invention. The boats may be spaced apart as desired by one inch spacers laid therebetween. The second boat is centered under the heating electrode in the hot zone, and both ends of the furnace are sealed by means of the graphite slabs 38 and 70, and additionally by fiber glass blankets (not shown), if desired. The furnace should be kept sealed at all times to prevent burning of the graphite. Electrodes 45 are then energized, and the furnace is kept sealed for a necessary length of time to permit the fusing of the silica in the boat in the hot chamber. This time may vary, but has been found by experimentation to be approximately 3 and a half hours under conditions of an input of 150 kilowatts in a furnace of the described dimensions. At the expiration of this period a new boat is inserted at the input end of the furnace, the furnace again sealed for approximately 1 and a half hours. At the end of this time the furnace may be considered to have reached maximum operating efficiency, and the third boat is pushed into the furnace and the furnace resealed and maintained sealed for approximately 55 minutes. Subsequent boats are introduced at fifty-five minute intervals, so that when the process is at full activity each boat remains in hot zone for a period of about 55 minutes. This time may vary with various furnace constructions, but with the input and furnace size herein described, it has been found that this time is the maximum allowable, because a longer time causes gas to be given off from the graphite in the boat bottom, which blows up the billet and jams the furnace. A lesser time is also permissible, but a full depth of fusion is achieved in the specified time. A lesser time results in a layer of unfused sand on the bottom of the billet which cannot be reused.

A varying electrical input is also possible, but a lesser input than the specified 150 kilowatts will take a longer time to reach full fusion. An input of less than 100 kw. is unsatisfactory because sand placed in the furnace at such input may remain indefinitely without fusion taking place.

A greater input may occasion strains to be developed in the billet due to the higher temperature and the shorter fusion time, and therefore, the shorter cooling time since the boats are all in line, and the cooling is determined by the fusion time. Such strains may occasion cracks in the billet reducing the value of the billet.

The temperature in the hot chamber is approximately 3800° F., which is the fusing temperature for quartz, and any higher temperature will, in addition to fusing a given quantity of sand more rapidly, also sublimate the top surface of the billet. The temperature is thus substantially self limiting due to the heat energy required in the sublimation of the top layer of the billet.

At the expiration of the desired time the silica sand has reached a completely fused vitreous non-crystalline stage and the quartz is completely formed. After leaving the

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hot zone the billet and its associated boat passes to an intermediate zone, where it slowly cools from the temperature achieved in the hot zone, and then to the cooling zone, where further cooling is effected. This is necessary before exposing the graphite boat to room air since otherwise at the temperature of the boat rapid oxidation would occur and the life of the boat would be very short, increasing the cost of the operation materially.

At the termination of the 55 minute period in the cooling zone the boat is removed to the shelf 78, at which time the portions 82 may be disassembled from the bottom 81 and the quartz billet Q, now completely fused, removed for further processing. Such processing includes the steps of slicing the billets Q into thin slabs as with standard wire rock saws 85, and cutting the slabs S to proper size with a rotary diamond saw 86. The slabs S are then surface ground with a wet Carborundum wheel 87 to remove saw marks and the resultant finished panel product P may then be employed in any desired manner.

From the foregoing it will now be seen that there is herein provided an improved apparatus for manufacturing quartz billets, which accomplishes all of the objects of the invention, and others, including many advantages of great practical utility and commercial importance.

As many embodiments may be made of this inventive concept, and as many modifications may be made in the embodiment hereinbefore shown and described, it is to be understood that all matter herein is to be interpreted merely as illustrative, and not in a limiting sense.

We claim:

1. A furnace for the production of quartz comprising a base formed of heat resistant blocks in the shape of a rectangle, sand filling said rectangle, a longitudinally extending tunnel formed of graphite slabs, said tunnel being open at the ends thereof, said tunnel including a top wall

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and side walls, there being an opening portion in said tunnel top wall intermediate said tunnel ends defining a heating zone, a heating unit disposed above said tunnel open portion, said unit including side walls and a partition extending between said side walls, said partition being spaced below the upper ends of said side walls and with the portions of said side walls above said partition defining a space, lamp black filling said space, sand covering said tunnel for the entire length of said base, an area in said tunnel of equal extent on each side of said heating zone defining respectively a preheating and a cooling zone, an inverted U-shaped tank disposed between said cooling zone and the adjacent end of said tunnel, said tank having the leg portions thereof extending downwardly and adjacent said side walls of said tunnel and with the bight of said tank superimposed upon the top wall of said tunnel, said tank being provided with an inlet for cooling water and with an overflow outlet.

2. The apparatus according to claim 1 in which said heating unit comprises a graphite electrode, and copper feed wires extending through water cooled copper blocks and graphite blocks to prevent oxidation of said feed wires.

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