F. CREELMAN.

APPARATUS FOR ELECTRIC SMELTING.

APPLICATION FILED JAN. 7, 1904.

978,137.

Patented Dec. 13, 1910.

3 SHEETS—SHEET 1.

FIG. 2.

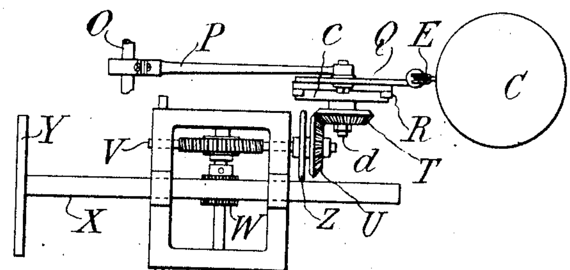


FIG. 1.

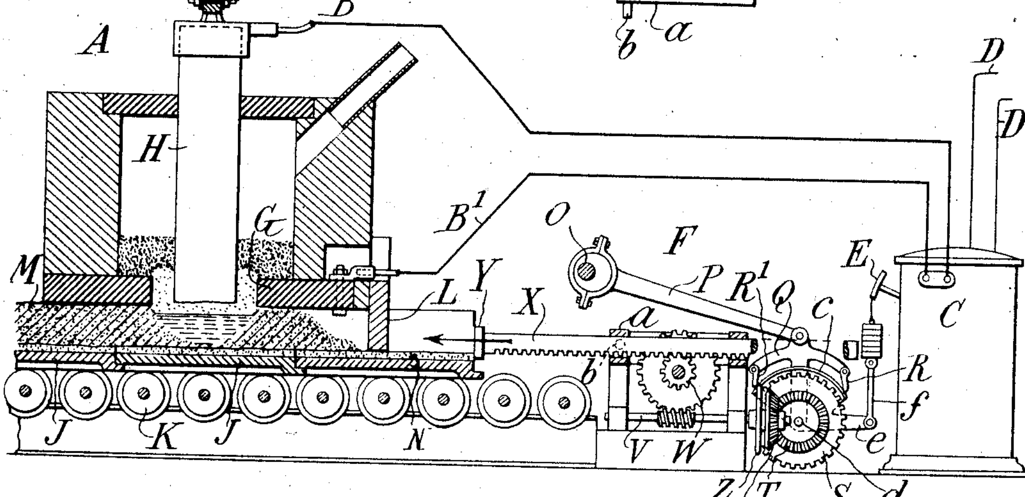


FIG. 4.

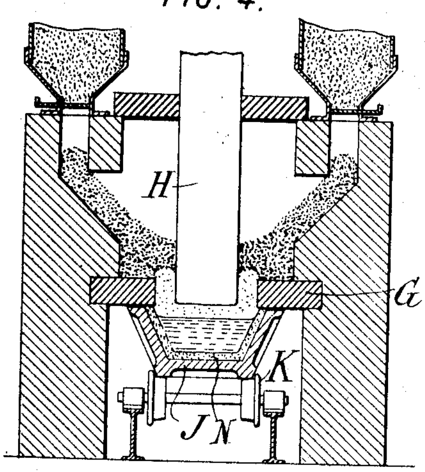
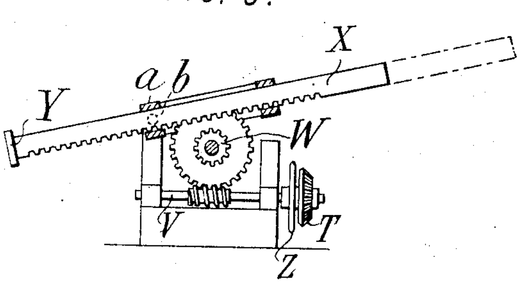


FIG. 3.



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3 SHEETS—SHEET 2.

FIG. 5.

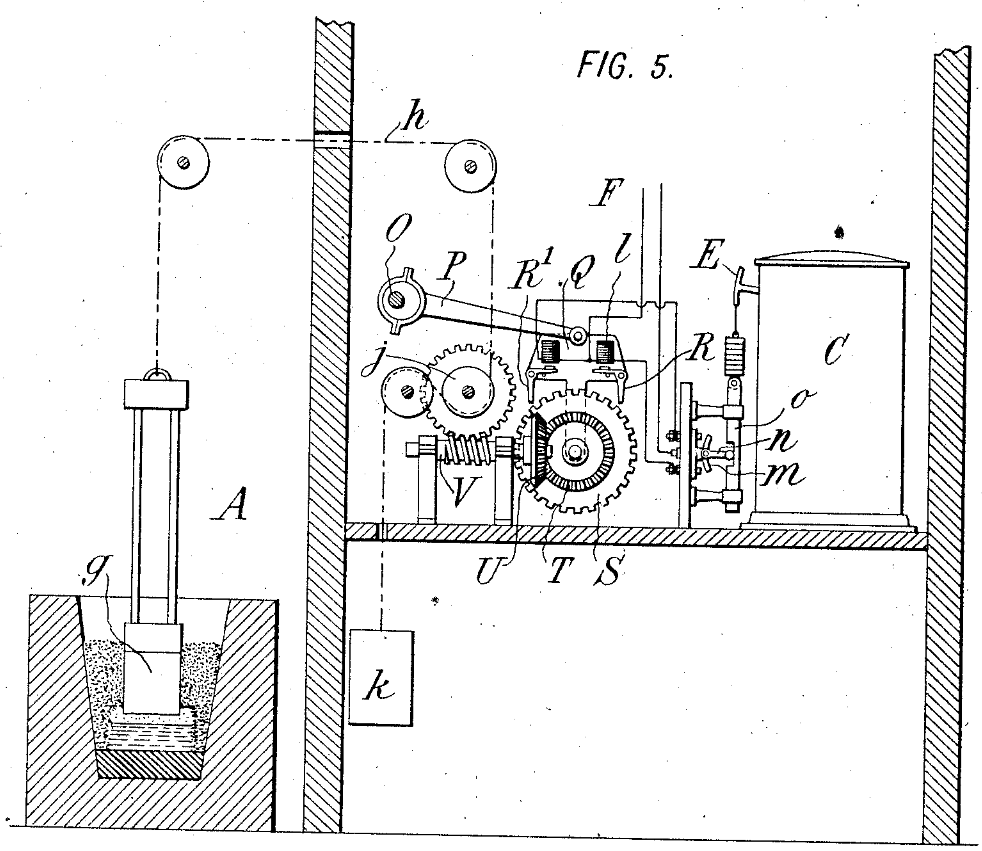
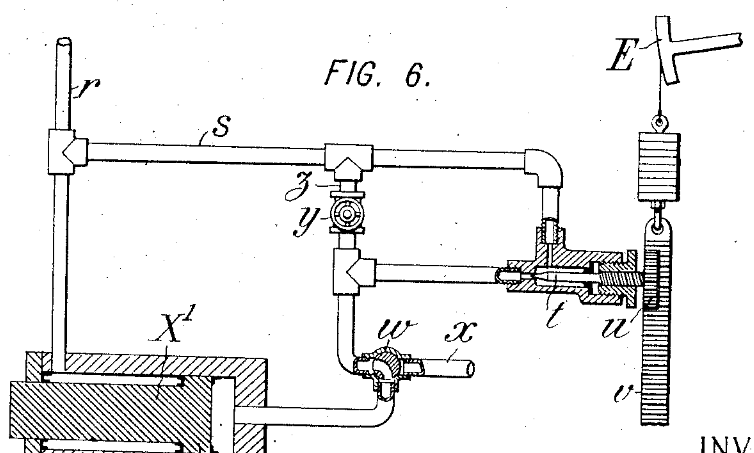


FIG. 6.



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3 SHEETS—SHEET 3.

FIG. 7.

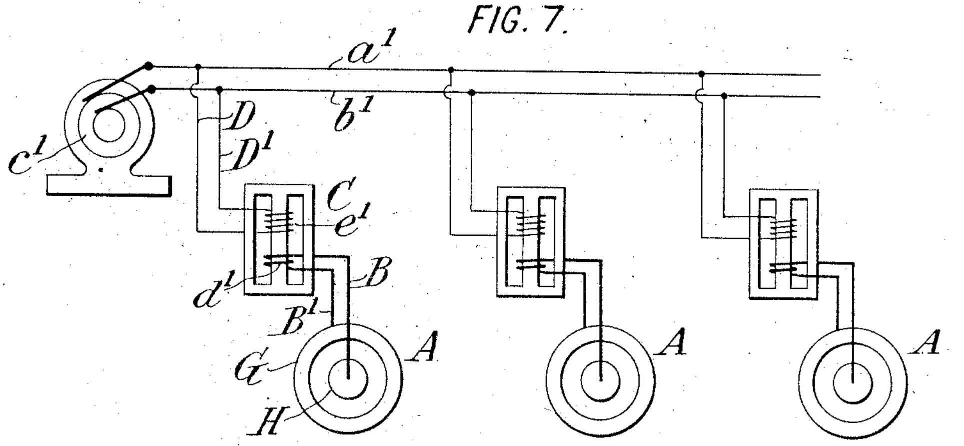
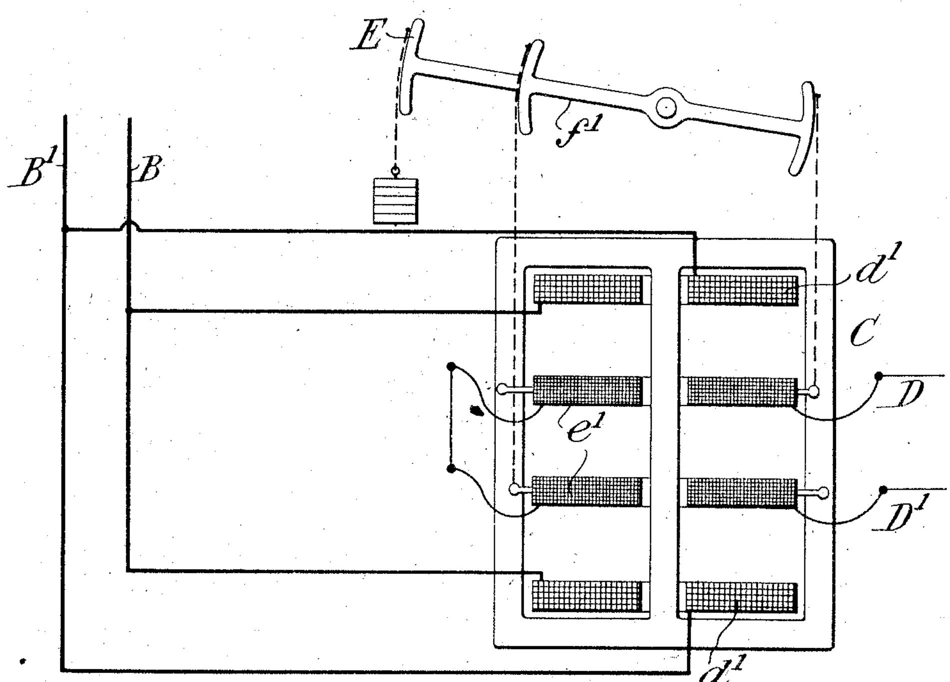


FIG. 8.



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UNITED STATES PATENT OFFICE.

FRANK CREELMAN, OF NEW YORK, N. Y., ASSIGNOR TO THE WILLSON CARBIDE WORKS COMPANY OF ST. CATHARINES, LIMITED, OF ST. CATHERINES, CANADA, A CORPORATION.

APPARATUS FOR ELECTRIC SMELTING.

978,137. Specification of Letters Patent. Patented Dec. 13, 1910.

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To all whom it may concern:

Be it known that I, Frank Creelman, a citizen of the United States, residing in the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Apparatus for Electric Smelting, of which the following is a specification.

My invention aims to provide certain improvements especially applicable to electric furnaces for the manufacture of calcium carbid or similar products.

An important feature of the invention is the supplying of a current of constant amperage to the furnace, so that under sudden reductions in the internal resistance of the furnace, there can be no dangerous rise in the quantity of current supplied; and the controlling of the operation of the furnace by means of variations in voltage. The operation of the furnace is controlled by a regulator of any suitable sort which either moves the zone of fusion, or moves the material so as to gradually reduce all or a desired part of the material. The application of a constant current, maintained constant by means outside of the furnace, is of special usefulness in connection with a regulator for automatically controlling the operation of the furnace. Trifling variations in the rate of movement of the electrode or of the material, which might produce a temporary reduction of the internal resistance, serve only to lessen the electrical energy which the furnace calls for. Preferably under normal conditions the voltage is maintained near the maximum. Variations which increase the resistance have no effect other than to induce momentarily a lesser supply of current than the normal, the departure from normal conditions being promptly rectified by the regulator. Preferably the regulator is controlled directly by the means for maintaining a constant current, such for example as a constant current transformer. Such a constant current transformer would then serve the three purposes of reducing the voltage below that of the line, maintaining the volume of current constant, and governing the regulator which controls the rate of operation of the furnace.

The electrical system and mechanism referred to are of special value in connection with a particular style of furnace wherein the entire material passes through an opening in which is maintained the zone of fusion, and from which the fused material runs into a receptacle beneath.

Various other improvements are referred to hereinafter.

The accompanying drawings illustrate certain embodiments of the invention.

Figure 1 is a longitudinal section through a furnace showing in side elevation a regulator controlling the rate of operation of the furnace; Fig. 2 is a plan of the regulator; Fig. 3 is a view of a part of the regulator similar to Fig. 1, but showing the parts in a different position; Fig. 4 is a section of the furnace at right angles to that shown in Fig. 1; Fig. 5 is a view similar to Fig. 1, showing the invention applied to an ordinary pot furnace, and showing a slightly different style of regulator; Fig. 6 is a diagrammatic view partly in section showing a hydraulic regulator applicable to either style of furnace; Fig. 7 is a diagrammatic view of the electrical elements and connections for a group of three furnaces; Fig. 8 is a diagrammatic view of a transformer adapted for use as a part of my invention.

Referring to the embodiments illustrated, A represents as a whole an electric furnace, which according to my broad invention may be of any suitable construction, the current to which is brought through leads B B′ from a constant current transformer C. The wires running from the transformer to the line are indicated at D D′. The specific construction of the transformer constitutes no part of this invention. Any suitable apparatus may be used. In fact a constant current regulator which does not transform the voltage may be used, the desired voltage being supplied directly by the generator, or being insured by a separate intermediate transformer. A moving part E of the transformer C controls the operation of a regulator which I designate as a whole by the letter F, and which like the furnace and the current regulator may be of any suitable construction, three different types being shown.

Referring now especially to Figs. 1 and 4, a furnace is illustrated having at its lower end an opening through which the material passes, the material emerging in a fused state by the extension of the zone of fusion to a sufficient depth in the opening. Preferably the zone of fusion is maintained in the desired location by making the opening through one of the electrodes G, and by introducing the opposite electrode in the form of a pencil H into the opening, and substantially or approximately through the same to the discharge end thereof. The zone of fusion extends throughout the cross-section of the opening, thus insuring the fusion and reduction of all the material which passes through the furnace. The electrodes may be adjustable to compensate for the burning or wearing off of their ends. They are preferably fixed in operation. The walls of the furnace, the inlet for material, and the outlet for the gases generated, may be of the ordinary form shown or of any other suitable form. Such a furnace eliminates two serious defects of the furnaces now ordinarily used for the manufacture of calcium carbid. In the old type of furnaces, the fused or reduced material is formed with a surrounding hard crust of only partially reduced material, which is surrounded in turn by a certain amount of practically unaltered material. The crust is not only practically worthless as carbid, but its removal from the inclosed pig of pure carbid is a cause of great expense, and dump heaps of it are of objectionable odor. The old unreduced material is generally re-used, but the extra handling of it, especially in the red hot condition in which it is taken out of the furnace, is a matter of great difficulty and expense. The present furnace by reducing completely all the material which passes through it, saves a very large part of the expense of manufacture of calcium carbid and similar products.

The finished product is carried away by a conveyer consisting preferably of a horizontal (or it may be sloping) line of separate trough-sections J which receive the fused material, and in which the material solidifies into a pig or pigs of suitable shape. This horizontal conveyer constitutes practically a part of the furnace, serving to hold up the pool of fused material, and serving by its rate of movement to determine the rate of passage of the material through the zone of fusion. These trough-sections travel on a series of stationary rollers K, or on any other suitable guide, and the line is maintained by introducing a new section at the starting end at proper intervals. A plate L depends from one side of the furnace, filling the internal space of the trough and substantially preventing access of air and burning away of electrodes, and also preventing escape of material or gases at this end. The plate L may be removable or may have a window therein, for permitting inspection of the conditions within the furnace. The other end of the trough is closed by means of the solid pig M of the product. The sections J may be of iron lined with slabs N of carbon or other suitable material to withstand the action of the great heat, and may overlap each other at the ends as shown in Fig. 1, or otherwise make a close joint and prevent the escape of any material. The trough is pushed gradually forward from the rear end in the direction of the arrow, the pig being broken and taken out of each section after it has passed through the furnace, and a new section being added at the rear end of the line as often as the line advances the length of one section. The regulator, therefore, in order to determine the rate of operation of this furnace, acts upon the line of trough-sections J.

In Figs. 1, 2 and 3, I have shown a regulator the principles of which are well known, especially modified to adapt it to the moving of the line of trough-sections J. A continuously driven shaft O carries an eccentric which reciprocates a link P and oscillates a frame Q carrying pawls R R′ at opposite ends. These pawls by the engagement of one or the other with a toothed wheel S, rotate the wheel in one or the other direction, and through the intermediation of bevel gears T and U rotate a worm-shaft V, the motion of which is transmitted in turn to a pinion W, which reciprocates a pusher X having at its end a cross arm Y which bears against the rearmost of the sections J. The pawl R which effects a gradual withdrawal of the pusher X may be omitted with the style of furnace here shown, the withdrawal of the pusher being effected quickly by lifting the rear end of the pusher X in the manner illustrated in Fig. 3 until its teeth are freed from those of the pinion W, when it may be quickly drawn backward its full length and a new section introduced between the last section of the line and the cross bar Y at the end of the pusher. The pusher will then be dropped again to come into engagement with the pinion W, and the pusher X will be quickly advanced by means of a hand wheel Z on the shaft V to bring the new section to bear hard up against the last previous section. The automatic operation then continues. For permitting the described movement of the pusher X, it may be mounted in a frame *a* pivoted at *b*. The automatic regulation of the feed is effected by means of a shield *c* loosely mounted on the shaft *d* and provided with an arm *e* which is connected by a link *f* to the usual weighted arm E or other movable member of the transformer or of any other suitable constant current regulator. As the arm E moves down in accordance with the falling resistance due to the accumulation of fused material, the shield c swings to the right, uncovering the pawl R′, which gradually pushes the sections forward until normal conditions are established and the arm E returns to its normal position. There will ordinarily be no occasion for retarding the rate of operation of the furnace, but this may be accomplished if desired by connecting the sections J to each other, and by connecting the bar X to the rear section. Upon the operation becoming too rapid, the pawl R will then come into action by the appropriate movement of the shield c, and the trough will be drawn backward.

The furnace of Fig. 5 is an ordinary pot or crucible furnace in which the operation proceeds by the gradual lifting of the upper electrode g as the fused product in the center of the mass of material rises. The raising and lowering of the electrode g is accomplished by means of a chain h passing around a sprocket wheel j and carrying at its end a counterweight k. The drum j is turned in one direction or the other by means of a worm shaft V driven as in Fig. 1 by means of a continuously rotating shaft O, link P, oscillating frame Q, pawls R R′, toothed wheel S, and bevel gears T and U. The pawls may be controlled mechanically, as in Fig. 1, or they may be controlled by means of magnets l controlled in turn by a double snap-switch m, the operating arm n of which is moved by means of a slide o connected to the arm E of the transformer or current regulator C. The furnace regulator here described could obviously be applied as well to the furnace of Fig. 1 as to that of Fig. 5.

A hydraulic governor is illustrated in Fig. 6 in a form especially applicable to the feeding movement of the furnace of Fig. 1. The pusher X′ is in the form of a ram or plunger working in a cylinder p and having a head q. The annular space in front of the head is constantly connected to the pressure supply by means of a pipe r, and this pipe has a branch s through which water may be supplied to the opposite or back end of the piston head q to force the ram forward by reason of the difference in total pressure on the two sides of the head, due to the difference in area. The controlling of the forward movement is effected by a needle valve t carrying at its end a pinion u engaging a rack v connected to the movable member E of the current regulator. Between the valve t and the cylinder p a three-way cock w is interposed which connects the needle valve with the cylinder during the gradual forward movement of the pusher, and which connects the rear end of the cylinder with the waste pipe x to permit a quick return of the pusher by means of the pressure in the annular space in front of the piston, when a new section of the conveyer is to be added. A valve y is provided in a by-pass z for moving the pusher quickly forward to take up the slack necessarily provided in the introduction of a new section.

The arrangement of the circuits by which the constant current is obtained is capable of considerable variation. A suitable and preferred arrangement is shown in Fig. 7, in which three furnaces represented at A receive electrical energy from main wires a' b', which in turn are supplied from an alternating current generator c'. The furnace typified at A may be supposed to represent the furnace of Fig. 1, having the central carbon pencil H and the lower carbon G. Or it may be an ordinary pot or crucible furnace, or any other suitable type of furnace. For each furnace A is provided a separate transformer C, the primary coil of which is connected with the wires D D′, which are connected in multiple with the main circuit leads a' b'. The secondary coil of the transformer is connected with the wires B B′ constituting the local circuit for each furnace. A constant current for each single furnace may of course be obtained directly from a suitably wound dynamo; but assuming that the dynamo shown maintains a normal constant potential or electromotive force upon the main wires, then the transformer C is of a type adapted to maintain a constant current in the circuit B B′ of its secondary coil, and which leads to the furnace. In fact in place of the single element C which both transforms the voltage and maintains a constant current, I may substitute a transformer which does not maintain a constant current, and add also a current regulator of any suitable type which shall maintain the desired constant current. A suitable type of constant current transformer is shown in Fig. 8 diagrammatically. The secondary coils d' are fixed at opposite ends of the core which carries the magnetic circuit, while the primary coils e' are made movable along the core and are counterbalanced by a series of levers, of which only one is shown at f', the projecting end E of which is utilized in governing the regulator as hereinbefore described. An increase in the current passing through the fixed secondary coils, causes the adjacent movable primary coils to recede therefrom and thereby diminishes the induction in such proportion as to maintain a constant current. Whenever from any cause the resistance in its furnace falls, the transformer by proportionally reducing the voltage in the circuit of its secondary coil, maintains the current constant and prevents any rise or rush of current as would otherwise occur. Thus instead of a dangerous rise of current under such circumstances, we have a harmless fall of voltage. The arrangement of the circuits shown in Fig. 7 is especially advantageous in rendering the several furnaces which take their power from a constant source, independent of each other. Each transformer becomes in fact a source of current for its own furnace, supplying a current of substantially uniform volume independently of variations in the internal conditions or the current demands of the other furnaces.

In previous ingot furnaces the lime and carbon had to be very finely ground so that the molten lime should not percolate too freely into the material outside of the zone of fusion and thus form a pig of irregular quality and with a thick crust. With my improved apparatus in which all the material passes through the zone of fusion and is reduced therein, the former expense for fine grinding is not necessary. Also in previous ingot furnaces it has been found impracticable to use limestone, the crust formed in such a case being very hard as compared with that obtained by the use of lime. With my improved apparatus producing a crustless pig, limestone may be substituted for lime with a considerable saving in expense.

A sufficiently constant amperage for practical purposes may be obtained by other arrangements than that shown. For example a plant of several furnaces may be supplied from a constant potential generator, and ordinary transformers arranged with their several primary coils in series in the main circuit and their secondary coils connected one to each of the furnaces. A short circuit in one such furnace would not short-circuit the system and the abnormal quantity of current would be in inverse ratio to the number of furnaces. Therefore with any considerable number of furnaces the disturbance of normal conditions would be slight. The regulation for each furnace could be accomplished separately by a voltmeter, or automatically by a coil connected between the furnace terminals.

What I claim is:—

1. In an electric furnace, in combination, a pair of stationary electrodes arranged to permit the passage of the material between them from above, with an outlet opening directly beneath them and a transversely movable receptacle for the molten product arranged close beneath said electrodes, and beneath said opening, whereby the product in said receptacle serves to support the material undergoing reduction in said opening.

2. In an electric furnace in combination, a pair of stationary electrodes arranged to permit the passage of the material between them from above with an outlet opening directly beneath them, and a receptacle for the molten material comprising a series of conveyer sections adapted to pass successively below said electrodes close beneath said opening to form a continuous pig of product and arranged close beneath the zone of fusion, whereby the product in said receptacle immediately beneath the electrodes is molten and serves to support the material undergoing reduction.

3. In an electric furnace in combination means for fusing the material, a transversely movable receptacle receiving the fused product, and an actuating mechanism for said receptacle controlled by the variations in the voltage.

4. In combination, an electric arc furnace, and means for supplying thereto a current of constant amperage notwithstanding variations in the internal resistance of the furnace, said furnace having an opening and constructed to maintain fusion of the material in said opening, and to withdraw the product therefrom progressively as it is formed and at a rate controlled by the variations in the voltage.

5. A regulating mechanism for electric furnaces comprising in combination a movable part of the furnace, a pusher therefor, and means for advancing said pusher by short steps continuously in one direction, said pusher being adapted to be quickly returned to its starting point.

6. An electric furnace, comprising a smelting chamber having a discharge opening, and a receptacle movable across said opening and arranged to retain a molten body within said chamber.

7. An electric furnace, comprising a smelting chamber having a discharge opening, and a plurality of receptacles movable across said opening and arranged to retain a molten body within said chamber.

8. An electric furnace, comprising a smelting chamber having a discharge opening, and a plurality of abutting receptacles movable across said opening and arranged to retain a molten body within said chamber.

9. An electric furnace, comprising a smelting chamber, having an open bottom, and a receptacle movable transversely beneath said bottom and arranged to retain a molten body within said chamber.

10. An electric furnace, comprising a smelting chamber having an open bottom, and a plurality of receptacles movable transversely beneath said bottom and arranged to retain a molten body within said chamber.

11. An electric furnace, comprising a smelting chamber having an open bottom, and a plurality of abutting receptacles movable transversely beneath said bottom and arranged to retain a molten body within said chamber.

12. An electric furnace, comprising a smelting chamber having an open bottom, electrodes extending into said chamber, and a receptacle movable transversely beneath said bottom and arranged to retain a molten body within said chamber.

13. An electric furnace, comprising a smelting chamber having an open bottom, electrodes extending into said chamber, and a plurality of receptacles movable transversely beneath said bottom and arranged to retain a molten body within said chamber.

14. An electric furnace, comprising a smelting chamber having an open bottom, electrodes extending into said chamber, and a plurality of abutting receptacles movable transversely beneath said bottom and arranged to retain a molten body within said chamber.

15. An electric furnace provided with electric heating means and having a traveling receiver or hearth adapted to travel substantially horizontally through said furnace below said heating means for receiving the reduced material or product and conveying the same from the furnace, the said traveling receiver or hearth being composed of detachable sections adapted to be transposed from end to end to permit of the same being made practically continuous in its travel through the furnace, and means for operating said receiver or hearth, substantially as and for the purpose set forth.

16. An electric furnace provided with electrical heating means and having a traveling receiver or hearth adapted to travel substantially horizontally through said furnace below said heating means for receiving the reduced material or product and conveying the same from the furnace, the said traveling receiver or hearth being composed of detachable sections adapted to be coupled and uncoupled to permit of the same being made practically continuous in its travel through the furnace and being practically sealed at the points where it enters and leaves the furnace, respectively, and means for operating said receiver or hearth, substantially as and for the purpose set forth.

17. An electric furnace provided with electrical heating means and having a horizontally traveling recessed or trough-shaped receiver or hearth adapted to travel through said furnace below said heating means for receiving the reduced material or product and conveying the same from the furnace, and means for operating said receiver or hearth, substantially as and for the purpose set forth.

18. An electric furnace provided with electrical heating means and having a traveling recessed or trough-shaped receiver or hearth adapted to travel substantially horizontally through said furnace below said heating means for receiving the reduced material or product and conveying the same from the furnace, the said traveling receiver or hearth being composed of detachable sections adapted to be transposed from one end to the other to permit of the same being made practically continuous in its travel through the furnace, and means for operating said receiver or hearth, substantially as and for the purpose set forth.

19. An electric furnace provided with electrical heating means and having a traveling recessed or trough-shaped receiver or hearth adapted to travel substantially horizontally through said furnace below said heating means for receiving the reduced material or product and conveying the same from the furnace, the said traveling receiver or hearth being composed of detachable sections adapted to be transposed from end to end to permit of the same being made practically continuous in its travel through the furnace and being practically sealed at the points where it enters and leaves the furnace, respectively, and means for operating said receiver or hearth, substantially as and for the purpose set forth.

20. An electric furnace provided with electrical heating means and having a traveling recessed or trough-shaped receiver or hearth adapted to travel below said heating means for receiving the material and conveying therefrom the reduced material, the said receiver or hearth constituting the bottom and also a substantial portion of the sides of said furnace, and means for operating said receiver or hearth, substantially as and for the purpose set forth.

21. An electric furnace provided with electrical heating means and having a traveling recessed or trough-shaped receiver or hearth adapted to travel below said heating means and having such depth thereto as to constitute the bottom of the furnace and the opposite sides thereof, such sides extending up to or near the level of the fusing zone, and means for operating said receiver or hearth, substantially as and for the purpose set forth.

22. An electric furnace provided with electrical heating means and having a traveling receiver or hearth adapted to travel through said furnace below said heating means and being composed of detachable sections adapted to be transposed from end to end to permit of said receiver being practically continuous in its travel through the furnace, driving connections engaging the two opposite sides of said traveling receiver or hearth, and means for actuating the said driving connections, substantially as and for the purpose set forth.

23. An electric furnace having a fusing or smelting chamber provided with means

for heating the charge therein, a discharge opening in said chamber, a receiver or receptacle traveling across said discharge opening and adapted to retain the charge within said chamber.

24. An electric furnace having a fusing or smelting chamber provided with means for heating the charge therein, a discharge opening in said chamber, a plurality of receivers or receptacles traveling across said discharge opening and adapted to retain the charge within said chamber.

In witness whereof, I have hereunto signed my name in the presence of two subscribing witnesses.

FRANK CREELMAN.

Witnesses:
Domingo A. Usina,
Fred White.