Dec. 23, 1941. E. A. LOF 2,267,593

ELECTRIC MELTING FURNACE

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FIG. 1.

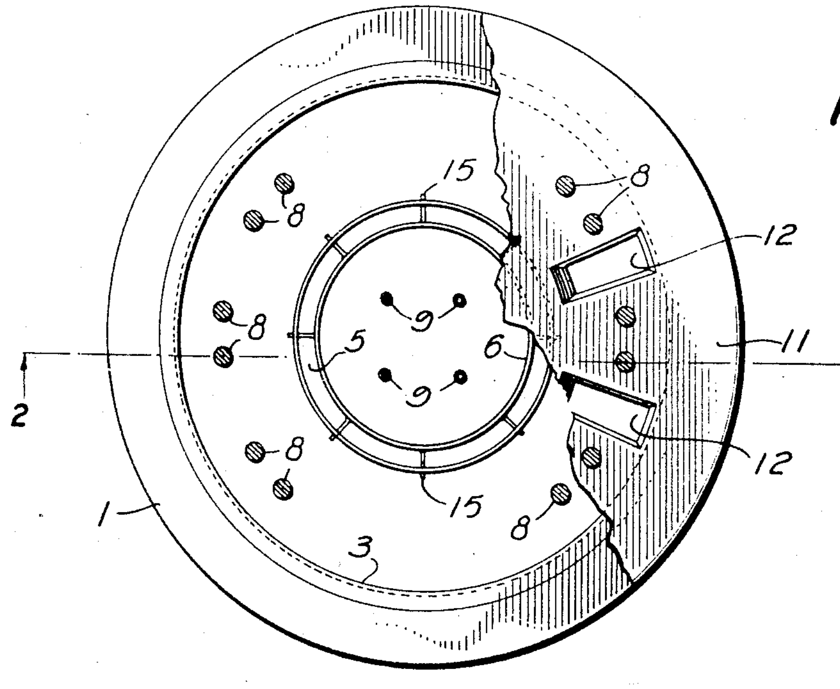
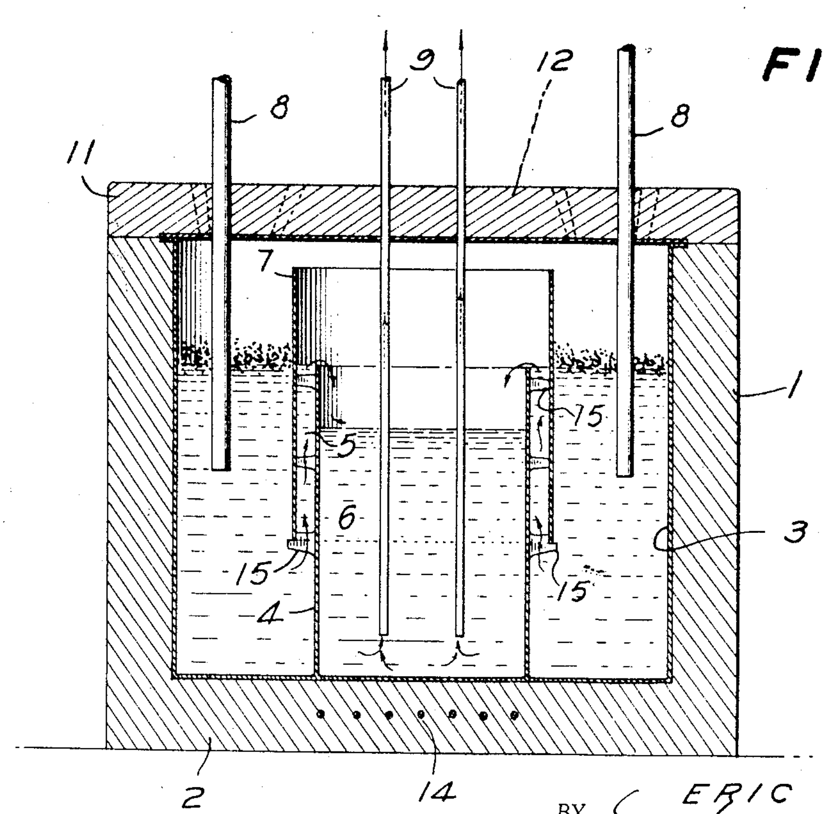


FIG. 2.



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ELECTRIC MELTING FURNACE

Filed March 29, 1941 2 Sheets-Sheet 2

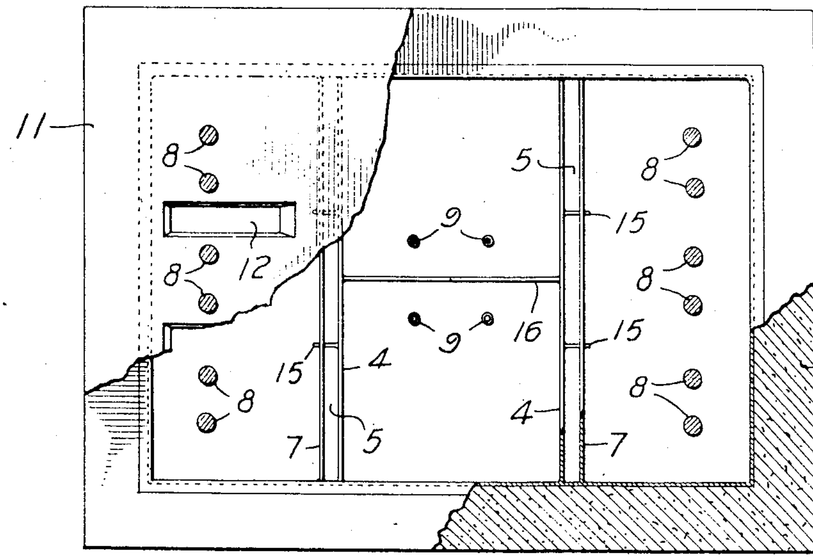
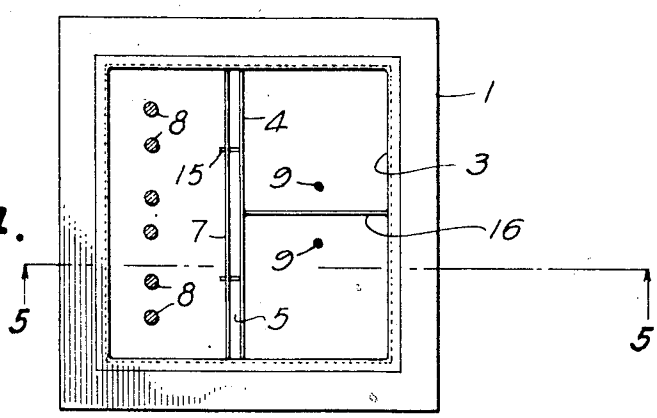


FIG. 3.

FIG. 4.



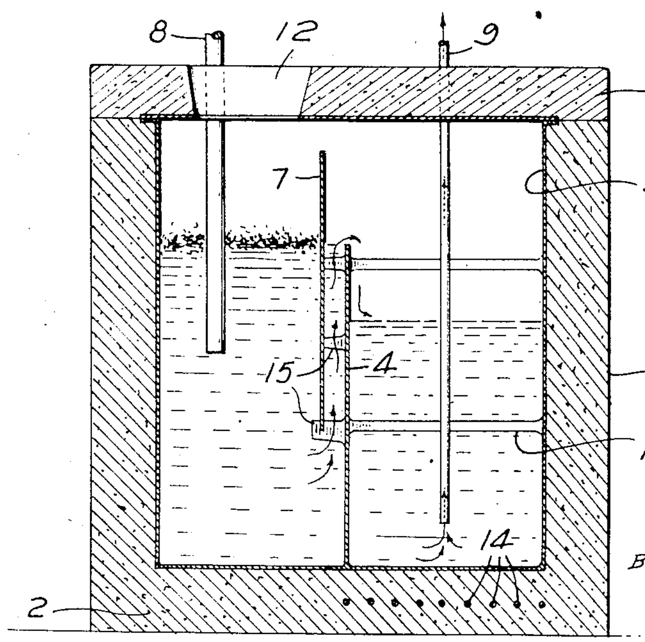


FIG. 5.

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ELECTRIC MELTING FURNACE

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Application March 29, 1941, Serial No. 385,822

3 Claims. (Cl. 13—23)

The present invention relates to an electric furnace of the type in which a molten bath is maintained therein by reason of electrical resistance.

Many chemical products require fusion and casting in suitable form before marketing. Many of these products also require refining, which is most readily done while the material is in the molten state. Usually such a refining period follows the melting period. During this refining treatment, the gaseous impurities are permitted to escape as such from the top of the bath while those in solid form deposit on the bottom of the furnace from which they are periodically removed.

There are a number of such electric furnaces on the market today which involve the use of one or more electrodes dipping into the molten bath. In such types of furnace, it is usual to supply additional quantities of the charge on top of the melt with the result that the level of the molten bath rises. As it is desirable to maintain a constant power input to the furnace during the melting cycle, it is necessary, under the above circumstances, to provide means for reducing the applied furnace voltage as the molten bath level rises and the electrode or electrodes become more and more immersed in the molten bath. This action reduces the resistance of the load.

The electric load on the furnace varies directly with the square of the applied voltage and inversely with the resistance of the bath, which latter also varies inversely with the electrode immersion. This is apparent from Ohm's law,

$$\text{kw.}=E^2/R$$

For example, with a voltage of ten applied to a furnace, the resistance of which was one ohm, the load would be $10^2/1=100$ kw.

If this load is to be maintained for a melting cycle until the electrode immersion has doubled, it is obvious that the resistance will have decreased to .5 ohm and the voltage would have to be reduced to—

$$x^2/.5=100;\ x^2=50\ \text{kw}$$
$$x=\sqrt{50}=7.1\ \text{volts}$$

That is, when the immersion of the electrodes in the bath is doubled, it becomes necessary to lower the applied voltage to 71% of the original voltage in order to maintain a constant load on the furnace. Under these circumstances, a continuous regulation of the voltage between these two limits is, of course, essential as the melting goes on.

In order to take care of such a circumstance, it becomes necessary to install intricate and expensive electrical control in order to avoid damage to the transformers and other electrical equipment connected with the furnace, damage to electrodes and overheating the bath with consequent damage to the material undergoing treatment.

The principal object of the present invention, therefore, is to design a furnace of the melting type where electrical resistance is obtained through immersion of one or more electrodes in the molten bath, in which the danger of overload occurring due to an increase in electrode immersion, is avoided without resorting to expensive and complicated voltage control.

This and other objects may be readily accomplished by providing a furnace of the above type with a refining or molten material removing chamber in proximity to the electrode containing melting chamber with a wall, baffle or weir between the two so that the molten material from the melting chamber spills over or through the wall into the removal chamber. In this way, a constant level of molten material may be maintained within the former. Due to the baffle between the two chambers, there is no possibility of a rise in this level during the operating cycle and consequent increase in electrode immersion. As a result, intricate electrical control apparatus to prevent overload is unnecessary.

While the level of molten material in the melting chamber may be lowered through abnormal feed of raw material thereto, yet this will cause no damage due to the fact that power automatically goes down as the level lowers due to decreased resistance.

The invention further consists in the novel construction, combination and arrangement of parts more fully hereinafter described, reference being had to the accompanying drawings, in which—

Fig. 1 is a fragmentary plan view of a circular furnace;

Fig. 2 is a sectional diagrammatic elevation along line 2—2 of Fig. 1 of a circular or rectangular furnace constructed according to the present invention;

Fig. 3 is a plan view of a rectangular furnace;

Fig. 4 is a plan view of a rectangular furnace having only one melting chamber; and

Fig. 5 is a sectional view on line 5—5 of Fig. 4.

Referring now with particularity to the embodiment illustrated in Fig. 1, and assuming that that illustration is of a circular furnace, the latter is shown with walls 1 and bottom 2 of any desired material, such as fire clay or other refractory or insulating brick containing an inner pot 3, usually of heavy boiler plate.

Upstanding from the bottom of the pot is a circular wall 4, thus dividing the interior of the furnace into an annular outer melting chamber 5 and an inner removal chamber 6.

Suitably secured to the walls 4 is an annular baffle 7 normally extending above the top of the wall 4 and below the bottom of electrodes 8. The latter may be arranged in pairs as shown in Fig. 2, any number of pairs being used, and so connected that a source of electrical potential heats the material surrounding the lower, submerged portions of the electrode to a fusion temperature through the resistance of the bath material to the passage of the electric current.

Within the inner chamber 6 may be located one or more draw-off pipes 9 terminating near the bottom thereof. The draw-off pipes 9 are connected to the usual casting pot or other apparatus equipped with suction means for drawing off the molten material in the well 6. This apparatus is not shown as it forms no part of the present invention and is well known equipment.

A cover 11 fits closely over the entire furnace, the electrodes 8 and draw-off pipes 9 projecting therethrough.

Also in the cover are one or more feed openings 12 through which the raw material to be fused is fed into the outer melting chamber.

In operation, the charge is melted in the chamber 5 in the usual manner, the electrodes being immersed in the charge to the desired extent. As additional raw material is fed through the openings 12 on top of the molten bath in the annular chamber 5, it fuses and becomes part of the bath. Due to this increased material, the molten charge from the chamber 5 rises between the baffle 7 and the wall 4 and spills over into the prefining or removal chamber 6. Baffle 7 preferably extends down into the molten material a sufficient distance so as to assure the hottest and most fluid part of the bath passing over into the compartment or chamber 6. It is to be noted that the upper portion of baffle 7 prevents undue contamination of the melt in chamber 6 by raw meterial fed through openings 12.

When the chamber 6 is filled with material from the melting chamber, the vacuum or other apparatus connected with the draw off pipes 9 is started with the result that the molten material is drawn off for further treatment, such as casting or the like.

It has been found that a considerable amount of solid impurities tend to drop out of the molten bath in chamber 5 to form a sludge at the bottom of the pot. This sludge can be periodically removed as desired. As a consequence, the material spilling over the top of wall 4 into the refining or removal chamber 6 is many times of a purity better than that existing in the melting chamber. As the melt in chamber 6 is not subjected to the stirring or agitation existing in the melting chamber due to convection currents, it is in a more quiescent state, and, consequently, has a tendency to deposit any additional solid impurities as well as permitting the escape of gaseous impurities.

Obviously the mass of material in chamber 6 may remain there for the desired refining period by proper control of the feed of raw material to the melting chamber.

Where desired, resistance or other heating elements 14 may be placed beneath the chamber 6 to assist in maintaining the desired temperature of the melt therein and to prevent undue radiation losses.

Where desired, bracing members 15 between the baffles 7 and walls 6 may be used to prevent buckling or collapsing of the walls under such circumstances that there is a volume of the melt on one side thereof only.

From the above, it will be observed that a maximum degree of submergence of the electrodes in the melt is definitely established by the relationship of the top of wall 4 and the bottom of electrode 8. This maximum cannot be exceeded during the operating cycle and, consequently, control apparatus or adjustment of power input by reason of such increase is unnecessary. It is not particularly serious if through an abnormal increase in feed of raw material, the level in the melting chamber drops below the top of wall 4 because, as above described, the power will automatically adjust itself downward under these circumstances.

It will be noted that Fig. 1 may also be a sectional elevation of a rectangular furnace embodying the features of the present invention in which case a plan view with the cover removed appears as Fig. 3. In such case, the walls 4 will extend from side to side with separate and corresponding baffles 7 to accomplish this overflow from the lower, and consequently hotter, portions of the fusion in the melting chamber.

The electrodes are shown at 8, which may have any desired arrangement, depending upon the circumstances. Draw-off pipes 9 are shown with much the same arrangement as in Fig. 2.

In a furnace constructed according to Fig. 3, it will be found desirable to provide a skeleton bracing element 16 between the walls 4 and located in the draw-off chamber in order to prevent a buckling of these walls inwardly due to an increased height of material in the melting chamber over that in the draw-off chamber.

In Fig. 4, a somewhat modified rectangular furnace is shown having but a single melting chamber 5, material from which feeds into the refining or draw-off chamber 6 as above described.

Fig. 5 shows somewhat in detail the arrangement of the furnace of Fig. 4.

From the above it will be noted that the furnace of Figs. 1 and 2 is preferred by reason of its greater mechanical strength. Moreover, this configuration is desirable in that there is less tendency for the material in the inner chamber to chill, as it is surrounded by molten material in the annular melting chamber.

It will be understood, of course, that the wall 4 need not have its upper limit at the level to be established in the melting chamber. On the other hand, it may extend considerably above the level to be established and ports may be provided in the wall at the liquid level. This is not shown inasmuch as it is considered to be the full equivalent of the modification illustrated.

While the invention has been shown and described with particular reference to specific embodiments, it is to be understood that it is not to be restricted thereto but is to be construed broadly and restricted solely by the scope of the appended claims.

I claim:

1. An electric furnace including an annular melting chamber, a series of pairs of electrodes therein for melting a charge fed thereto, a cylin-

drical molten material removal chamber in the center of the furnace with a plurality of molten material removing means extending downwardly and terminating short of the bottom thereof therein, a dividing wall between the two chambers closed at the bottom, the top thereof determining the normal level of molten material in the melting chamber, a cylindrical baffle on the melting chamber side of the dividing wall, the baffle extending above and below the normal level of molten material in the melting chamber.

2. An electric furnace including a metallic pot, a dividing wall upstanding on the bottom thereof dividing the pot into a melting chamber and a refining and removal chamber, a baffle between the dividing wall and the outer pot wall, and spaced from the bottom of the pot, freely suspended electrodes in the melting chamber, the bottom of the refining chamber being closed by the pot bottom, and means to withdraw molten material from the refining and removal chamber, said means extending short of the bottom of the said chamber so as to clear any solid impurities deposited therein.

3. The furnace of claim 2, with means beneath the refining chamber to supply heat thereto.

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