A. EIMER.

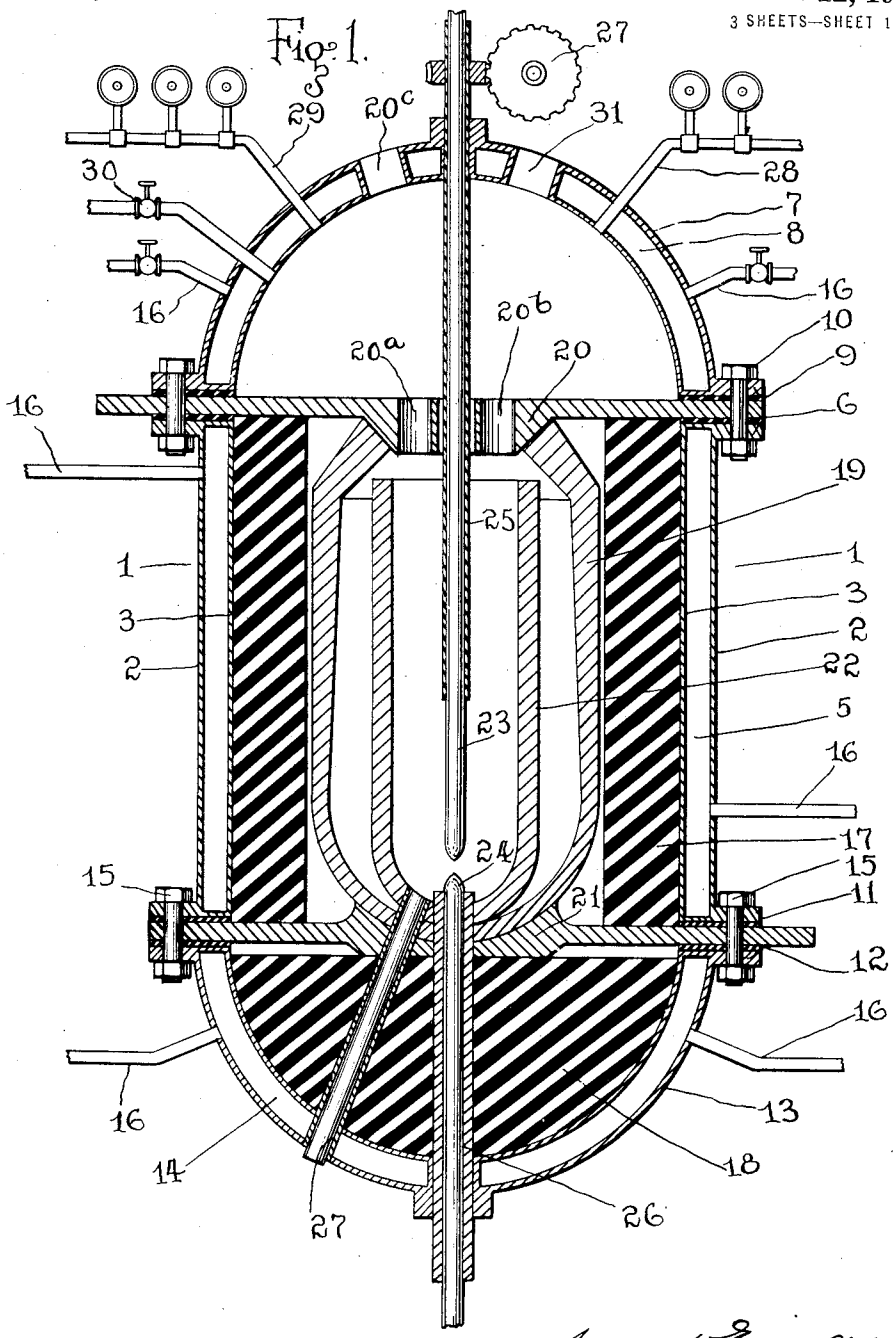
ELECTRICAL FURNACE.

APPLICATION FILED AUG. 24, 1921.

1,438,936. Patented Dec. 12, 1922.

3 SHEETS—SHEET 1.

Fig. 1.



August Eimer
Inventor

By his Attorney
Fetherstonhaugh & Co

A. EIMER.

ELECTRICAL FURNACE.

APPLICATION FILED AUG. 24, 1921.

1,438,936.

Patented Dec. 12, 1922.

3 SHEETS—SHEET 2.

Fig. 3.

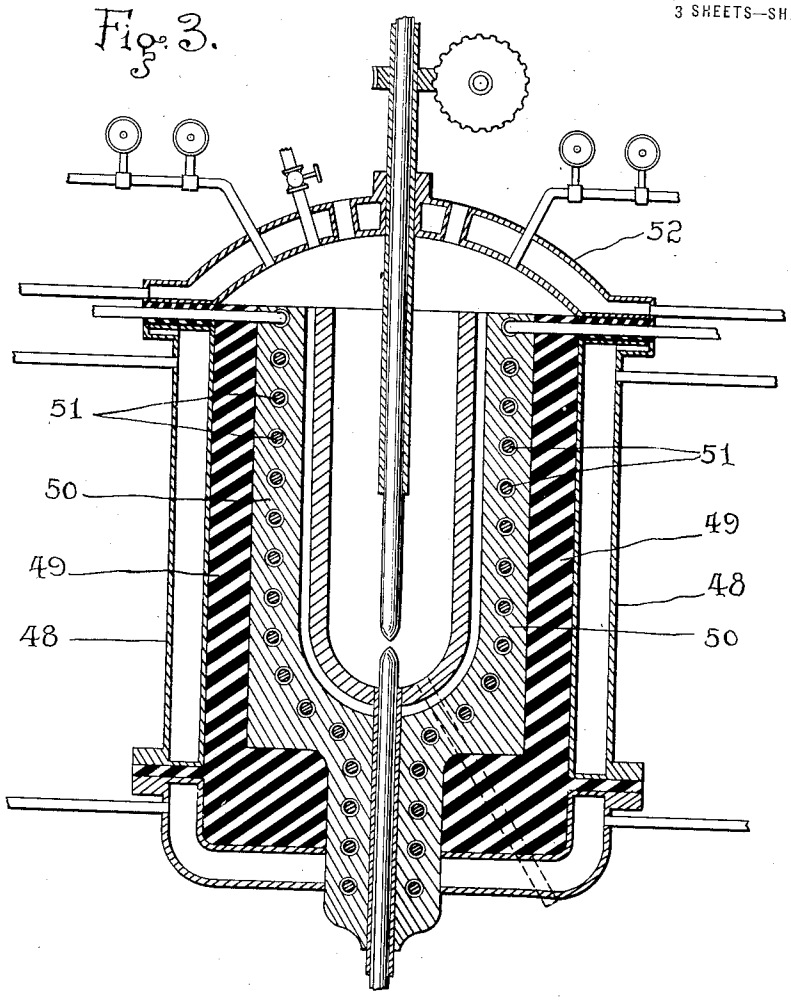
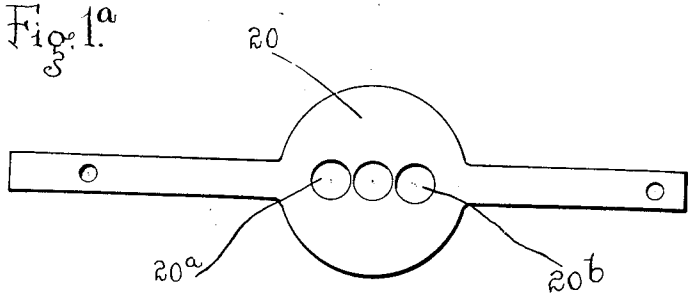


Fig. 1a.



August Eimer, Inventor

By his Attorney

Pettersonhaugh & Co.

A. EIMER.

ELECTRICAL FURNACE.

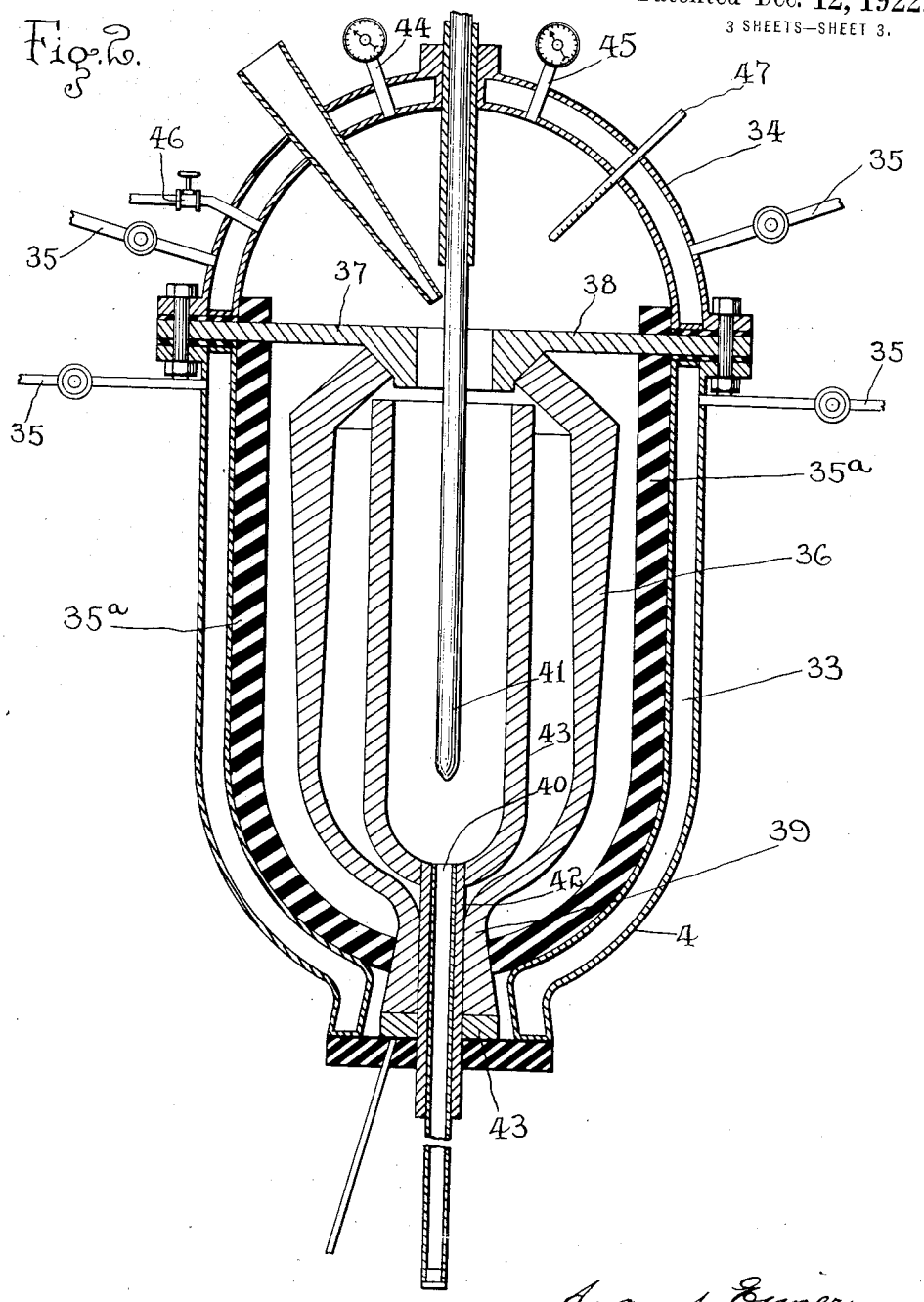
APPLICATION FILED AUG. 24, 1921.

1,438,936.

Patented Dec. 12, 1922.

3 SHEETS—SHEET 3.

Fig. 2.



August Eimer
Inventor

By his Attorney
Fetherstonhaugh & Co.

Patented Dec. 12, 1922. 1,438,936

UNITED STATES PATENT OFFICE.

AUGUST EIMER, OF NEW YORK, N. Y.

ELECTRICAL FURNACE.

Application filed August 24, 1921. Serial No. 495,033.

To all whom it may concern:

Be it known that I, AUGUST EIMER, a citizen of the United States, residing at 203 Third Avenue, in the city, county, and State of New York, have invented certain new and useful Improvements in Electrical Furnaces, of which the following is a specification, reference being had to the accompanying drawings, which form a part of this specification.

This invention relates to means for reducing substances like silica, quartz, alumina, and other materials, metals like tantalum, etc., and compounds that are difficult of fusion to a fluid state for casting and other purposes, and my improvements are directed to a new method and apparatus of large size whereby this operation may be carried into effect for industrial purposes, the apparatus involving the employment of combined resistance and arc heating agencies for the attainment of the requisite degree of temperature, operating in the presence of a vacuum, and employing pressure as required.

Heretofore attempts have been made on a laboratory scale to fuse silica (for example) in the arc furnace, but the resultant product has been only semi-fluid, or plastic, so that while capable of being drawn and blown, it is not fit for casting, and since this product contains air bubbles, which render it non-transparent, it is unsuited for broad commercial usage. When subjected to the oxy-hydrogen flame, for instance, quartz has been reduced to a state of fusion wherein it may be drawn and blown more freely from air bubbles, and therefore clearer, but the necessarily localized character of heat application with the oxy-hydrogen flame prevents its employment on a large industrial scale, instead limiting its application to small sizes, operated by hand labor and at great expense.

Besides, with the intense heat of the oxy-hydrogen flame or arc under ordinary conditions, as heretofore, there is a tendency toward volatilization of the reduced product.

Therefore my invention consists in the main of the new method of heating the material to be moulded to a semi-fused state in a furnace provided with initial heating means, such as resistance conductors, and, at the point of maximum temperature attained by these means, I apply auxiliary heat with the arc, withdrawing one or both of the electrodes through the mass as it progressively reaches a fluid state. The auxiliary heat can be applied by any appropriate means, but preferably the electric arc is employed by me as I have found it to give good results.

The auxiliary heat may be applied in the presence of a partial or high vacuum, for the purpose of effecting the fusion at a lower temperature than would otherwise be required, thereby also preventing volatilization of the fused material, and destruction of the carbons or other electrodes.

In carrying out my improved method of fusing silica, quartz and other material that is difficult of fusion, I provide a novel form of furnace having an outer shell which is water jacketed, and interiorly lined with highly refractory, insulation material, such as zirconia or the like. Contained within this insulation material and in spaced relation therewith is a heating element, which may be in the form of a vessel composed of graphite or carbon, and comprising a resistor.

A crucible composed of either graphite, carbon or other suitable material, which may be lined with a relatively infusible material like zirconia, or silicate of alumina, is disposed within the heating element aforesaid, in spaced relation therewith, and is intended to serve the purpose of containing the silica, quarts or other material to be fused. Opposed electrodes, having means of relative adjustment, are introduced within this crucible, and are included in an arcing circuit.

It is my purpose to first apply current for energizing the resistor heating element in order to reduce the silica, quartz or other material to a state of semi-fusion, or to subject said material to as high a temperature as may be obtained by a resistor circuit, and then, to apply the arc circuit, whereby the temperature within the crucible will be raised to a point at which the semi-fused or preheated mass therein will become fluid, and therefore capable of flowing for casting and other purposes.

The furnace is equipped with means whereby suction may be applied to its interior to exhaust air therefrom, so that the method may be performed in vacuo, and therefore at a lower temperature, to eliminate air bubbles from the reduced product. Also, to prevent volatilization of the reduced material under the intense heat of the arc, means are provided for the introduction of a gas, under pressure, to the furnace interior.

Other features and advantages of my invention will hereinafter appear.

In the drawings:—

Figure 1 is a sectional elevation of an apparatus embodying my invention in one of its forms, using carbon or graphite heating resistors.

Figure 1[a] is a plan detail of an electrode,

Figure 2 is a similar view of an apparatus of like character, but including a heating sleeve and certain modifications, and

Figure 3 is a further, similar view showing other modifications, using enclosed metallic heating resistors.

In the performance of my new method of fusing silica, quartz, and other materials that are difficult of fusion to a fluid state I provide a furnace structure whereof one example is shown in Figure 1, the numeral 1 indicating a hollow cylindrical casing, which may be composed of the spaced, concentric shells 2, 3, said shells being of sheet steel, or other suitable material, and the space between them constituting a water containing chamber 5. Said chamber 5 is closed at its upper end, there having a flange 6, whereby a hollow cover portion 7, of similar character, to constitute a water chamber 8, and having a flange 9 to seat upon flange 6, may be secured thereto, as by bolts 10.

Also the hollow casing 1 is closed at its lower portion, and there has a flange 11, which seats against a flange 12 extending from a base portion 13 that is also provided with a water space 14. The casings 1 and 13 are united as by bolts 15, which secure their flanges together.

The several casings 1, 7 and 13 are each provided with means for circulation of water or other cooling mechanism, connections 16 being indicated as serving the purposes of ingress and egress.

At the inner surface of casing portions 1 and 13 respectively, I provide substantial linings 17 and 18 of highly refractory insulating material, such for example as zirconia, and concentrically disposed within said lining 17, in spaced relation therewith, I provide an approximately cylindrical resistor heating element 19 in the form of a vessel, composed of carbon or graphite.

The vessel shaped resistor 19 is here shown of enlarged wall section at its upper end, where it is in electrical contact with an electrode 20, that extends transversely across the casing 1, and is lodged and supported between the flanges 6, 9 from which it is insulated. The wall section of the vessel shaped resistor 19 diminishes in area toward its base for the purpose of increasing the resistance to the flow of current, that the temperature may be more intense in the lower region of the resistor, because, as will hereinafter appear, the main fusion zone occurs in that region.

An opposite electrode 21 is lodged and supported between the flanges 11, 12 and insulated therefrom. This electrode 21 is in electrical contact with the base of resistor 19, the circuit for electrodes 19 and 21 therefor being completed through said resistor.

A crucible 22, composed of graphite or carbon is here shown as centred within the vessel-like resistor element 19, and is intended to contain the material to be fused. Located within said crucible are the opposed ends of a pair of carbon or other arc producing electrodes 23, 24 which extend axially of the furnace. The upper electrode 23 is provided with a substantial insulation jacket 25, of zirconia or the like, and similarly, the lower electrode 24 is also provided with a jacket 26. The upper electrode 23, with or without its jacket, may be adjustable vertically, these adjustments being desirable in order that the zone of the arc may be shifted and also to provide the feed of the carbon or other electrodes that may be employed.

Also the electrodes, which may be solid or tubular, either with or without the jackets, may be entirely withdrawn, this being a useful feature with respect to the lower electrode, which, with its jacket is entered through an orifice in the base of the crucible, because thereby a pouring orifice is provided for the fused material. However, I need not resort to the withdrawal of the lower carbon for the provision of a pouring or casting orifice, nor use a hollow electrode, and have shown, at 27, a channel which may be suitably plugged and which is devised for the purpose of drawing off the molten material.

In the plan view of electrode 20 shown in Fig. 1[a] the aperture 20[a] therefor may serve for inspection purposes when using peephole 31, and the aperture 20[b] may serve for charging purposes, by the application of a funnel thereto through orifice 20[c].

It will be appreciated that all the joints in the furnace are to be rendered air tight for its practical operation.

The furnace is provided with valved means 28, here shown as carried by the cover 7, for the application of suction when it is desirable to create a suitable vacuum in the furnace; which feature constitutes a phase of my improved method.

Also, I have shown as carried by cover 7, valved means 29 for admission of a gas, under pressure, for use in counteracting any tendency toward volatilization of the reduced mass, or to aid in expelling the molten material.

Also I provide a safety valve 30, here shown located in cover 7, for relief of internal pressures which may become excessive; also for the blowing off of dust or gases which may arise from vaporized material.

In the operation of my improved furnace, which may be of very large dimensions, the crucible 22 having been charged with silica, quartz or other material that is difficult of fusion, for which purpose the cover 7 may have been removed—and subsequently replaced, the resistor circuit is closed, thereby energizing the resistor element 19, and causing it to apply heat directly to the crucible 22, heat losses by radiation being prevented by the refractory linings 17, 18. The temperature thereby applied to the crucible is very intense and serves to reduce its contents to a state of semi-fusion, which can be noted through an observation opening 31 that has a suitable covering as of fused quartz. At this critical temperature point the arcing circuit may be closed when the resultant arc between the electrodes 23, 24 will raise the temperature in that region to the point at which the semi-fused mass will become fluid. Then, by gradually adjusting the electrodes, the zone of the arc is extended through the mass to render it fluid throughout. The fluid material can then be poured off into a mould by withdrawal of the lower electrode, or by unplugging a hollow electrode, or by removing the casting plug from channel 27.

In the modified form of my improved furnace shown in Figure 2 I have shown the hollow casing as consisting of the body portion 33, and a cover 34 therefor. Each of these portions is provided with water circulation means 35. Refractory insulation material 35^a, such as zirconia, is used as an inner lining for the body portion 33. The carbon or graphite heater element 36 is here shown as in electrical contact at its upper end with the electrodes 37, 38.

The vessel-like resistor element 36 in this modification resembles that shown at 19 in Fig. 1 with the exception that its lower portion is dependingly extended to form a heating sleeve 39 which surrounds the lower electrode of the arcing pair 40, 41. The lower electrode 40 is shown as provided with an insulation jacket 42, which fits an orifice therefor in the base of crucible 43, and pouring of the molten material may take place either through the jacket 42, by withdrawal of electrode 40, or by the withdrawal of both the electrode and its jacket, the temperature of the molten material being maintained while it is passing through this depending extension 39 of the resistor element. A carbon block 43, having an orifice in which the jacket 42 is snugly fitted, lies close up against the lower end of extension 39 to close the latter.

My improved furnace, in this form, is also provided with vacuum producing means, indicated at 44, pressure increasing means, indicated at 45, and safety valve 46. A pyrometer, introduced at 47, in the casing may be provided to indicate the furnace temperature.

In still another modified form of my improved furnace the hollow casing may have the form indicated at 48, with interior lining 49 of refractory insulation. In this form the refractory heating element 50 is composed of zirconia or other suitable material in which a resistor coil 51 is embedded, the opposite terminals of said coil extending out at points between the upper edge of casing 48 and the cover 52 therefor.

I prefer, in this instance, to employ a substance like the oxide of zirconia, with a coil of very high melting point as a metallic conductive element or alloy, like molybdenum, tungsten, iridium, etc. While the fusing point of zirconia is very high, some 2500 deg. C., the fusing point of, say, tungsten is about 3267 deg. C., or 767 deg. higher. I may therefore embed the tungsten wire in such insulating refractory, excluding in this way the excess of air or other gases which otherwise would attack the metallic conductor such as tungsten. Now, when the temperatue is 2500 deg. C., the zirconia adjacent to the tungsten becomes fused, and the tungsten wire expands to its corresponding coefficient, retiring to its original size in cooling, while the fused zirconia remains expanded, after cooling, permitting the metallic resistor, as the heating element, to expand without cracking the refractory zirconia at the next heating. It is not new to fuse a metal wire in glass, but if such metallic wire becomes heated to high temperature it will crack the glass, whereas zirconia, for example, applied in powder or a paste mass around tungsten wire of considerable size as used in high temperature furnaces, will fuse the zirconia to tube-like retainers, which remain so expanded, providing sufficient space for the expansion of the wires.

In the practice of my invention when employing a metallic resistor element in the manner referred to I have found that very desirable results have been achieved by the use of alloys of tungsten and molybdenum as well as by the use of these metals alone.

My uses of tungsten and molybdenum in alloyed form have been successfully employed in the following proportions:—

(1) 80% molybdenum with 20% tungsten.
(2) 70% molybdenum with 30% tungsten.
(3) 49% molybdenum with 51% tungsten.
(4) 30% molybdenum with 70% tungsten.

The very high fusing point of these alloys, as is the case with either tungsten or molybdenum alone, renders these alloys very desirable for the purpose indicated.

When the final heating effect to render the mass fluid is achieved in the presence of a vacuum there may, as stated, be a tendency toward volatilization of the fused product, because the fusion will occur at a

lower temperature when the furnace is exhausted or partially exhausted of air. Therefore pressure may be introduced into the furnace as in the form of a gas, to counteract such tendency and prevent the transition of the fused material from a fluid to a volatile state. Also, the pressure thus introduced into the furnace may serve the useful function of facilitating the discharge of the molten material through the casting orifice.

The use of zirconia, for example, as a lining for the crucible, and the casting hole, has the advantage that it combines with the fused product, like silica or quartz, and functions in the manner of a lubricant to facilitate the flow of the molten material, instead of permitting adhesion of the mass to the crucible surface.

Variations within the spirit and scope of my invention are equally comprehended by the foregoing disclosure.

I claim:—

1. The method of fusing silica on an industrial scale which consists in heating the substance until it arrives at a semi-fluid state, and then in raising the temperature by means of heat applied to the semi-fused substance through an electric arc, to complete the fusion, thereby bringing the substance to a state of fluidity.

2. The method of fusing silica on an industrial scale which consists in heating the substance until it arrives at a semi-fused state, and then in raising the temperature by means of heat applied internally of the semi-fused substance through an electric arc, to complete the fusion, thereby bringing the substance to a state of fluidity.

3. The method of fusing silica on an industrial scale, which consists in applying heat to the substance through an electric resistor until it arrives at a semi-fused state, and then in raising the temperature by means of heat applied to the semi-fused substance through an electric arc, to complete the fusion, thereby bringing the substance to a state of fluidity.

4. A furnace comprising a casing, an interior refractory lining therefor, heating means within said casing, a crucible within said heating means, an arcing circuit, and opposed electrodes within said crucible to apply the heat of the electric arc to the material therein.

5. An electrical furnace comprising a casing, an interior refractory lining therefor, a heating element within said casing and a circuit therefor, a crucible within said heating element to contain the fusible material, an arcing circuit, and opposed electrodes within said crucible to apply the heat of the electric arc to the material therein.

6. A furnace comprising a casing having cooling means, an interior refractory lining, heating means within said casing, a crucible within said heating means to contain the fusible material, an arcing circuit, and opposed electrodes within said crucible to apply the heat of the electric arc to the material therein.

7. A furnace comprising a casing, an interior refractory lining therefor, heating means within said casing, a crucible within said heating means to contain the fusible material, an arcing circuit, opposed electrodes within said crucible to apply the heat of the electric arc to the material therein, and means for the creation of a suitable vacuum within the furnace.

8. A furnace comprising a casing, an interior refractory lining therefor, heating means within said casing, a crucible within said heating element to contain the fusible material, an arcing circuit, opposed electrodes within said crucible to apply the heat of the electric arc to the material therein, and means for the introduction of pressure to the furnace interior.

9. An electrical furnace comprising a casing, an interior refractory lining therefor, a heating element within said casing, and a circuit therefor, said heating element having a depending extension to form a sleeve-like casting passage, a crucible within said heating element to contain the fusible material, an arcing circuit, and opposed electrodes within said crucible to apply the heat of the electric arc to the material therein.

10. An electrical furnace comprising a casing, an interior refractory lining therefor, heating means within said casing, a crucible within said heating means to contain the fusible material, an arcing circuit, opposed electrodes within said crucible to apply the heat of the electric arc to the material therein, and jackets of highly refractory insulating material for said electrodes.

11. An electrical furnace comprising a casing, an interior refractory lining therefor, heating means within said casing, a crucible within said heating means to contain the fusible material, an arcing circuit, opposed adjustable electrodes within said crucible to apply the heat of the electric arc to the material therein, and fixed jackets of highly refractory material in which said electrodes are movable.

12. The combination with an electrical furnace adapted for fusing silica, of a crucible therefor that is lined with material characterized as capable of combining with the substance undergoing fusion, to facilitate the delivery flow thereof.

13. The combination in an electrical furnace, of a lining therefor consisting of refractory insulating material having a high fusing point, a resistor element embedded in said lining and having a still higher fusing point, the lining material characterized by fusing in the vicinity of the resistor ele-

ment, thereby permitting the resistor to expand, and the lining also characterized by retaining its expanded, resistor containing form after cooling.

14. The combination, with an electrical furnace adapted for fusing silica, of a crucible and a hollow, electrically conductive element communicating with said crucible and capable of use both as an electrode and a tube for the delivery of either molten or volatilized material.

15. The combination, with an electrical furnace adapted for fusing silica, of a crucible having a casting orifice, and an electrically conductive element removably entered in said orifice to close it, said element also serving as an electrode.

16. A furnace adapted for fusing silica, initial heating means for said furnace to bring the substance to a state of semi-fusion, electric arcing means to raise the temperature, thereby completing the fusion and rendering the substance fluid, and the furnace provided with pressure reduction means whereby fusion is effected at a relatively low temperature.

17. A furnace adapted for fusing silica, initial heating means for said furnace to bring the substance to a state of semi-fusion, electric arcing means to raise the temperature, thereby completing the fusion and rendering the substance fluid, and the furnace provided with pressure increasing means to prevent volatilization of the fused product, and for facilitating the discharge of the molten material.

18. A furnace adapted for fusing silica, initial heating means for said furnace to bring the substance to a state of semi-fusion, electric arcing means to raise the temperature thereby completing the fusion and rendering the substance fluid, and the furnace provided with means for the delivery of volatilized products, for condensation.

Signed at New York, in the county and State of New York, this 16th day of August, 1921.

AUGUST EIMER. [L. S.]