(No Model.) 2 Sheets—Sheet 1.

G. DE CHALMOT.

ELECTRIC FURNACE.

No. 587,182. Patented July 27, 1897.

FIG. 1.

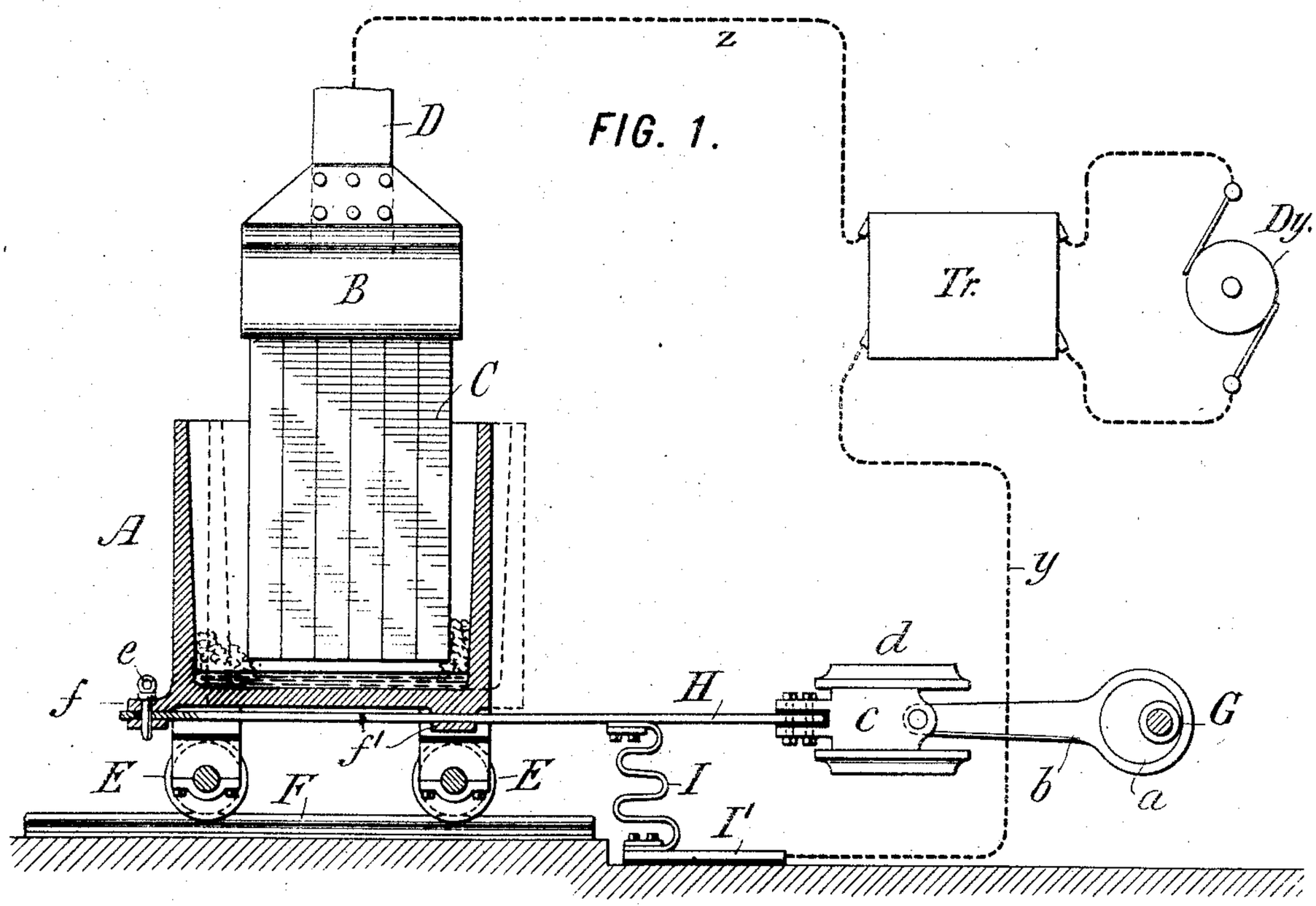


FIG. 2.

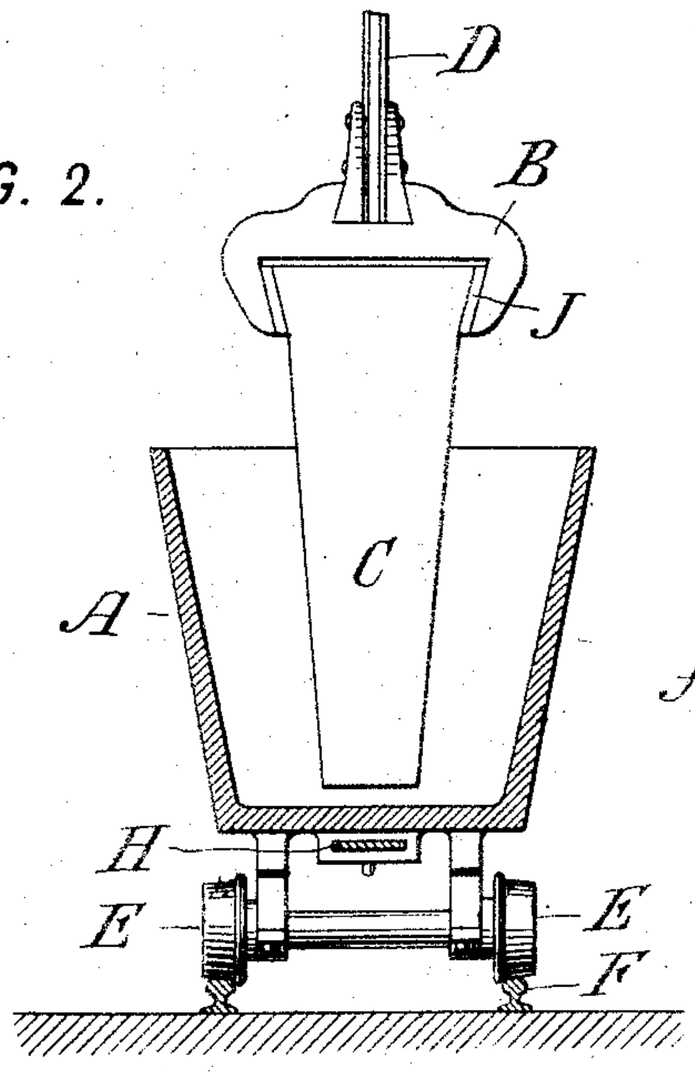


FIG. 7.

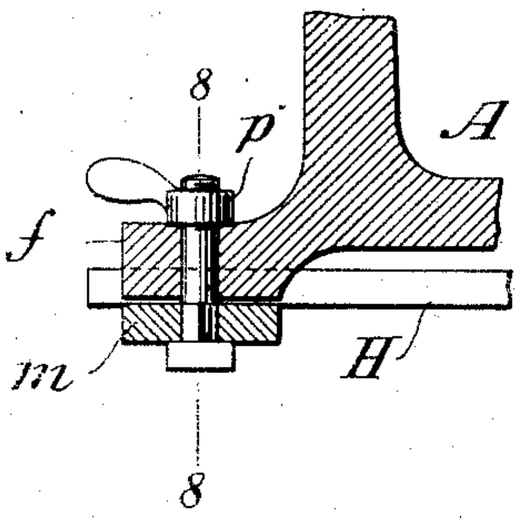
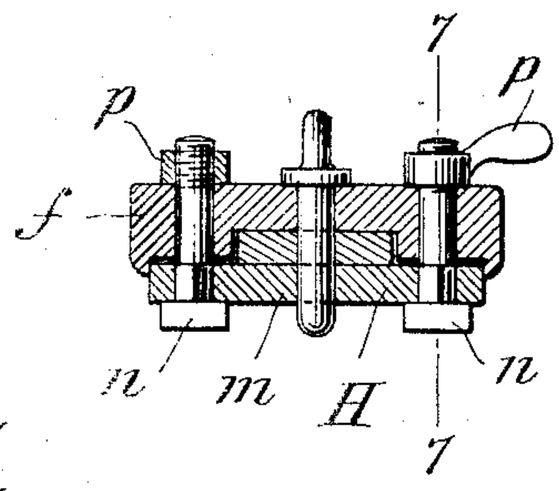


FIG. 8.



WITNESSES:

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(No Model.) 2 Sheets—Sheet 2.

G. DE CHALMOT.

ELECTRIC FURNACE.

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FIG. 3.

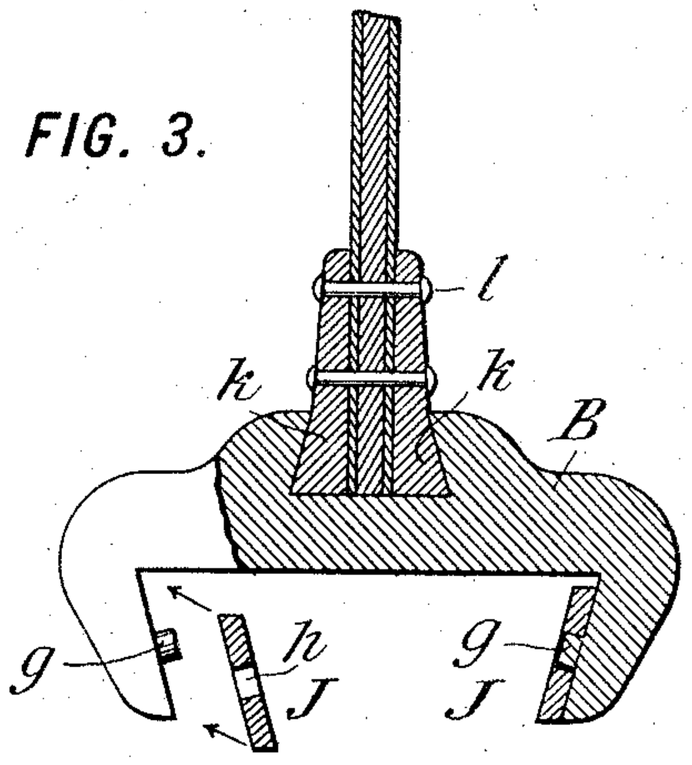


FIG. 4.

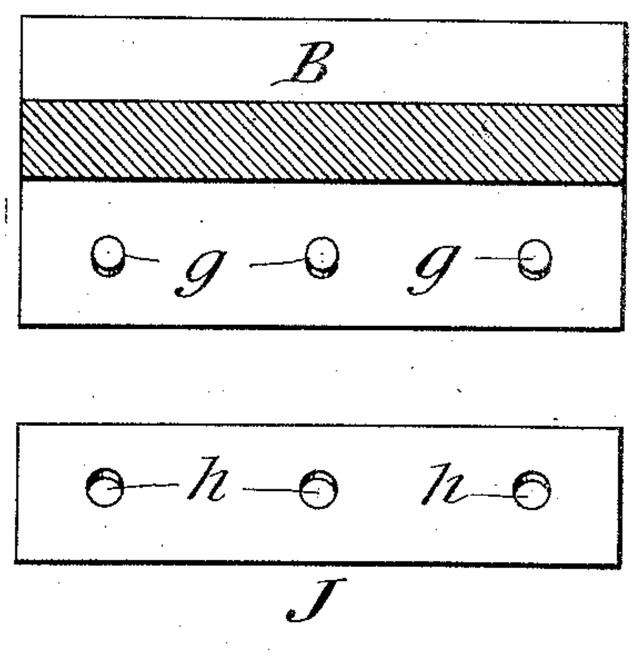


FIG. 5.

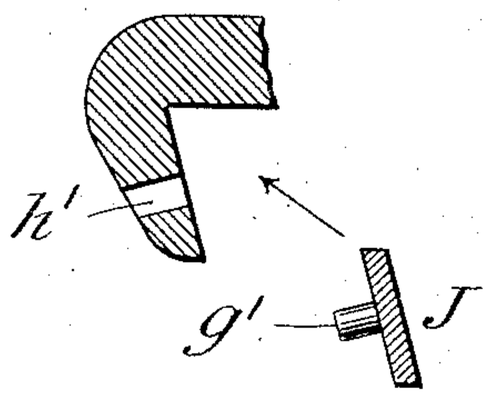


FIG. 6.

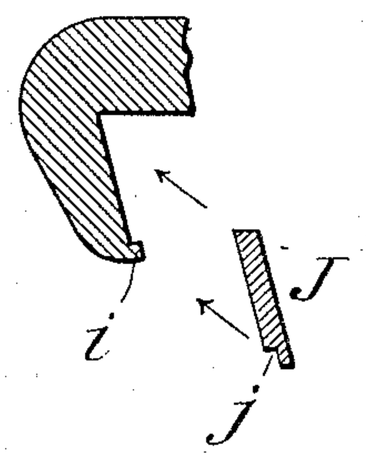
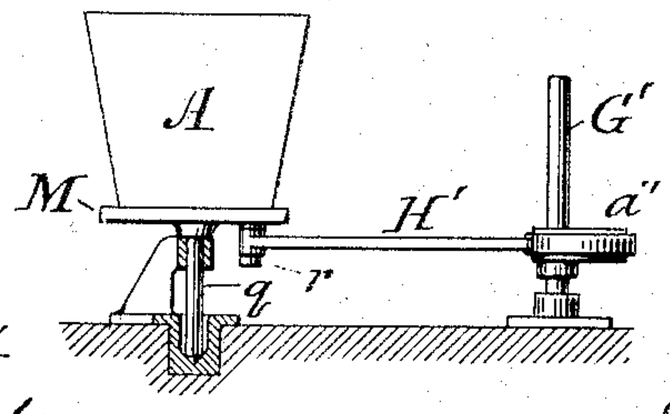


FIG. 9



WITNESSES:

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UNITED STATES PATENT OFFICE.

GUILLAUME DE CHALMOT, OF LEAKSVILLE, NORTH CAROLINA, ASSIGNOR TO THE WILLSON LABORATORY COMPANY, OF NEW YORK, N. Y.

ELECTRIC FURNACE.

SPECIFICATION forming part of Letters Patent No. 587,182, dated July 27, 1897.

Application filed February 27, 1896. Serial No. 580,971. (No model.)

To all whom it may concern:

Be it known that I, GUILLAUME DE CHALMOT, a subject of the Queen of the Netherlands, who has declared his intention of becoming a citizen of the United States, residing at Leaksville, in the county of Rockingham and State of North Carolina, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification.

This invention relates to electric-arc furnaces of that class in which a crucible or hollow hearth or furnace-chamber is used to receive the material undergoing action and the bottom of which constitutes one electrode, while the other is constituted by a so-called carbon "pencil" or slab carried by a suitable holder and lowered vertically into the crucible or chamber. In such furnaces the granular material to be smelted is fed in around the pencil, and difficulty is experienced, especially in the case of very massive pencils, in effecting a proper stoking of the material into the arc. Difficulty is also experienced in providing practical means for making an electrical connection between the carbon pencil and its carrier by reason of the liabilty of imperfect contact causing an arc between the carbon and the metal surface of the holder by which the metal is fused. The object of my invention is to overcome these difficulties.

The invention is illustrated in the accompanying drawings, wherein—

Figure 1 is a sectional side elevation. Fig. 2 is a sectional front elevation. Fig. 3 is an enlarged front view of the carbon-holder, partly in section. Fig. 4 is a transverse section of the carbon-holder. Figs. 5 and 6 are fragmentary views illustrating modifications of Fig. 3. Fig. 7 is an enlarged fragmentary vertical section on the line 7 7 in Fig. 8, and Fig. 8 is a transverse section on the line 8 8 in Fig. 7. Fig. 9 is a sectional elevation of a modification.

Let A designate a crucible or furnace-chamber, B a carbon-holder, and C a carbon pencil. The pencil C is ordinarily for large furnaces, made up of a series of parallel flat slabs of carbon of the outline shown in Fig. 2. These are preferably made tapering, so as to be of gradually-decreasing section from the carbon-holder to the lower end from which the arc springs. The upper end or head of the pencil is made flaring or dovetailed, as shown, its flaring sides being received in a dovetailed cavity in the carbon-holder B. This carbon-holder is hung from a vertical bar D, which in practice is suitably guided and provided with means for moving it up and down in order to properly adjust the carbon pencil within the furnace.

The crucible A is preferably constructed as a cast-iron pot, preferably of approximately the shape shown in Figs. 1 and 2, and to render it easily movable it is mounted on car-wheels E E, rolling on a track F. The crucible may be lined if deemed necessary for any particular purpose, but for ordinary smelting operations, where a refractory material which is a poor non-conductor of heat is employed, this material, introduced in proper form in the crucible, affords sufficient protection to the crucible from the high heat of the arc. Preferably a layer of an inch or so of carbon is first provided in the bottom of the furnace in order that in starting the operation the arc shall be formed between this carbon lining and the pencil and shall not come in direct contact with the iron bottom of the crucible. Instead of an iron crucible it may be made of other material—such, for example, as a metal shell filled in with fire-brick and internally lined with carbon, or a metal shell and a carbon lining alone, or the side walls and bottom may be constructed in different sections and of different materials.

So far as my present invention is concerned, all that is essential is that the furnace shall be provided with a crucible, pot, receptacle, or hollow hearth, of which either the bottom or the sides, and preferably both, are of conducting material in order that by being connected with one terminal of the electric circuit they may serve as one of the electrodes.

The first part of my invention relates to means for effecting an automatic stoking or feeding of the material introduced into the furnace to the arc. It is obvious that where the pencil is of large cross-section the granular material fed into the crucible around the sides of the carbon pencil will not find its way fully into the space beneath the pencil except

so fast as it is fused by the arc. The most effective utilization of an arc in electric smelting is only to be attained by filling the entire area in which the arc exists with the material to be smelted and feeding this material in throughout this area as fast as the previously-introduced material becomes fused and reduced or fully smelted. With an ordinary arc-furnace only the outer margin of the area of the arc is fully effective, since the material to be reduced cannot be introduced beneath the pencil far enough to completely fill the arc, but will only fall in so far as corresponds to its natural or characteristic slope. My invention effects a more thorough stoking of the material into the arc by effecting a rapid movement of the crucible, whereby the material is simultaneously agitated or shaken down and spread out beneath the pencil.

To carry out this invention, I provide, by preference, the apparatus shown best in Fig. 1. On a revolving shaft G, mounted in suitable bearings and revolved in any suitable way, is fixed an eccentric *a*, (or it might be a crank or cam or other equivalent of an eccentric,) by which movement is communicated through a rod or pitman *b* to a cross-head *c*, moving between suitable guides *d d* and carrying a bar H, which connects mechanically (and also by preference electrically) with the crucible A. This bar is shown as extending beneath the crucible and connecting by a pin *e* with a lug *f*, formed on the front of the crucible, this arrangement being due to the general construction of the brick-work or bench incasing the furnace, which construction is for clearness not here shown, but which is well understood in the art. Suffice it to say that the construction is such that by lifting up the carbon pencil C the crucible A may be rolled out on the track F to the left in Fig. 1. On the crucible being rolled into place the pin *e* is dropped in to catch it with the bar H, and the shaft G being set in motion the crucible is moved back and forth or front and back on the track F with any suitable speed—say, for example, a distance of from two to four inches at each movement, and say, for example, at the rate of from five to thirty times per minute. The effect of this movement is to continually shake down the material, which is fed from time to time into the crucible around the sides of the carbon pencil and cause this material to be carried or spread out to a considerable distance beneath the lower end of the pencil, and thereby to effect a more thorough distribution of the material to be smelted over the area of the arc. If desired, a certain degree of lost motion may be introduced into the connections, as indicated in Fig. 1, where the pin *e* passes through the hole in the end of the bar H, the effect of which is to commence each movement of the crucible with an abrupt jerk, whereby the shaking down of the material in the crucible may be facilitated.

By means of this invention the output of an electric furnace of a given size and employing a given amount of electrical horse-power may be greatly increased.

I prefer to employ the bar H also as a means for conveying the electric current to the crucible. By so doing I avoid the necessity of making two separate connections with the crucible when it is run into place, one the mechanical connection to the bar by which it is reciprocated and the other an electrical connection for carrying the current to it. To this end the bar H is insulated in any suitable manner from the shaft G, preferably by introducing an insulation between the bar H and the cross-head *c*, as shown, or between the eccentric Q and shaft G, if preferred. The bar H is connected to a flexible conductor I, which may be in the form of a flexible cable or a zigzag conducting-plate, as shown. This flexible conductor connects with a rigid conductor I′, suitably insulated, which in turn is connected with the conducting wires or cables *y*, leading in the case of an alternating current to a transformer T*r*, from the other terminal of which a conductor *z* leads to the upright bar D of the holder.

D*y* is the dynamo, connected to the primary terminals of the transformer.

The bar H may advantageously be made as a composite bar, consisting of a bar or plate of copper and a bar or plate of iron or steel. An extended surface of contact should be afforded between the bar H and the crucible in order to enable the current to pass from one to the other without heating. To prevent arcing or heating at the junction between the bar H and the crucible, means may be provided for clamping the bar H firmly between two opposing faces in a manner equivalent to the example illustrated in Figs. 7 and 8. In these figures the lug or plate *f* is formed to project from the crucible A, and beneath it is mounted a clamping-plate *m*, connected to it by clamping-bolts *n n*, having tightening-nuts *p p*. By tightening these nuts *p* the lower bar is drawn upward against the plate *f*, thereby tightly clamping the bar H between them. The coupling-pin *e* prevents the bar H slipping out of place in case the clamp is not closed tightly enough to hold it frictionally. In the construction shown the lower portions of the bolts *n* are squared and fitted in square holes in the plate *m*. To disconnect the crucible from the bar H, the nuts *p p* are slackened enough to release the clamp and the pin *e* is withdrawn. Various other constructions by means of which the bar may be clamped to the crucible might be substituted for that shown. An additional connection may be located at *f′* in Fig. 1, if desired, or this latter connection may be simply a stirrup through which the bar H passes more or less freely.

Another feature of my invention pertains to the construction of the carbon-holder. Ordinarily the carbon-holder is made of a single piece (or built up of two or more pieces

permanently bolted together) formed with a head extending over the top of the carbon pencil or slabs and with depending inclined side flanges, which embrace between them the head of the carbon pencil, the opening or socket between them being thus dovetailed, as described, so that it fits the dovetail or wedge-shaped head of the pencil, the latter being held in place by its weight, and reliance being placed on the considerable extent of surface of contact between the iron carbon-holder and the carbon slabs to afford sufficient conductivity for conducting the current from the holder to the pencil. It sometimes occurs that the contact thus afforded is imperfect by reason of slight irregularities in the surfaces, which should fit intimately together, and it results that an arc is formed between the carbon and the holder, which arc causes a portion of the metal to be fused, thereby forming a hole in the carbon-holder and rendering it useless. My invention avoids the loss entailed by such occurrences by providing false or removable contact-faces for the carbon-holder in the form of separable plates, which come into immediate contact with the carbon pencil on one side and on the other fit closely and intimately against the body of the holder. These plates, which may be of iron, this being the material of which the carbon-holder is preferably made, are shown at J J in Figs. 3 and 4. On the right in Fig. 3 the plate J is shown in place as part of the holder and on the left it is shown as removed. The plates are held in place by any suitable construction whereby a supporting shoulder or ledge is formed. A simple construction for this purpose consists in the formation of pins or lugs *g g*, projecting from the holder and entering the holes *h h* in the plates. In Fig. 4 three lugs and holes are shown, but any suitable number may be used. In Fig. 5 the lug *g'* is shown formed on the plate and the hole *h'* in the holder. In Fig. 6 the lugs and holes are omitted and the plates are held in position by a projecting shoulder or ledge *i* on the holder entering a rabbet *j* in the lower side of the plate. Any means for supporting the plates upon the holder which will prevent the plates from falling out of place while the pencil-slabs are being inserted will fill the requirements of my invention. The current is conducted from the solid metal of the holder into the metal of the plates and thence to the carbon. If an arc occurs by which any of the metal is melted away, the injury is confined to one of the plates and the body of the holder is not affected. Hence it is only necessary to discard the injured plate and replace it by a new one.

My invention also provides an improved means for connecting the carbon-holder with the upright rod or bar D by which it is supported. An intimate and secure connection is required between these parts, while the upright bar should possess a high conductivity and considerable strength. Heretofore a round or square shaped connection has been employed, screwed or welded or cast into a boss on the top of the holder, but such constructions have not been found to be wholly satisfactory in practice. I have therefore devised a connection (shown best in Fig. 3) wherein the bar D consists of a flat plate of suitable thickness, (being either built up of three plates or laminæ, as shown, or not.) To opposite sides of this plate or bar are fastened the wedge-shaped pieces *k k* by means of fastening-bars *l l*, which may be either rivets or screw-bolts and which pass through from side to side. The pieces *k k* are flared or widened at their lower ends, preferably to the entire width or length of the carbon-holder. Their lower ends constitute a dovetail which fits into a dovetailed socket across the top of the carbon-holder B, as shown. By this means an extended surface of contact is afforded between the tapered plates *k k* and the carbon-holder B and between these plates and the bar D, so that not only is a strong and secure joint formed, but ample conductivity is provided, so as to avoid heating by the passage of the current. The composite or laminated bar D is made up of an inner plate of copper and two outer plates of iron or steel, the inner plate affording of itself practically all conductivity required, while the outer plates serve to take the mechanical wear and afford the desired stiffness. This part of my invention renders easy the disconnecting of the carbon-holder B from the bar D, which is of considerable importance where a large carbon-holder is employed.

That part of my invention which relates to the giving to the crucible of a horizontal reciprocatory movement is not confined to moving the crucible back and forth in a straight line or to mounting it on a truck and rolling this truck back and forth on a track. Any arrangement by means of which the crucible is subjected to a shaking, jarring, vibratory, or other similar movement by which to jar down and distribute the powdered material beneath the pencil is within my invention in its broadest sense. In a more limited sense my invention includes any means or arrangement by which the crucible is moved back and forth in an approximately horizontal direction, whether in a straight or curved line and independently of whether the going and returning movements are in the same path or not. The movement of the crucible horizontally forward and then horizontally backward through the same path is the simplest and generally the most practicable means of carrying out my invention, but other means may be provided in lieu thereof. For example, such a construction as that shown in Fig. 9 may be employed, in which the crucible A is mounted on a disk or table M, arranged to oscillate on a vertical axis or shaft *q*, and oscillated back and forth by means of an eccen-

tric a' on a revolving shaft G', acting through a connecting-rod H', which is jointed to a stud r, projecting beneath the table M. By this means the crucible A is given a horizontal movement in curved lines around an axis which intersects the crucible at approximately the middle thereof. The vertical axis or center of movement, however, might be removed to any practicable extent from the middle. The crucible might otherwise be also mounted so as to turn on an axis arranged horizontally or otherwise in any practicable way. Instead of communicating movement to the crucible by means of an eccentric movement may be imparted by any device known in the mechanic arts adapted to impart a to-and-fro or reciprocatory movement.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. In an electric-arc furnace, the combination with a carbon pencil, of a crucible or hollow hearth into which said pencil may enter, and independent mechanism connected thereto for agitating or jarring said crucible in order to shake down the granular material fed thereto, and facilitate the feeding thereof into the arc.

2. In an electric-arc furnace, the combination with a carbon pencil, of a crucible or hollow hearth into which said pencil may enter, and independent mechanism connected thereto for communicating a horizontal reciprocatory movement to said crucible in order to shake down the granular material fed thereto, and facilitate the feeding thereof into the arc.

3. In an electric furnace, the combination with the carbon pencil of a crucible or hollow hearth, wheels on which said crucible is mounted, a track on which said wheels roll, and a mechanism for reciprocating said crucible by rolling it back and forth on said track.

4. The combination in an electric furnace, with a carbon pencil C and crucible A, of means for reciprocating said crucible consisting of a rotary shaft G, a longitudinally-reciprocating bar H, and means interposed between said bar and shaft for reciprocating the bar from said shaft, and a separable connection between said bar and the crucible.

5. In an electric furnace, the combination with a carbon pencil and a crucible or hollow hearth mounted to be movable longitudinally, of a longitudinally-movable bar adapted to be detachably connected to said crucible, mechanism for longitudinally reciprocating said bar, and an electric circuit one terminal of which is connected by a flexible conductor with said reciprocating bar, and the other terminal of which is connected with said carbon pencil.

6. In an electric furnace, the combination with a carbon pencil and a crucible or hollow hearth mounted to be movable back and forth, of a longitudinally-reciprocating bar and mechanism for driving it, and a clamping device for connecting said bar to the crucible consisting of clamping-jaws connected to the crucible, adapted to receive said bar between them, and provided with means for drawing them forcibly together to grip said bar.

7. In an electric furnace, a carbon-holder for the carbon pencil thereof consisting of a metal body portion comprising a head and opposite depending side flanges formed to embrace the sides of the head of the carbon pencil, inclined toward each other to form a dovetail space between them for receiving the pencil, and having a separable lining-plate fitted to the inclined inner surface of one of said flanges and in contact with one side of the carbon pencil, whereby the formation of an arc against that side of the pencil can injure only such removable plate.

8. In an electric furnace, a carbon-holder for the carbon pencil thereof, consisting of a metal body portion fixed on the bottom end of an upright conducting-bar, and comprising a head and opposite depending side flanges having inclined sides forming between them a dovetail space adapted to receive the head of the carbon pencil, and having separable lining-plates applied to said inclined sides at their surfaces of contact with the carbon, whereby the formation of an arc which fuses the contacting portions of the holder can injure only such removable plates.

9. The combination of the carbon-holder B and separable plates J J, fitting within its side flanges, and reciprocal means for connecting said holder and plates consisting of projections on the one part engaging recesses in the other.

10. In an electric furnace, the combination of a carbon-holder formed with an undercut channel across its top, of an upright metal bar from which the carbon-holder is suspended, and plates fastened to the lower end of said bar shaped to fit said undercut channel, and adapted to enter the same to form a detachable connection between the carbon-holder and bar.

11. In an electric furnace, the combination of a carbon-holder B formed with a dovetail channel across its top, wedge-shaped plates k k fitting said channel, and an upright metal bar D fastened between said wedge-shaped plates and extending upwardly above them to serve as a means for suspending the carbon-holder.

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

G. DE CHALMOT.

Witnesses:
W. W. HAMPTON,
J. W. STEPHENS.