Aug. 10, 1937. Y. R. CORNELIUS 2,089,689

ELECTRIC FURNACE

Filed April 5, 1934 2 Sheets-Sheet 1

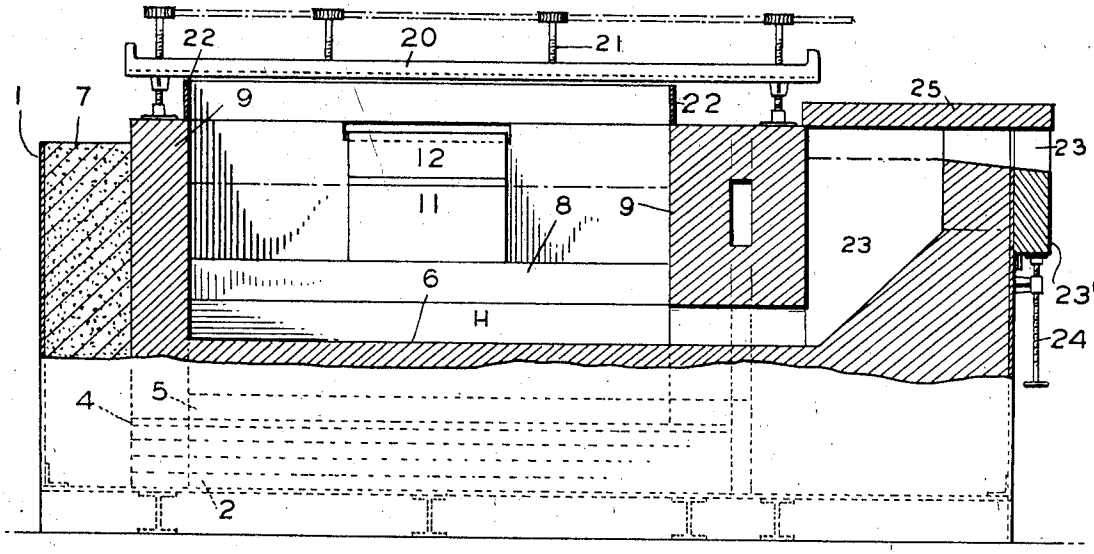


FIG. 2.

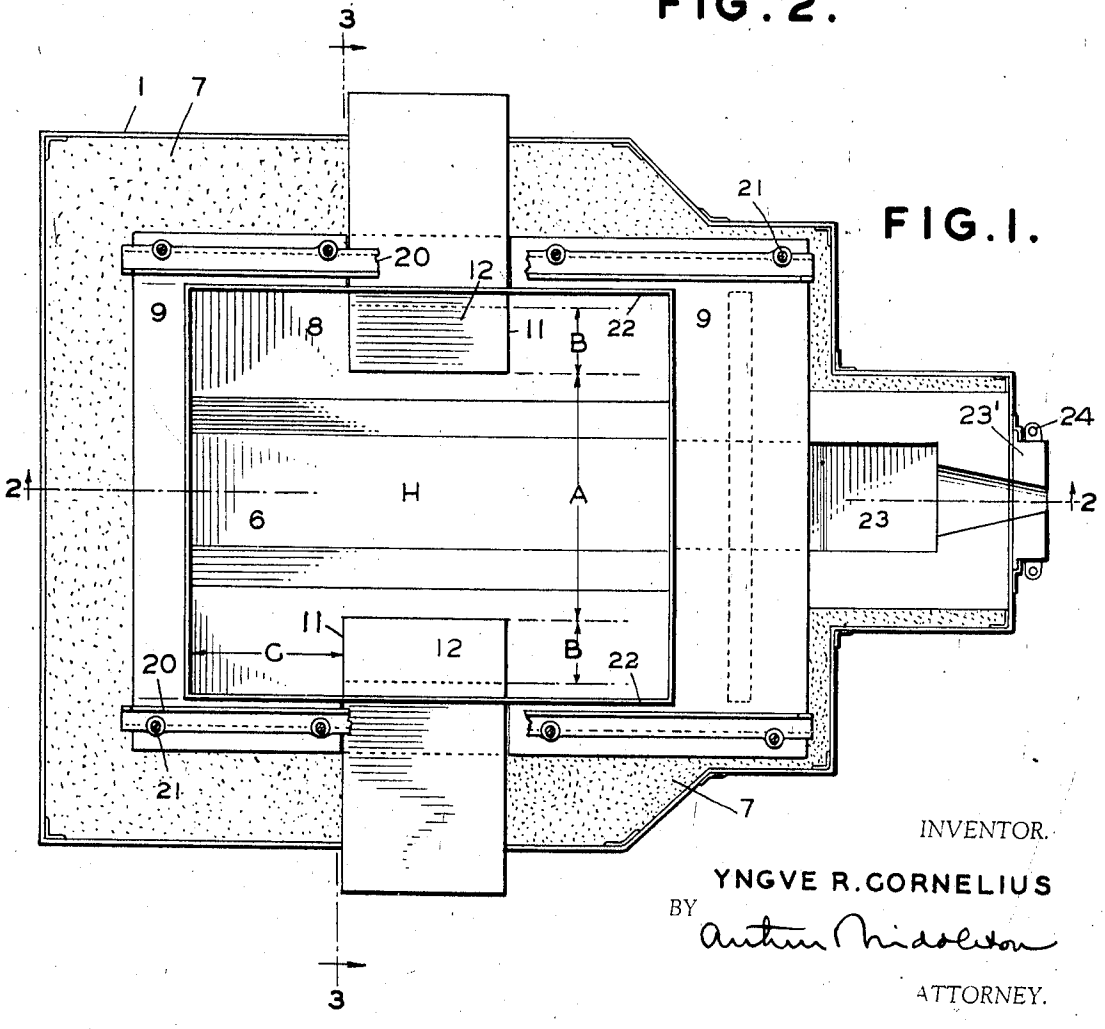


FIG. 1.

INVENTOR.

YNGVE R. CORNELIUS

BY Arthur Middleton

ATTORNEY.

Aug. 10, 1937. Y. R. CORNELIUS 2,089,689

ELECTRIC FURNACE

Filed April 5, 1934 2 Sheets-Sheet 2

FIG. 3.

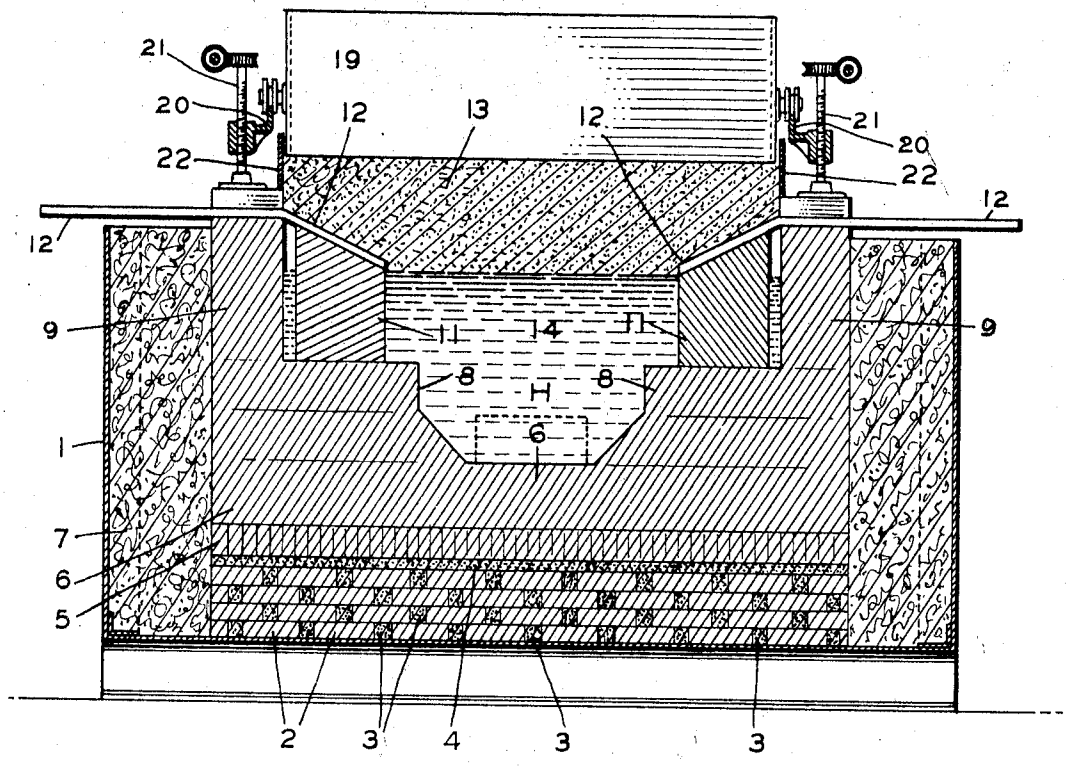


FIG. 4.

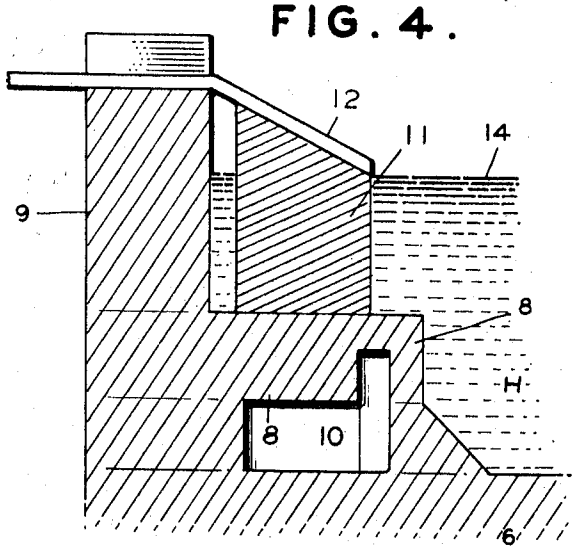
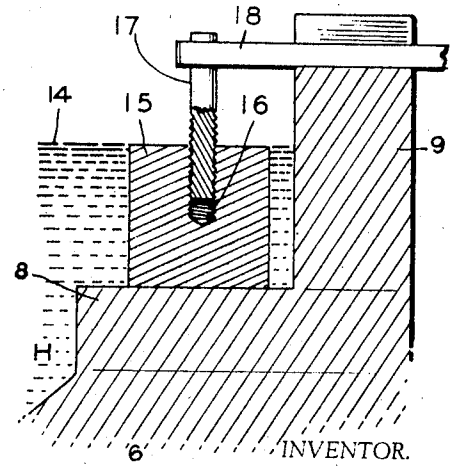


FIG. 5.



INVENTOR.

YNGVE R. CORNELIUS

BY Arthur Nicholson

ATTORNEY.

Patented Aug. 10, 1937 2,089,689

UNITED STATES PATENT OFFICE

2,089,689

ELECTRIC FURNACE

Yngve R. Cornelius, Brooklyn, N. Y.

Application April 5, 1934, Serial No. 719,076
In Canada January 19, 1934

4 Claims. (Cl. 13—6)

The present invention relates to an electric furnace construction and to a method of operating the same.

The principal object of the invention is to design a furnace construction which will avoid the destructive influence of the electric current flow on the furnace lining, the destructive influence of movement of the molten charge by reason of convection currents, and to control the electrical conductivity of the charge in a novel manner.

In the construction of electric furnaces for industrial use, little regard has been given to the destructive influence that the electric current flow therein has on the refractory lining. In furnaces for certain uses this is unavoidable, in others, the melted bath itself is so destructive that the deterioration caused by current flow is negligible. In other productions, such as glass and sodium silicate where it is of importance that the product be of the highest quality, it is necessary to design the furnace so that the batch is contaminated as little as possible by the refractory lining.

A considerable amount of investigation by me has demonstrated that where the side walls of a furnace are within the path of the electric current flowing between the electrodes this current causes a destructive action on such furnace walls which if continued may even completely destroy such walls within a short space of time.

Another destructive influence on electric furnace walls, in which the batch being acted on is molten, is caused by convection currents of the melted bath itself. These currents are present in almost every melting furnace, but are more noticeable in electric furnaces of the direct resistance type where the heat is generated in the bath instead of at the surface as in a fuel fired furnace.

Another drawback in the operation of electric furnaces consists in their manner of control. When, for instance, production from a furnace is reduced, this is usually accomplished by decreasing the voltage. This voltage drop will momentarily decrease the furnace amperage thus sharply reducing the load, but when the furnace has stabilized itself to the new voltage it will have regained most of this loss. As this stabilization may take as long as one or two days, this method of control is expensive from the standpoint of time wasted. It is, therefore, much more profitable to regulate and control the furnace by directly varying the amperage rather than the voltage or by regulating both in combination.

The present invention, therefore, aims to overcome the above deficiencies in the manner more fully hereinafter set forth.

The invention in one of its aspects consists in placing the furnace walls, whether parallel, angular or curved, with regard to the electrodes and the current flow therebetween in such relation thereto that such walls are out of the current flow field and hence not subject to deterioration thereby.

In another aspect the invention contemplates the design and arrangement of electrodes in such a furnace to reduce heat losses caused by the electrode connections with the bus bars which ordinarily pass through the furnace walls.

The invention further contemplates an electrode of large mass in the interests of heat conservation where these electrodes are mounted upon platforms or blocks which may be suitably cooled so that the depth of the molten bath surrounding the electrodes is less than that of some portion of the bath between the electrodes.

The invention further contemplates the blanketing of the molten charge with a dry layer of raw material which prevents heat losses through radiation and which by manipulation thereof may be used to suitably control the operation of the furnace.

The invention further consists in the novel arrangements, construction and combination of parts and the method of operation more fully hereinafter described and shown in reference to the accompanying drawings.

In the drawings—

Fig. 1 is a plan view through a typical furnace construction of this invention.

Fig. 2 is a sectional elevation along the line 2—2 of Fig. 1.

Fig. 3 is a sectional elevation along the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary enlarged sectional elevation of an electrode showing cooling ducts.

Fig. 5 is a fragmentary sectional elevation of a modified form of electrode.

Referring now with particularity to the embodiments illustrated, I have shown for the purpose of illustration only, a single phase furnace constructed in accordance with this invention although, obviously, the invention contemplates the use of poly-phase as well as single phase currents. The furnace proper may consist of a steel casing 1 on which a floor is laid composed of checker bricks 2, the space between bricks being filled with dry sand 3 on top of which is a bed of fire clay 4, say 2" thick. A course of

bricks 5 on edge is placed on top of the fire clay bed and upon these bricks are set the bottom blocks 6 forming the bed of the furnace. The bed thus constructed is enclosed between suitable side walls 7.

In order to reduce convection currents in the molten bath, electrode supporting blocks 8 are placed upon the bottom of the furnace and these blocks may obviously be separate from the bottom block 6 or integral therewith, as desired. These blocks form in effect two longitudinal platforms at each side of the furnace and support the electrodes. Between these two platforms 8 and below the electrode bases, there extends between the transverse furnace walls or wall sections 9 a channel or basin H which is so broad and deep as to contain a substantial body of molten material so that the glass or other molten charge contained therein will be cooled very slowly through the platform sides and furnace bottom to a temperature lower than that of the glass in the heating zone between the electrodes. The glass thus cooled will be of a greater specific gravity than the warmer glass above, and will therefore not take part in the movement of the glass in the melting or heating zone, thus materially conserving heat and materially preventing movement due to convection currents. This cooling should not take place to such an extent that the fining process in the glass will cease.

Each platform 8 may be provided with cooling channels 10 for any desired cooling medium combined with suitable draft regulators (not shown) for controlling the degree and rate of heat removed from this section of the furnace charge. The furnace being heavily insulated, radiation is small, and it is therefore possible to control the temperature of the glass in the basin by regulating the amount of cooling medium passing through the channels 10. Pyrometers inserted at different points, in connection with other suitable apparatus (not shown) may automatically control this temperature.

The electrodes shown at 11 may be made of iron having a low carbon content, iron alloys, non-iron metals and metal alloys with a high melting point, carbon or graphite, but in most cases a low carbon iron is best suited as it is cheap, strong and durable and does not in any high degree contaminate the bath, and due to its good heat conductivity the temperature thereof may be uniformly maintained. The electrodes are so designed that they not only have a large contact surface toward that part of the bath which acts as the resistance for the electric current, but they also have a large cubical content which tends to equalize their heat and serves as a protection against local over-heating.

The electrode connection may be made by means of a plate 12 extending through or outside the walls or wall sections of the furnace to which the bus bar connection may be made. As shown in Fig. 3 the top of the electrodes may extend through the raw material blanket 13 on top of the molten bath 14 in which case it has been found that deterioration or oxidation is negligible. As shown, the electrodes are surrounded on their four vertical walls by the molten bath.

When carbon or graphite electrodes are used a form as shown in Fig. 5 is desirable. This may consist of a rectangular block 15 containing a screw hole 16 therein to receive a bar 17 with a connection 18 to the bus bar. It is to be noted that such a design permits the parts 17 and 18 to be embedded in the raw material blanket.

Great care must be taken in designing the location of the furnace walls or wall sections so that no substantial part of the current flow passes through such walls. I have found after a considerable amount of experimentation that the location of these walls may be determined by the following formula:

$$C=\frac{A+B}{2}$$

where A is the electrode gap, B the electrode thickness and C the distance between the side of the electrode and the facing furnace wall, all as shown in Fig. 1.

This distance has proved to increase somewhat with the furnace voltage and hence a more accurate formula is as follows:—

$$C=\frac{A+B}{2}\times\frac{V}{74}$$

in which V stands for the average operating voltage of the furnace when the voltage exceeds 74.

By locating the furnace side walls with regard to the electrodes according to these formulas deterioration of the furnace walls due to current flow may be either entirely eliminated or materially decreased. Obviously the dimension C may be between the electrode side, a substantially parallel side wall, or between the side of the electrode extended and a furnace side wall.

The raw material blanket 13 may be used as a means to decrease or increase the electrical conductivity of the resistance which is the molten bath itself. In any event the raw material blanket covering the surface of the molten bath should have such a minimum thickness that gases penetrating the same leave the blanket as cool as the newly charged raw material. It must further be so thick that there will be no gas pockets between the bottom of the same and the surface of the molten bath. The raw material blanket 13 may be evenly spread over the furnace by a motor driven charging car 19 carried on tracks 20, which tracks may be lowered or elevated by means of a worm driven screw 21 powered in any suitable manner. The bottom of the charging car 19 operates between side rails 22 to accommodate different heights of the blanket. A tap outlet 23 for the finished charge is arranged with a spout 23' likewise to be raised or lowered by the screw mechanism 24. The tap opening may be provided with a cover or lid 25 as shown in Fig. 2. As this cover can be made removable it is not shown in Fig. 1.

Regulation of the electrical conductivity of the resistance which is the molten bath may be had by raising or lowering the level of the bath in the melting chamber. This may be accomplished either by raising or lowering the tap spout 23' to the desired extent or by increasing the thickness of the raw material blanket 13. Obviously if the raw material blanket 13 is increased in thickness, its weight will cause a lowering of the level of the molten bath by flow through the tap opening or hole 23 and control the electric load of the furnace, resulting in a lower conductivity and lower amperage. If one attempts to secure this control by voltage regulation the amperage remains practically unchanged and the refractory destruction caused by the current the same. The time for stabilization at the lower load is also much longer. In the production of sodium silicate it is advan-

tageous to use a combination of both tap hole vertical adjustment and raw material blanket height regulation. However, tap hole regulation cannot be used when the furnace is operated in connection with certain types of bottle machines, in which case the batch level alone may be used to take care of this contingency. One advantage of this manner of regulation is that it considerably cheapens the electrical installation as a much simpler transformer can be used and no expensive voltage regulator is required.

While the invention has been shown and described with reference to particular embodiments, obviously I do not wish to be limited thereto, but the invention is to be construed broadly and restricted only by the scope of the claims.

I claim:

1. An electric glass melting furnace comprising means for passing electric heating current through the molten glass contained therein, a hopper mounted over the molten glass for discharging batch material thereon, and adjustable means for supporting said hopper above the level of the molten glass at such distance therefrom as to variably control the weight of the batch material supported thereby.

2. A glass melting furnace comprising means for heating the furnace to maintain the glass in molten condition therein, a hopper supported above said furnace for containing batch material to be discharged onto the surface of the molten glass, and means for adjusting the relative position of the hopper with respect to the level of the molten glass contained therein to variably control the weight of the batch directly supported by the surface of the molten glass.

3. An electric furnace for melting and producing glass, sodium silicate and other analogous materials in which the molten material itself forms a conductive bath and acts as a resistance for the electric current, comprising a plurality of furnace wall-sections, a furnace bottom section, and a plurality of pairs of electrodes substantially rectangular in horizontal cross-section between the faces of which current is adapted to flow so located that certain wall sections each have one electrode of a pair thereof adjacent thereto and other wall-sections do not, with the non-adjacent wall-sections being spaced from the electrodes a distance lying in the range from

$$\frac{A+B}{2} \text{ to } \frac{A+B}{2}\times\frac{V}{74}$$

where A equals the electrode gap, B equals the electrode thickness, and V equals the average operating voltage where that voltage exceeds 74.

4. Apparatus according to claim 3 in which the distance between the non-adjacent wall sections and the electrode is equal to

$$\frac{A+B}{2}\times\frac{V}{74}$$

YNGVE R. CORNELIUS.