No. 859,136. PATENTED JULY 2, 1907.

F. T. SNYDER.

ELECTRIC FURNACE.

APPLICATION FILED JUNE 30, 1906.

2 SHEETS—SHEET 1.

Fig. 1

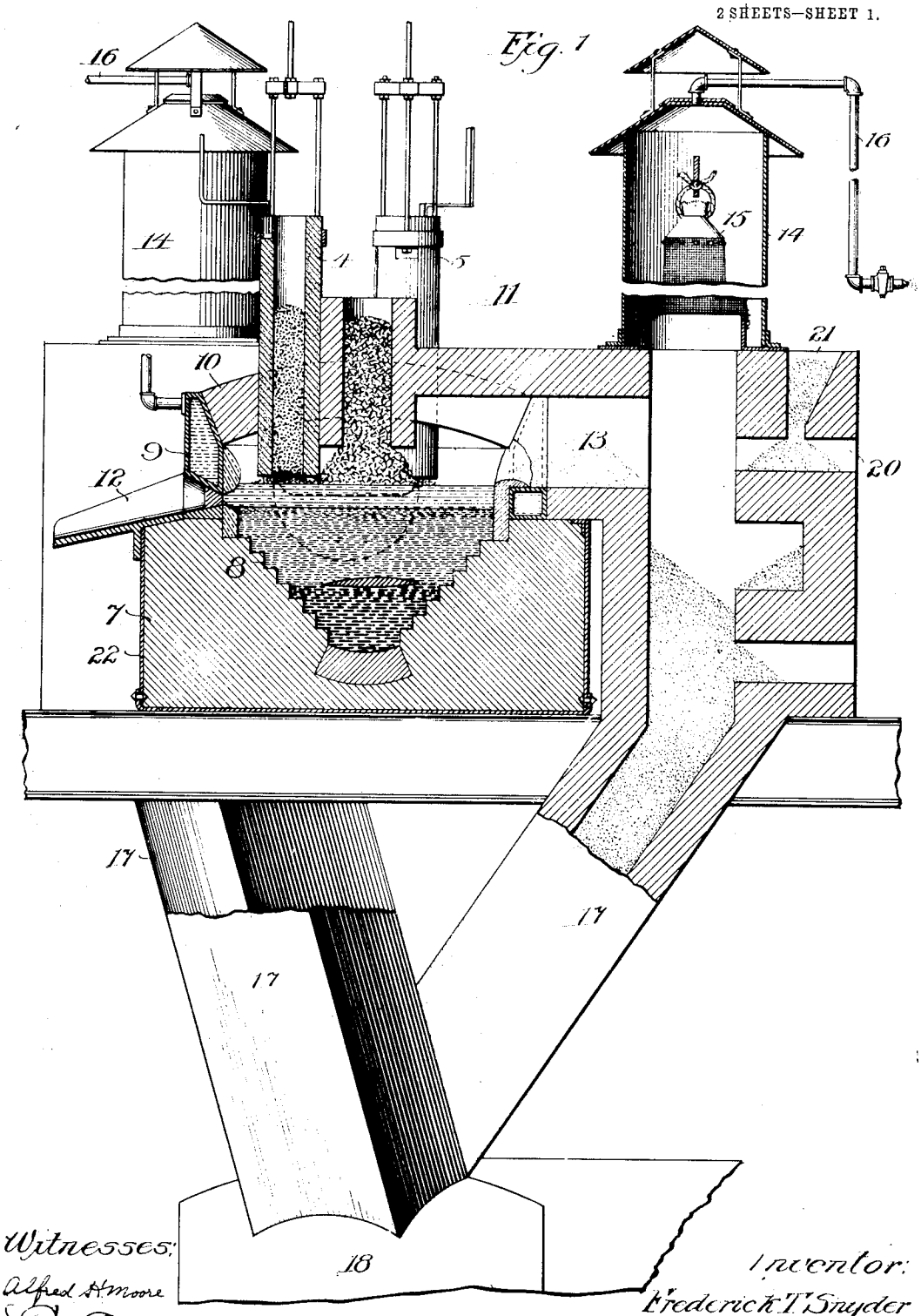

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Fig 2.

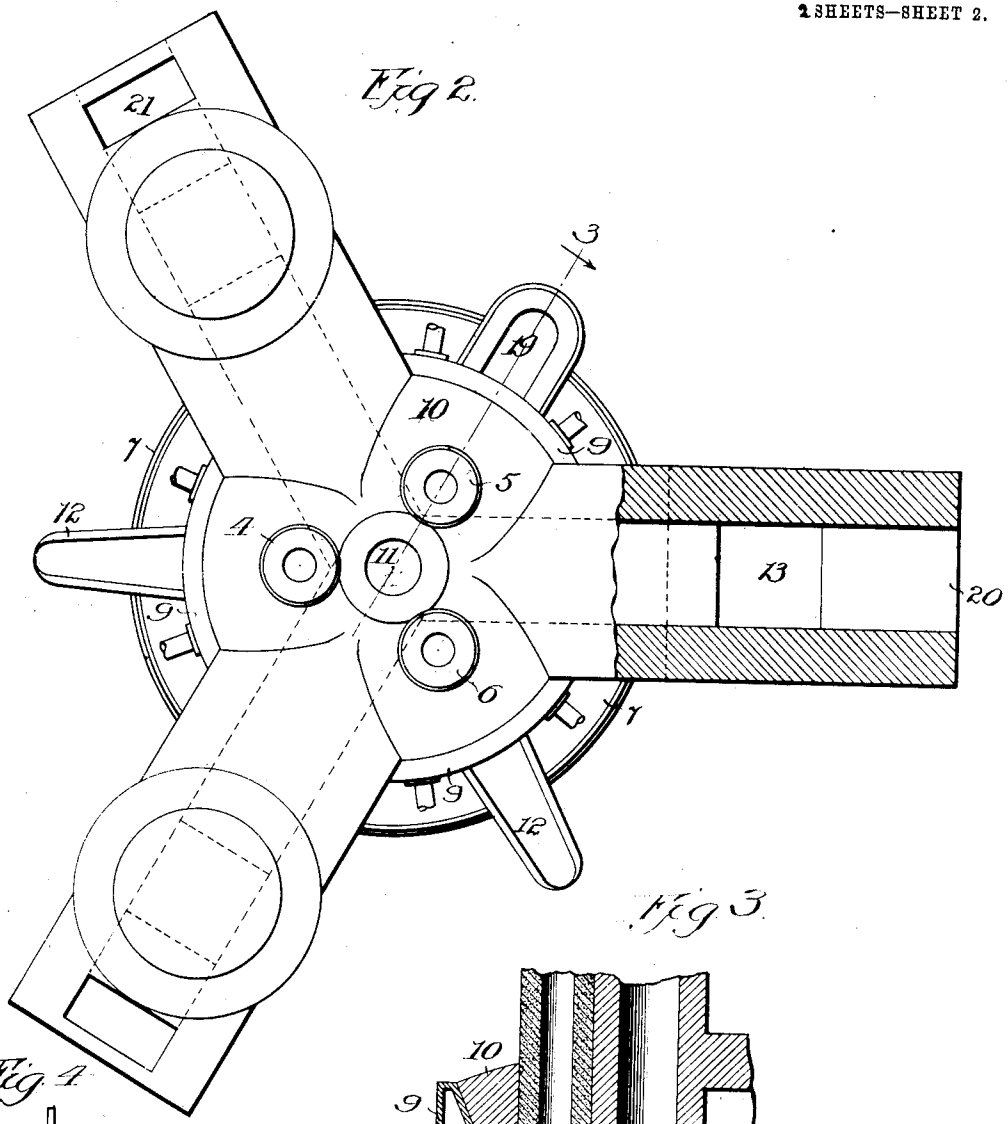


Fig 3.

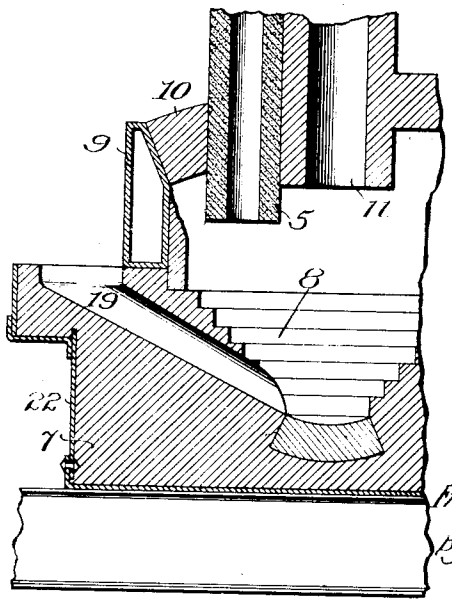
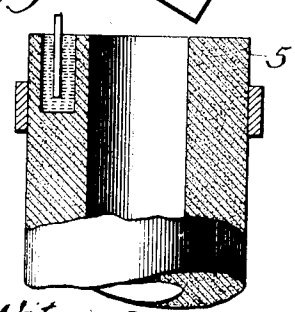


Fig 4



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UNITED STATES PATENT OFFICE.

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ELECTRIC FURNACE.

No. 859,136. Specification of Letters Patent. Patented July 2, 1907.

Application filed June 30, 1906. Serial No. 324,117.

To all whom it may concern:

Be it known that I, FREDERICK T. SNYDER, a citizen of the United States, residing at Oak Park, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Electric Furnaces, of which the following is a full, clear, concise, and exact description.

My invention relates to an electric furnace, and its object is to provide an improved construction which will be especially adapted for the smelting of lead-zinc ores, to recover both the zinc and the lead; although the furnace will be capable of other uses.

One feature of the invention resides in a construction by which zinc dust produced by one furnace may be readily collected and conveyed, while still in a heated condition and protected from the air, to a second furnace, where it is converted into spelter.

Another feature of the invention relates to a construction of the furnace walls such that they will not be liable to be destroyed by the corrosive action of the mixtures under treatment.

Another feature resides in an improved form of electrode and improved means for connecting the leading-in conductors thereto.

Another feature is the provision of means for maintaining the furnace closed against the passage of gas into or out of the same, through the holes by which stirring rods are introduced, this means consisting of a construction of the hole in such a way as to permit a continuous supply of comminuted material to be maintained therein to constitute a gas check.

Still another feature lies in an improved arrangement of the slag tap, together with a construction such as to insure that the slag, when tapped, will have been subjected to the maximum heating and reducing conditions.

The invention will be explained in detail and further features thereof described by reference to the accompanying drawings, which illustrate the preferred form of the furnace.

Figure 1 is a vertical sectional view of the furnace; Fig. 2 is a plan view thereof, partly in section. Fig. 3 is a detail sectional view on line 3 of Fig. 2; Fig. 4 is a detail view of a portion of one of the electrodes, showing how the electrical connection of the leading-in conductor thereto is accomplished.

The same letters of reference indicate the same parts wherever they are shown.

The furnace shown in the drawing is adapted to be operated by current delivered on the three phase system, and three electrodes, 4, 5, 6, are shown, which project vertically through the roof of the furnace to receive and deliver the current. The furnace comprises a base portion 7 of refractory material having a funnel-shaped crucible 8 hollowed out in the central portion thereof, adapted to receive the molten metal. The upper portion of the furnace is preferably cylindrical, and the side walls thereof are formed of a water jacket 9 made in segments, each of which is provided with means for conveying the water to and from the body thereof. This cylindrical water jacket is surrounded by a dome-shaped roof 10 of refractory material, through which the carbon electrodes 4, 5, 6, project, through suitable openings. The central portion of the dome-shaped roof has a charging opening 11 therein through which the ore or material to be smelted is fed into the furnace.

It is intended that during the operation of the furnace the funnel-shaped crucible 8 will contain molten metal; above which will be a bath of molten slag. In some cases a layer of matte may be formed between the slag and the molten metal, this matte layer being preferably quite deep, to protect the underlying metal from the heat which is localized in the upper part of the fused bath. The slag is very corrosive, and is apt to eat away fire brick, of which furnaces are ordinarily made.

In my furnace the portion which immediately contains the slag is constructed with the double walls or water jackets 9, as shown, within which the flow of cooling fluid is maintained; the result being that the slag is congealed around the inside of the furnace wall, and forms a thick glassy lining thereon, which acts to conserve the heat, and more especially to insulate the iron walls and prevent short circuiting of the electric current which is designed to pass through the molten portion of the slag in the center of the furnace. I thus take advantage of the fact that slag—especially a high silica-slag such as I preferably use,—when cold, is an almost perfect insulator, and while hot is a very good electrical conductor, by having the molten slag bath lined with congealed slag, which is kept in a solid state by flowing water within the double walls of the furnace.

The electrodes which I prefer to employ consist of hollow carbon shells, through which comminuted conducting material, such as granular carbon, is fed into the furnace, the portion of the electrode which is in contact with the slag, and subject to eating away, being the body of granular carbon. The tubular carbon shell may be maintained entirely out of contact with the slag bath, and may be raised up high enough so that it is not likely to be broken by the tapping or stirring rods.

It is of considerable advantage to construct the electrodes as above described, with hollow permanent shells, and comminuted or granular carbon fed through these shells into contact with the slag; because the solid carbon is much more expensive than that which is in powdered form, especially in the case of large

electrodes, and by my invention the solid portion of the electrode is subjected to very little action tending to wear it away. A further advantage is that the granular carbon forms a floating electrode on the surface of the slag, making an approximately constant area of contact with the slag, whether the level of the slag be high or low. In the case of solid electrodes projecting into the molten slag, it is evident that if the electrodes are stationary, and the level of the slag rises, the resistance of the contact will be reduced on account of the increased surface thus provided. My arrangement, on the other hand, permits of a better regulation and a more even consumption of current.

Slag taps are provided, consisting of openings through the furnace walls, preferably in line with the electrodes, and suitable troughs 12 for running off the molten slag, these troughs extending over the upper edge of the refractory base 7. The object of locating the slag tap adjacent to and in line with the electrode, is that the maximum heat of the furnace is produced at the electrode, and when the slag is tapped off it must pass by the electrode to get to the tap hole, so that it is thus subjected to the maximum heat and to the reducing action of the granular carbon just before it is tapped off, thus insuring a thorough exhaustion of the slag from zinc.

It will be observed that owing to the relative position of the electrode between the tap hole and the charging opening through which the ore is introduced, the tapping off of the slag, and the consequent lowering of the surface thereof, tends to draw down the unreduced ore toward and under the floating electrode.

In one wall of the furnace an opening 20 is provided through which an iron bar may be thrust to stir the materials in the furnace. In the operation of zinc smelting it is essential that the access of air to the furnace be prevented, and it is also desirable that the escape of zinc vapors be prevented as far as possible. For this purpose I provide a funnel-shaped pocket 21 leading into the opening 20 and adapted to contain comminuted material, such as sand or zinc dust, which will form a gas check in said opening. In other words, the opening may be of an inverted T shape, the horizontal or transverse arm of the T being that through which the stirring rod is introduced, and the vertical arm being that through which the sand or dust is fed into the transverse opening to keep the latter filled. When a rod is thrust through the transverse opening it will displace some of the comminuted material, but more will be fed through and fill in around the stirring rod. When the rod is withdrawn the opening is instantly closed by more of the comminuted material flowing down to occupy the vacant space. In practice I prefer to use some of the zinc dust product of the furnace itself to form the gas check in the opening 20.

The furnace shown is intended especially to be used in practicing the process of my invention described in my application, Serial No. 324,116 filed June 30, 1906, which contemplates diluting the zinc vapor so that it will all condense as zinc dust. I therefore provide flues 13, 13, for carrying off the gases due to reduction, each of these flues leading into a high vertical stack or pipe 14, in which a long inverted woolen bag 15 is suspended. From the top of the stack a pipe 16 is provided to conduct away the uncondensed gases. Immediately underneath the stacks 14 the flues 13 are continued downward and lead to extensions or pipes 17, which serve to convey the zinc which has been condensed in said flues to a second smelting furnace 18 located underneath. This second smelting furnace is indicated diagrammatically; it may be of the general type of the first furnace, or of any other suitable construction adapted to remelt the zinc dust and convert it into spelter.

A well 19 is provided in the furnace leading diagonally upward from the bottom of the crucible to a point outside the furnace walls, as shown in Fig. 3. When the furnace is in operation, this well will be filled with the molten metal which is contained in the crucible, which metal may be withdrawn from time to time by ladling.

I preferably surround the brick work base 7 with an iron jacket 22, to hold it in shape to prevent the escape of molten lead which may leak through the interstices in the brick work. It will be noted that the slag trough 12 rests over the upper edge of this base, and is so located that none of the lead leaking into the brick work can escape by it.

The operation of this furnace is as follows: The furnace may be started by first building a wood fire in the crucible for three or four days to get the brick work red hot, this fire being assisted by means of a blast, which may be introduced through the lead well 19 or otherwise. After the furnace is thoroughly heated, pig lead is put in through the electrode holes and melted down. The wood fire is then allowed to burn down to embers on top of the lead crust, these embers being then scraped up in piles, one under each electrode. The electrodes 4, 5, 6, are then let down on the piles of embers or charcoal, a supply of comminuted carbon being fed through the hollow bar of each electrode. Cold slag, crushed to the size of walnuts, is then introduced into the furnace until there is a layer four or five inches deep on top of the lead. The slag should be heaped up against the water jacket 9 so that when it melts it will coat the water jacket clear up to the top. As the slag melts it becomes sticky, and readily adheres to the cold water jackets. The current is now turned on and the furnace starts its operation. The ore to be smelted is fed through the opening 11 onto the molten slag bath, which occupies the upper portion of the furnace. The mixture of materials forming the furnace charge is now smelted in the interior of the furnace, in the absence of external air, the metals being reduced by the carbon in the charge, supplemented by the carbon which is fed through the hollow electrodes. The lead, as it is reduced, sinks to the bottom of the crucible, from which it may be removed as required, through the lead well 19. The zinc is volatilized and passes off with the other diluting gases through the flues 13. The zinc vapors in these flues and in the stacks 14 are condensed in the form of zinc dust, which collects on the inside of the woolen bags 15 and generally throughout the flues, the accumulations falling down to the bottom, from which they pass through pipes 17 to the secondary furnace 18. In this secondary furnace the zinc dust, being undiluted, may be remelted in the absence of air and converted into spelter.

As the slag accumulates from time to time, the excess

may be drawn off through the slag taps 12. As before stated, these slag taps are preferably in line with the electrodes, so that the slag is thoroughly exhausted before being drawn off, and the drawing off of the slag serves to draw down the unreduced ore from the center to a point underneath the carbon electrodes. By having floating electrodes on the surface of the slag body, between which electrodes the current is passed, an effective regulation of the current may be secured in the furnace of the type indicated.

By reference to Fig. 1, it will be seen that part of the current may be passed horizontally through the slag from one electrode to the other, while another portion of the current will pass crosswise or vertically through the slag, and thence through the metal to the vicinity of the other electrode, again crossing the slag to reach the last mentioned electrode. These two paths for the current are indicated by dotted lines. When the slag is tapped down, the metal level being maintained constant, it will be seen that the resistance of the path through the slag will increase. If the resistance of the metal be low relative to that of the slag (either by its composition or volume) the second path in series through the slag to the lead will decrease in resistance. By properly proportioning the volume and dimensions of the slag and metal bodies in accordance with their specific resistance, the increase in resistance of the first path when slag is tapped, can be made to approximately balance the decrease in resistance of the second path. In this way the current taken by the furnace at constant potential will remain constant, and the load on the generators will therefore not fluctuate.

It will be apparent that certain of the distinctive features of construction described herein and shown in the drawings may be adopted in types of furnace not in all respects like the one shown, and which may or may not embody all the various details herein disclosed, and may or may not have as a whole the same mode of operation, and I desire my claims to be understood accordingly.

I also wish to refer to my copending applications relating to the same general subject-matter, namely, the treatment of ores of zinc and other metals, some of which applications contain claims to matter disclosed but not claimed herein:—Serial No. 266,208, filed June 21st, 1905; Serial No. 266,541, filed June 23rd; 1905, Serial No. 321,159, filed June 11th, 1906; Serial No. 322,140, filed June 18th, 1906; Serial No. 323,211, filed June 25th, 1906; Serial No. 327,635, filed July 25th, 1906; Serial No. 336,186, filed September 25th, 1906.

I claim:

1. An electric furnace comprising a base portion of refractory material, a double wall of metal surmounting said base, means for maintaining a flow of cooling fluid within said double wall, a bath of fused slag being maintained within the furnace, said slag being congealed upon the inside of the furnace wall to form a lining therefor, and means for passing electric current between different points in said bath, said lining of congealed slag serving to electrically insulate said metal walls and also to conserve the heat.

2. An electric furnace comprising a base portion of refractory material having a crucible hollowed out therein, adapted to contain molten metal, a double wall of metal surmounting said base portion, means for maintaining a flow of water within said double wall, a bath of molten slag being sustained above said molten metal on a level with said double wall, the inside of said wall being lined with congealed slag which serves to electrically insulate said wall and to conserve the heat of the bath.

3. In an electric furnace, the combination with a base portion of refractory material having a crucible hollowed out therein, a double wall of metal surmounting said base, means for maintaining a flow of water within said double wall, said wall having a tap hole through the same and a tapping trough extending over the upper edge of said base, a dome-shaped roof supported upon said wall, said roof having a central charging-opening and electrode holes and electrodes projecting downward through said holes into the furnace chamber.

4. The combination with an electric furnace adapted to smelt zinc ore, of flues leading therefrom adapted to collect condensed zinc dust, a secondary smelting furnace connected therewith, and ducts leading from the flues of the first furnace to the charging opening of the secondary furnace; whereby the heat remaining in the zinc dust may be conserved, and the dust converted into spelter without damage by the external air.

5. The combination with an electric furnace adapted to smelt zinc ore, of vertical flues adjacent to said furnace and communicating with the interior thereof to receive the zinc vapor therefrom, means for collecting the condensed zinc in said vertical flues, ducts forming extensions at the lower ends of said flues, and a second furnace adapted to convert zinc dust into spelter, located below the first furnace, said ducts being led to a charging opening of said second furnace.

6. In an electric furnace, the combination with the base, of an annular wall surmounting said base, a dome-shaped roof supported by said annular wall, said roof having a central charging opening and electrode holes, and means for feeding granular carbon through said holes into the furnace, to form electrodes.

7. In an electric furnace, the combination with a vessel containing a body of metal, a body of molten conducting material of higher resistance being sustained upon said metal, of electrodes floated upon the surface of said resistance material and adapted to be connected with the terminals of a source of current, and means for drawing off a portion of said resistance material; whereby the current is regulated as between the metal and the resistance material while the total current between said electrodes is maintained approximately constant.

8. In an electric furnace, the combination with a vessel adapted to contain a bath of molten conducting material, of carbon tubes suspended above said bath and adapted to be connected with the terminals of a source of current, and a supply of granular carbon fed through said tubes to the surface of said bath and forming separate floating electrodes thereon, between which the current is passed.

9. In an electric furnace, the combination with a vessel of refractory material adapted to contain a fused mineral bath, of separate electrodes of conducting material floated upon the surface of said bath, and means for passing current between said floating electrodes through said fused bath.

10. The combination with an electric furnace, of a hollow carbon electrode therefor, comminuted carbon within said hollow carbon electrode and fed thereby into said furnace, a metallic leading-in conductor conveying current to said electrode, said conductor being held in a cup hollowed out in said electrode, and easily fusible metal held in said cup and completing a good electrical contact between said metallic conductor and said carbon.

11. In an electric furnace, the combination with a base of refractory material, of an annular double wall of metal surmounting said base to form a furnace chamber, of smaller diameter than said base, means for maintaining a flow of water within said double wall, a tap-hole being provided through the wall, a tapping trough for said hole, extending over the edge of the base, and a roof for the furnace chamber, having a central charging opening and electrode openings, one of said electrode openings being in line with said tap-hole.

12. The combination of a closed electric furnace with a condenser, a dust collector, a second closed electric furnace a closed conduit leading from said dust collector

to said second furnace and a second condenser; all arranged serially with respect to the passage of material therethrough.

13. In an electric furnace, the combination with a refractory crucible, of a metal curb surrounding said crucible, hollow walls forming an upward extension of said crucible, said walls inclosing a smaller area than said curb, a tap hole in said walls, and a spout extending from said walls across said curb.

14. An electric furnace comprising a chamber of refractory material and a reverberatory roof therefor, a plurality of electrodes extending through said roof into the furnace chamber, said roof having a feed opening therein located centrally between said electrodes, said furnace chamber having tap openings through the walls, opposite the respective electrodes; whereby the material fed to the furnace is drawn toward the electrodes by the tapping operation.

In witness whereof, I, hereunto subscribe my name this 28th day of June A. D., 1906.

FREDERICK T. SNYDER.

Witnesses:

A. H. MOORE,

D. C. TANNER.