March 25, 1947. A. E. A. S. CORNELIUS 2,417,913

ELECTRIC GLASS FURNACE

Filed April 28, 1944 2 Sheets-Sheet 1

Fig. 1.

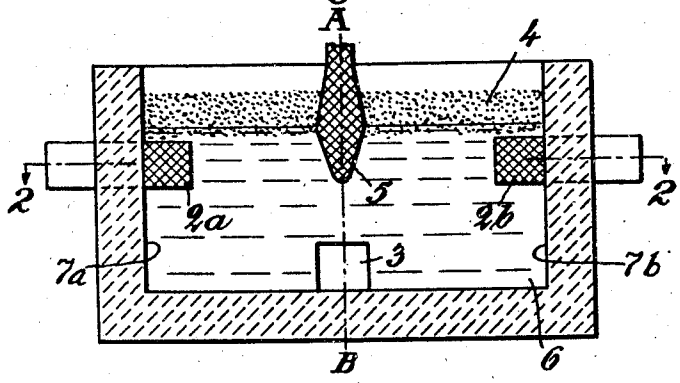
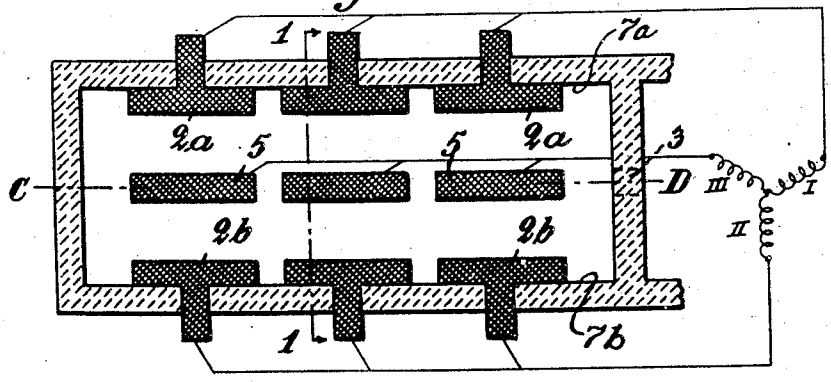


Fig. 2.



INVENTOR,
ANDERS E. A. S. CORNELIUS,
BY
ATTORNEY

March 25, 1947. A. E. A. S. CORNELIUS 2,417,913

ELECTRIC GLASS FURNACE

Filed April 28, 1944 2 Sheets-Sheet 2

Fig. 3.

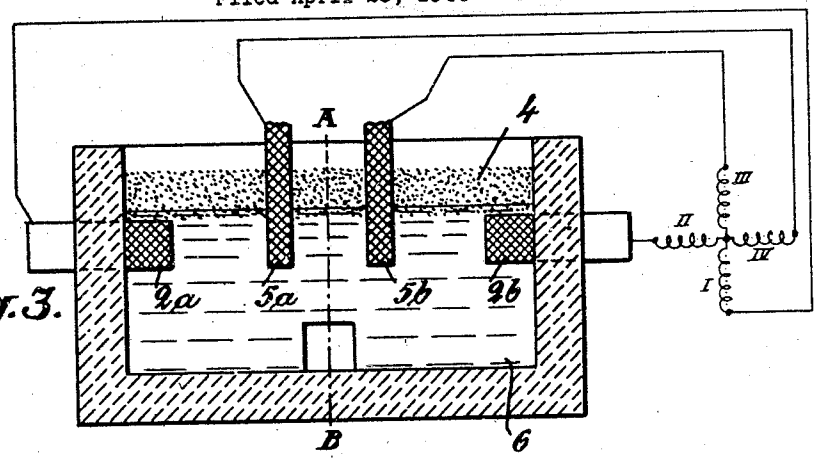


Fig. 4.

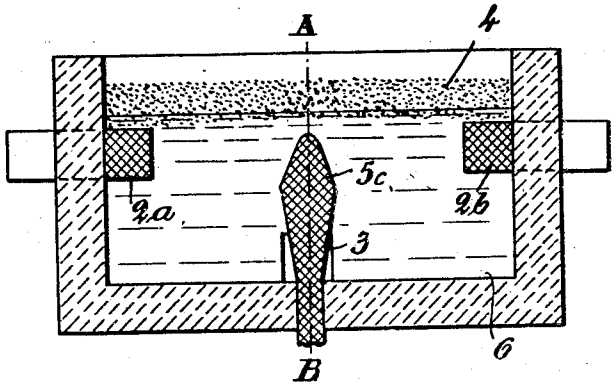
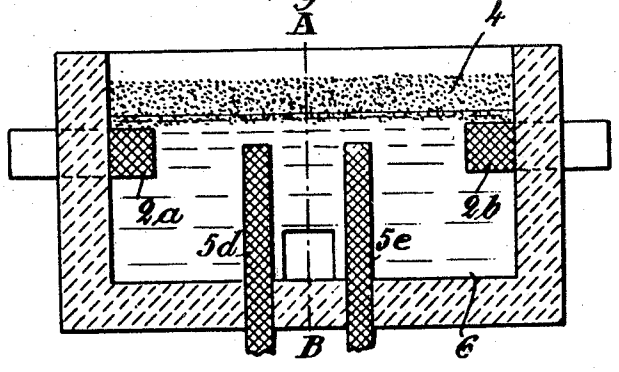


Fig. 5.



INVENTOR,
ANDERS E. A. S. CORNELIUS,
BY Austen Middleton
ATTORNEY

Patented Mar. 25, 1947 2,417,913

UNITED STATES PATENT OFFICE

2,417,913

ELECTRIC GLASS FURNACE

Anders Erik Alexander Streling Cornelius, Stockholm, Sweden, assignor to Yngve Ragnar Erik Cornelius, Portland, Oreg.

Application April 28, 1944, Serial No. 533,197
In Sweden April 30, 1943

4 Claims. (Cl. 13—6)

1

In electric glass furnaces it is known to let electric alternating current pass between electrodes, placed along opposite sides of the interior of the furnace, and through the glass bath which itself constitutes a heating resistance for the electric current. Due to the fact that the heat developed in each part of the bath liquid is proportional to the square of the current density, the greater part of the heat will be produced in zones surrounding and being close to the operative surfaces of the electrodes. A minimum of heat will be produced in the bath in an intermediate zone between the electrode zones. This uneven distribution of the heat produced by the electric current will cause, inter alia, two heat convection currents or whirls in the bath which have opposite directions of rotation. The bath liquid drawn into said currents or whirls is moved upwards at opposite side walls of the furnace or at the electrodes positioned therein respectively and it continues then in opposite directions towards the middle of the furnace and downwardly along the longitudinal vertical middle plane of the furnace and from there it returns in opposite directions towards the respective side walls or electrodes and so on. It is customary to provide an outtake at the bottom of the furnace in such a position that it is intersected by the beforementioned middle plane. When drawing-off molten glass through said outtake there is a risk that the convection currents moving downwardly may take along with them from the top of the bath unmolten material and glass, which have not yet become refined, as well as air bubbles whereby the quality of the drawn-off glass is impaired.

The present invention has for its object, inter alia, to avoid said inconvenience and to improve the quality of the drawn-off glass, and is based on the fact that the highest temperature in furnaces of the kind set forth is developed adjacent the electrodes. If, according to the present invention, one or more central electrodes is or are suspended or otherwise supported along the vertical middle plane of the furnace and supplied with electric alternating current of a voltage, different from that of the lateral electrodes, further electric currents will pass into the bath and additional heat be developed therein adjacent to the central electrode or electrodes. In this way the downwardly moving convection currents may be retarded or even reversed on account of the change in the distribution of heat in the bath.

The invention has further for its object to arrange the central electrodes on such a level

2

in relation to the lateral electrodes that the heating of the central part of the bath will have its most favourable influence on the counterbalance of any central downward currents. Extensive tests have shown that this is attained if, according to the present invention, the average level of the central electrodes is the same as or even lower than that of the lateral electrodes.

In order to explain the invention more in detail reference is made to the accompanying drawings wherein

Figure 1 is a cross section on line 1—1 in Figure 2 of a furnace according to the invention.

Figure 2 is a horizontal section on the line 2—2 in Figure 1.

Figures 3, 4 and 5 show cross sections through modified embodiments.

In Figs. 1 and 2 there are provided in the side walls 7*a* and 7*b* lateral electrodes 2*a* and 2*b* respectively. One or more central electrodes 5 are suspended along the lines AB (Fig. 1) and CD (Fig. 2) respectively representing the middle plane of the furnace in parallel with the lateral electrodes 2*a*, 2*b*. The operative surfaces of the central electrodes 5 have an average level which is practically the same as that of the corresponding surfaces of the lateral electrodes 2*a* and 2*b*. The central electrodes are fed with current of a voltage different from that of the lateral electrodes. Such a voltage difference may be caused, for instance, by using three phase current, one phase I and II respectively being connected to each one of the lateral electrode groups 2*a* and 2*b* respectively and one phase III to the central electrode group 5.

Assume at first that the central electrodes 5 are disconnected. Referring to Figure 1 the bath liquid 6 is then drawn upwards adjacent to the side walls 7*a*, 7*b* of the furnace or close to the electrodes 2*a* and 2*b* if they protrude into the bath as shown. The bath liquid is then drawn in opposite directions towards the middle of the furnace and down along the central vertical plane AB, so that there is a risk that unmolten charge from the floating layer 4 will be carried down and out through the outlet 3. Therefrom the currents will separate and return in opposite directions towards the side walls 7*a* and 7*b* or the lateral electrodes 2*a* and 2*b* respectively.

We now assume that the central electrodes 5 are connected into circuit as shown on the drawing. On account of the development of heat around said electrodes 5 the downwardly moving convection currents above described are retarded, caused to cease or even to reverse their directions.

In this way the downward stream in the bath near the center of the floating charge 4 of solid particles is avoided and the molten glass, drawn-off through the outtake 3, is no more mixed with solid particles and air bubbles.

According to Figure 3 there is provided, instead of one central electrode, a pair of separate electrodes 5a and 5b arranged approximately symmetrically on opposite sides of the middle plane AB. On said two central electrodes or electrode groups electric alternating voltages are impressed which differ both in respect of one another and in respect of the voltages of the lateral electrodes. For instance, the alternating current source may deliver current of the four-phase type, one phase I and II respectively being connected to each one of the lateral electrode groups 2a and 2b and one phase III and IV respectively to each one of the central electrode groups 5a and 5b respectively. The central electrodes may be positioned so close to one another that no detrimental convection currents can be set up between them.

One or all of the central electrodes 5 shown in Figure 2 may be replaced by pairs of electrodes 5a, 5b, as described in connection with Figure 3.

In the embodiment shown in Figure 4 the central electrode 5c projects upwards through the bottom of the furnace and into the bath so far that the average level of its operative surfaces is below that of the corresponding surfaces of the lateral electrodes 2a and 2b. According to Figure 5 a similar arrangement can be made in such furnaces wherein for the central electrodes there are substituted pairs 5a and 5b.

What I claim is:

1. A glass furnace having a substantially rectangular body adapted to hold a burden of vertically supplied glass-making constituents which when molten has a liquid level, a pair of horizontally disposed electrodes extending into the burden from two opposite sides of the body, a glass take-off adjacent the bottom of the body disposed in a vertical plane extending between said electrodes, and another electrode unit extending into the burden to an elevation not higher than the elevation of said pair of electrodes and located

in a vertical plane sufficiently adjacent to the vertical plane of the out-take as to minimize bubbles and unmelted constituents of the burden from approaching the out-take.

2. A glass furnace according to claim 1, wherein the electrode unit has impressed on it an electric current different in voltage from that impressed upon the pair of electrodes.

3. A glass furnace according to claim 1, wherein the electrode unit comprises a pair of electrodes, and alternating electric current is impressed thereon which differs in voltage both in respect of one another and of the pair of horizontal electrodes.

4. An electric glass furnace of the type in which a charge of solid particles is melted to form in said furnace a bath of molten glass through which electric alternating currents are passed, comprising a charging zone for introducing and melting said charge, an underlying clearing zone covered by said charging zone for causing air bubbles and unmolten particles to ascend through the bath to said charging zone, and a tapping-off zone for withdrawing molten glass from the bottom of the furnace, said zones being vertically superposed in regard to one another, lateral alternating current electrodes of different polarities, two opposite side walls of said furnace each carrying but lateral electrodes of the same polarity, and an intermediate electrode device provided in the interspace between the lateral electrodes of the opposite walls and having a polarity differing from those of the electrodes of both side walls.

ANDERS ERIK ALEXANDER STRELING CORNELIUS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,122,469	Hitner	July 5, 1938
2,280,101	Slayter et al.	Apr. 21, 1942
1,594,496	Clark	Aug. 3, 1926
2,145,677	Adam, Jr.	Jan. 31, 1939