No. 672,054. Patented Apr. 16, 1901.

G. DE CHALMOT.

ELECTRIC CRUCIBLE FURNACE.

(Application filed Sept. 5, 1899.)

(No Model.)

FIG. 1.

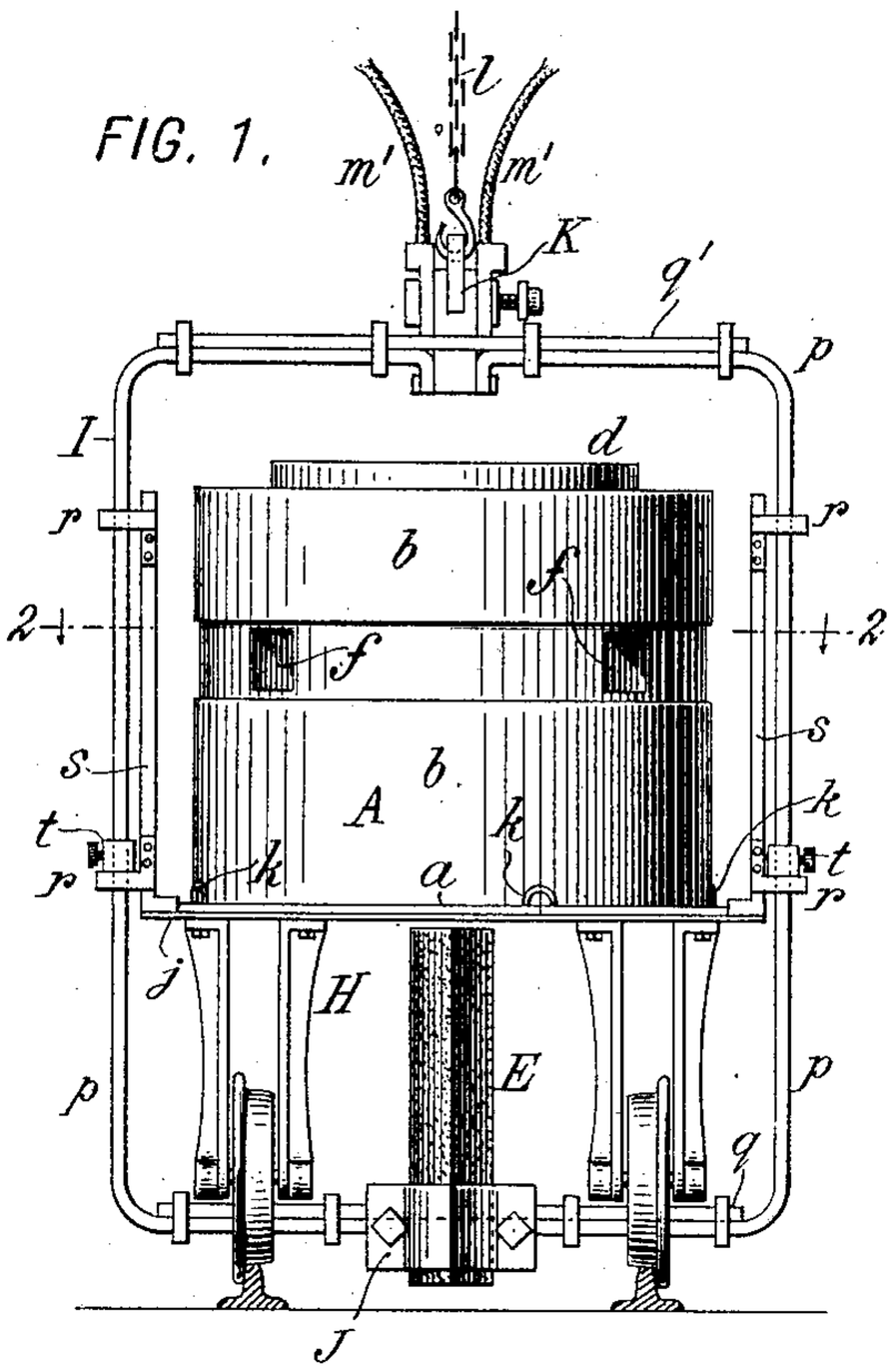


FIG. 3.

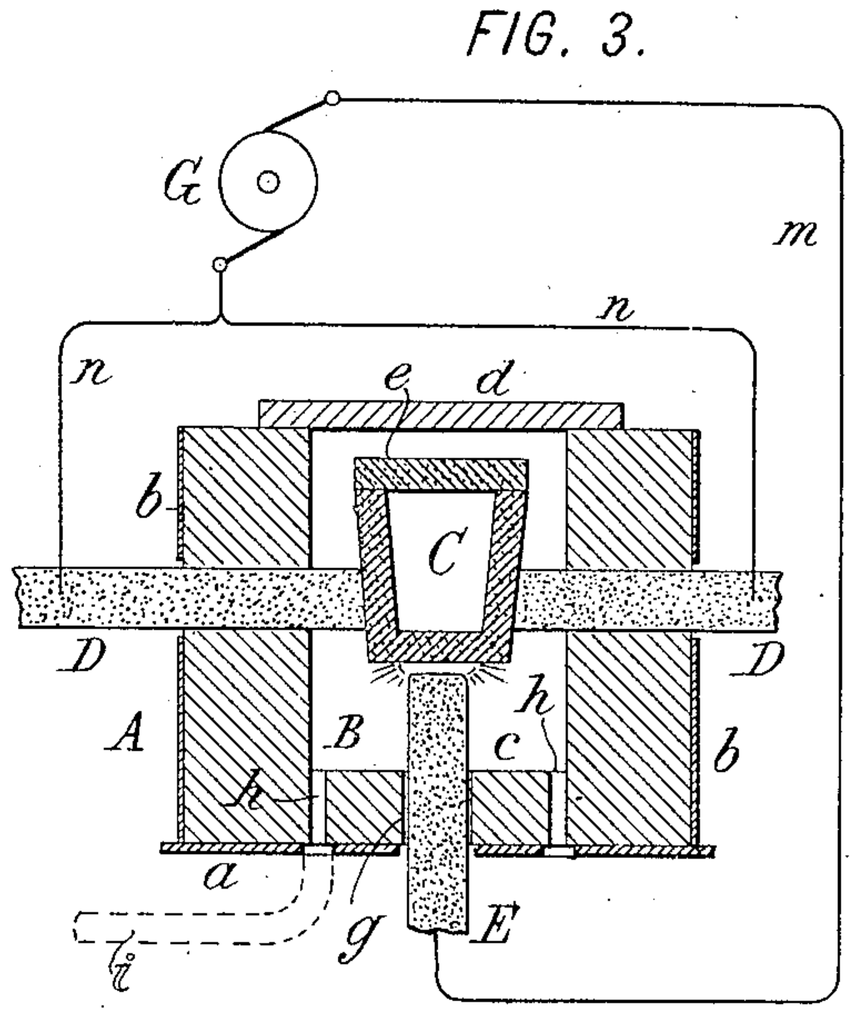


FIG. 5.

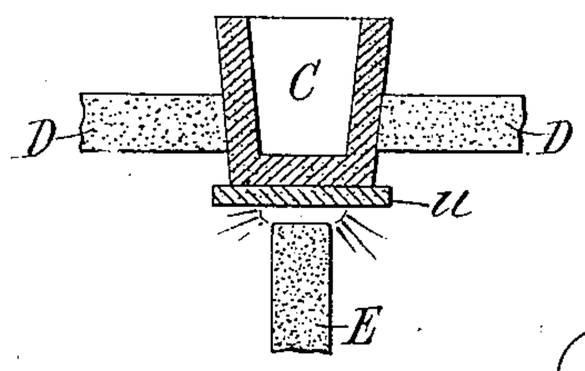


FIG. 2.

FIG. 4.

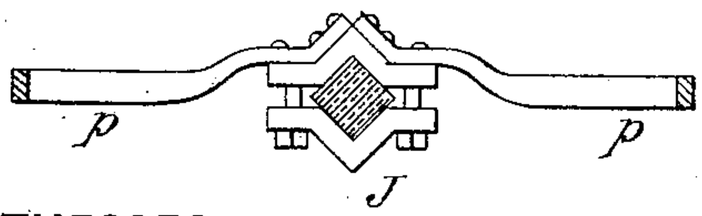
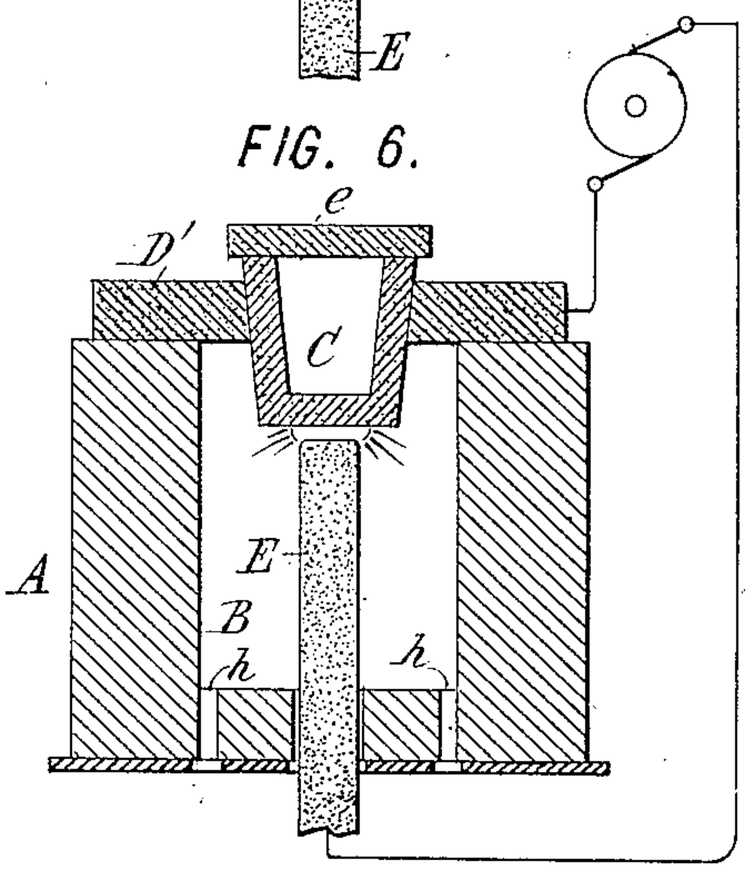


FIG. 6.



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GUILLAUME DE CHALMOT, OF HOLCOMBS ROCK, VIRGINIA, ASSIGNOR TO THE WILLSON ALUMINUM COMPANY, OF NEW YORK, N. Y.

ELECTRIC CRUCIBLE-FURNACE.

SPECIFICATION forming part of Letters Patent No. 672,054, dated April 16, 1901.

Application filed September 5, 1899. Serial No. 729,462. (No model.)

To all whom it may concern:

Be it known that I, GUILLAUME DE CHALMOT, a citizen of the United States, residing at Holcombs Rock, in the county of Bedford and State of Virginia, have invented certain new and useful Improvements in Electric Crucible-Furnaces, of which the following is a specification.

This invention relates to electric furnaces wherein the material to be acted upon is placed in a crucible or chamber and is subjected to heat generated electrically and transmitted to it through the walls of such chamber in contradistinction to furnaces of the arc type in which the material under treatment is subjected to the direct action of the electric arc and to furnaces of the incandescent type in which the material under treatment is commingled with broken resistance material through which the current passes and which is heated by reason of its low conductivity. In a crucible-furnace the crucible may advantageously be heated by an electric arc passing between the crucible itself as one electrode and a carbon pencil or bar constituting the other electrode. Such a crucible-furnace has the advantage over any other arc furnaces that the disturbing influences of the electric arc do not act on the material under treatment, so that the operation may be conducted with more economy of material. A common source of loss of heat in electric furnaces is due to the upward current of gases escaping from the furnace. This loss is prevented in my furnace by making the upper part of the furnace hermetically tight and affording vent-openings beneath. I also arrange the furnace so that the electric arc plays beneath the crucible, while the upper part of the latter is heated also by electric resistance.

To these ends my invention provides a furnace comprising a refractory and non-conducting body formed with a furnace-chamber within it, within which chamber is mounted the crucible in such manner as to be separated from the walls of the furnace and held supported within said chamber, the support being effected by a suitable number of carbon bars or slabs projecting through the walls of the furnace and entering into contact with the crucible or by support from the bottom of the chamber. Beneath the crucible I arrange a movable carbon pencil or electrode, which is so mounted or suspended as to be adjustable vertically. I connect this carbon pencil with one terminal of a suitable generator, and the other terminal thereof is led to the carbon bars or slabs which support the crucible. This arrangement permits of an arc being drawn between the bottom of the crucible and the carbon pencil. However, instead of an arc the carbon pencil by making imperfect contact with the crucible may interpose sufficient resistance to suitably heat the crucible. In either case the passage of the current through the crucible itself generates an additional amount of heat by reason of the poor conductivity of the crucible and the imperfect contact made between the crucible and the supporting-bars of carbon.

I will now proceed to describe the preferred form of my invention, which is illustrated in the accompanying drawings, wherein—

Figure 1 is an elevation of the furnace. Fig. 2 is a horizontal section thereof on the line 2 2 in Fig. 1. Fig. 3 is a vertical section cut in the oblique plane indicated by the line 3 3 in Fig. 2. Fig. 4 is a plan of the support for the movable carbon pencil. Fig. 5 is a fragmentary section showing a modification of Fig. 3. Fig. 6 is a sectional view answering to Fig. 3 and showing another modification.

Referring to the drawings, Figs. 1 to 4, let A designate the main shell or body of the furnace, forming within it a furnace-chamber B. The shell A may be of any refractory material, such as fire-brick or fire-clay, being preferably supported upon a plate or disk *a*, preferably of wrought-iron. The shell is preferably cylindrical and is preferably inclosed by iron bands *b b*. It is formed with a bottom *c* for the chamber B and has a removable top or cover *d* therefor, which may be lifted off and which may consist of a slab of fire-brick, carbon, or other refractory material. Within the chamber B is placed the crucible C of carbon, graphite, &c., which preferably is covered over by a cover *e* of any refractory material. The crucible is sup-

ported by any suitable number of carbon bars D D, (two or more,) which project into the chamber B through openings *f*, formed through the shell A, two of these openings being shown in Fig. 1 with the carbons removed. The inner ends of the carbon bars D are beveled, so as to fit the inclined sides of the crucible C, Fig. 3, so that the crucible by fitting in between these beveled ends is firmly supported. The carbon bars are of course tightly fitted in the holes *f*. These carbons are insulated in any suitable manner from the conducting portions of the furnace. The crucible may also be supported directly from bottom *c*. If the shell A is of non-conducting material, as fire-clay, the carbons may be fitted directly in this material, in which case the metal bands *b b* should be separated sufficiently to avoid their touching the carbon bars, as shown.

The bottom *c* of the furnace has a central opening *g*, through which passes the vertical electrode or carbon pencil E, which is movable freely up and down through this opening. Any suitable generator of electric energy, as a dynamo or transformer, may be provided, this being indicated diagrammatically at G, Fig. 3, with its opposite terminals connected the one by wire *m* to the carbon pencil E and the other by wires *n n* to the several carbon bars D D.

When the generator is in action and the circuit is closed by lifting the pencil E into contact with the crucible C, the current passes between the pencil and the bars D through the crucible. This current may generate heat by the imperfect conductivity of the crucible itself, by imperfect contact between the crucible and the carbon bars D, and by imperfect contact between the crucible and the pencil E. The resistance between the crucible and the pencil E may be increased to any desired extent by lowering the pencil to draw an arc between itself and the crucible, as shown, which arc may be drawn to greater or less length. By this means the crucible may be heated to a most intense degree, and any material to be treated which may have been placed within the crucible will be subjected to the high heat thus imparted without danger of exposing it to the oxidizing influence of the gases from the air or to other gases generated within the furnace, the contact with which might be deleterious to the particular material under treatment. For example, one important application of my invention is to the production of metallic titanium or titaniferous alloys by the reduction of titaniferous ores with pulverized carbon, it being well known that such reduction as ordinarily attempted leads to the production of titanium nitrid, a result which by the use of my furnace can be almost wholly avoided.

In order to permit the gases generated within the furnace to readily escape without needless waste of heat, I vent the furnace-chamber B through its lower portion, preferably by forming special vent-holes *h* through its bottom, as shown. Obviously the hole *g* may be made sufficiently larger than the pencil E to afford itself the necessary vent. When the furnace is in operation, the top is hermetically closed by the cover *d*. Hence any gases produced in the furnace have to escape by the vent-holes *h* in the bottom. These holes may, if desired, be suitably connected to vent-pipes for carrying off the gases, one such pipe being indicated in dotted lines in Fig. 3 at *i*. If desired, any suitable gas may be introduced through one of the vent-holes—as, for example, an indifferent gas, such as carbon monoxid (CO) or water-gas.

To facilitate the manipulation of the furnace, I provide certain details, which I will proceed to describe. I prefer to mount the furnace on a truck H, which may travel upon a track. This truck consists of a plate *j*, mounted on wheels, on which plate the furnace-body is placed. The furnace-body may be lifted off from the truck by hooking chains into eyes *k k*, fixed in the bottom plate *a*, and lifting it through these chains by any suitable hoist.

For operating the movable electrode or pencil E, I provide a vertically-sliding frame I, surrounding the furnace, the lower part of this frame being formed with a carbon-holder J, (shown in plan in Fig. 4,) while the upper part terminates in a suspension-block K, which is suspended by a rope or chain *l* from any suitable hoist, by means of which the frame I and carbon pencil E may be bodily raised or lowered. The frame I may advantageously serve as the conductor for carrying the current to the electrode, for which purpose it is made of conducting metal, and its block K is connected to the ends of conducting-cables *m' m'*, forming part of the circuit connection *m*, which is shown diagrammatically in Fig. 3.

The preferred construction of the frame I and its accessories is as follows: One of the jaws of the carbon-holder J is connected to two horizontal bars *p p*, Fig. 4, preferably of copper, which bars are bent upwardly, as shown in Fig. 1, and extend vertically parallel with one another to form the sides of the frame and are then bent toward each other to form the top thereof, their ends being riveted to the copper block K. The horizontal portions of the copper bars *p* may be strengthened by means of iron bars *q* and *q'*, as shown. In order to guide the frame so as to impart a true vertical movement to the pencil E, the upright portions of the bars *p p* are caused to slide in guides *r r*, which are fastened on uprights *s s*, mounted on the plate *j* of the car. To limit the movement of the frame, set-collars *t t* may be fastened at any desired height upon the upright sliding portions thereof, which collars will play between the upper and lower guides *r r*. These collars should be set

so that when the frame is fully lowered the carbon-holder and carbon pencil will not drop onto the floor, but the pencil will be lowered entirely below the furnace-body, as is shown in Fig. 1.

Whenever it is deemed undesirable to expose the crucible directly to the arc, a thin carbon slab *u* may be placed beneath it, as shown in Fig. 5, this slab being suitably supported from the bottom or sides of the furnace.

I show a modification of my invention in Fig. 6, where instead of the crucible being supported by carbon bars projecting into the furnace-chamber it is supported by a carbon slab D′, forming the top of this chamber. The crucible instead of being with its cover wholly inclosed within the furnace-chamber projects at its upper part outside of the chamber. The hole in the plate D′ is made tapering or conical to fit the taper of the crucible. With this construction the crucible may be opened without opening the furnace-chamber.

The improved means provided by my invention for imparting vertical movement to the carbon pencil E has the advantage of avoiding the use of any gears or other mechanical device beneath the furnace, where they are difficult to manage and are liable to be injured by hot material escaping from the furnace.

That feature of my invention which provides a furnace-body having a chamber which is closed except for a vent at its lower part is important, because the gases generated within the chamber thus successfully oppose the ingress of air, which being comparatively cold is of greater specific gravity. It is obvious that this feature is applicable to furnaces other than of the particular construction set forth herein.

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

1. An electric furnace comprising a furnace body or shell forming a chamber within it, a crucible suspended within said chamber, the chamber being materially larger than the crucible to form a heat-insulating space around the latter, a carbon-support for said crucible making circuit connection therewith, said support connected to one terminal of the circuit, and a carbon electrode adapted to make contact with the lower part of said crucible and connected to the other terminal of the circuit and movable so that it may be fed toward the crucible as it is consumed.

2. An electric furnace comprising a furnace body or shell having a chamber within it, a crucible in said chamber, and electrodes extending within said chamber and connected to the opposite terminals of a circuit, one of said electrodes being movable and entering said chamber below the crucible, and said chamber having a vent at its lower part, and being otherwise hermetically closed.

3. An electric furnace comprising a furnace body or shell forming a chamber within it, a crucible suspended within said chamber and connected to one terminal of the circuit, a movable carbon electrode adapted to make contact with the exterior of said crucible at the lower part thereof and connected to the opposite terminal of the circuit, said furnace-chamber having a vent at its lower part and being otherwise hermetically closed.

4. An electric furnace comprising a furnace body or shell forming a chamber within it, a crucible suspended within said chamber, a carbon-support for said crucible making circuit connection therewith, said support connected to one terminal of the circuit, and a carbon electrode entering the lower part of said furnace-chamber and adapted to make contact with the bottom of said crucible and movable toward and from the crucible in order to form an arc between it and the crucible.

5. An electric furnace comprising a furnace body or shell forming a chamber within it, a crucible arranged within said chamber, a plurality of carbon bars passing through the sides of said body into said chamber for supporting said crucible, said bars connected to one terminal of the circuit, and a carbon electrode connected to the opposite terminal of the circuit, entering the lower part of said chamber, adapted to make contact with said crucible, and movable toward and from the latter, whereby an arc may be established between the crucible and said electrode.

6. The combination of a furnace-body forming a chamber having an opening through its bottom, two electrodes within said chamber, connected to opposite terminals of an electric circuit, one of said electrodes being a carbon pencil movable into said chamber through said opening, an upright frame inclosing said furnace-body, having at its lower end a carbon-holder for holding said pencil, adapted to be suspended at its upper end above said furnace-body, and guides for guiding said frame in its movement.

7. The combination of a furnace-body forming a chamber having an opening through its bottom, a carbon pencil forming an electrode movable into said chamber through said opening, an upright frame inclosing said furnace-body, having at its lower end a carbon-holder for holding said pencil, adapted to be suspended at its upper end above said furnace-body, guides for guiding said frame in its movement, and a second electrode having a portion within said chamber, said electrodes being connected to the terminals of a suitable generator.

8. An electric furnace comprising a furnace body or shell forming a chamber within it, a crucible suspended within said chamber and connected to one terminal of the circuit, a movable carbon electrode adapted to make contact with the lower part of said crucible and connected to the opposite terminal of the circuit, whereby an arc may be established in said chamber between the exterior of the

crucible and said electrode and means for closing the crucible against ingress of gases from said chamber.

9. An electric furnace comprising a furnace body or shell forming a chamber within it, a crucible arranged within said chamber having sloping walls, a plurality of carbon bars passing through the sides of said body into said chamber and engaging the walls of the crucible, said bars connected to one terminal of the circuit, and a carbon electrode connected to the opposite terminal of the circuit, entering the lower part of said chamber, adapted to make contact with said crucible and movable toward and from the latter, whereby an arc may be established between the crucible and said electrode.

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

GUILLAUME DE CHALMOT.

Witnesses:

SARAH M. SADLER,

MATILDA WHITE.