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Jan. 30, 1923. 1,443,580

G. M. LITTLE.
ELECTRIC FURNACE.
FILED MAR. 23, 1921.

2 SHEETS-SHEET 1

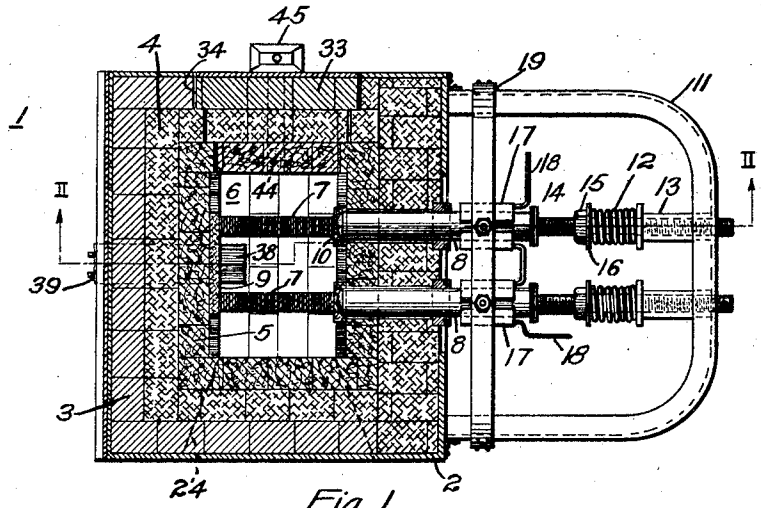


Fig. 1.

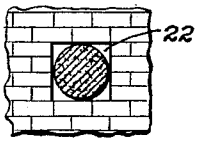


Fig. 3.

Fig. 2.

WITNESSES:
A. L. Jeffrey
H. M. Bibel

INVENTOR
George M. Little
BY
Wesley G. Carr
ATTORNEY

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2 SHEETS-SHEET 2

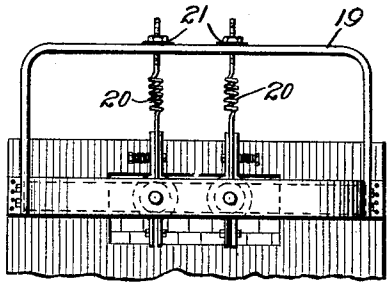


Fig. 4.

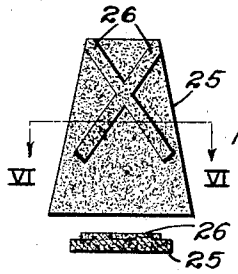


Fig. 5.

Fig. 6.

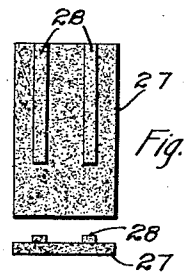


Fig. 7.

Fig. 8.

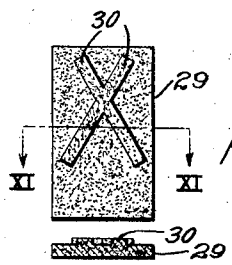


Fig. 9.

Fig. 10.

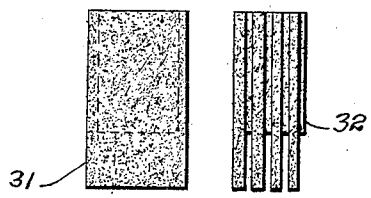


Fig. 11

Fig 12.

WITNESSES:
R. L. Jeffrey
H. M. Bickel

INVENTOR
George M. Little
BY
Wesley G. Carr
ATTORNEY

Patented Jan. 30, 1923.

1,443,580

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UNITED STATES PATENT OFFICE.

GEORGE M. LITTLE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

ELECTRIC FURNACE.

Application filed March 23, 1921. Serial No. 454,776.

To all whom it may concern:

Be it known that I, GEORGE M. LITTLE, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Electric Furnaces, of which the following is a specification.

My invention relates to electrically-heated apparatus and particularly to electric-resistor furnaces, and it has for one of its objects to provide a heating element, comprising a plurality of units, and to so mount it in a furnace chamber, out of contact with the furnace walls, as to permit of maintaining a temperature of 2500° C. or over, in such chamber and in which a relatively large energy input may be maintained uninterruptedly for relatively long periods of time without material damage to any part of the furnace.

Another object of my invention is to provide resiliently supported compression means for a refractory sectionalized resistor.

Another object of my invention is to provide means for water cooling the carbonaceous electrode by means of which the current is led into and out of the resistor.

Another object is to provide means for quickly removing a damaged resistor and quickly inserting a new resistor into the furnace chamber.

Another object is to provide a resistor element which shall have a form best adapted to withstand the oxidizing effect of air entering the furnace chamber, and further to provide means for protecting not only those portions of the resistor which are most subject to the oxidizing influence of the entering air but also the furnace walls.

Another object of my invention is to provide an electric resistor furnace in which the upper portion of the furnace chamber, in which the heating element is located, shall always be filled with hydro-carbon vapors, while the lower portion of the chamber may or may not be filled therewith, as may be desired. As the metal to be heated is to be placed in the lower portion of the furnace chamber, it may be heated in either an oxidizing or a reducing atmosphere.

Another object is to provide a roof made of carbonaceous material, in order to withstand the relatively high temperature experienced in the operation of the furnace at temperatures of 2500° C. and over and to protect the same, by the hydrocarbon vapors, against the oxidizing action of inleaking air.

Another object of my invention is to provide a relatively simple means for varying the resistance and, therefore, the current input into a given resistor in accordance with the desired capacity of the furnace.

Still another object of my invention is to provide a resilient mounting for the entire furnace so arranged as to co-operate with the resilient suspending means for the outer end of the electrodes as to prevent breakage of the electrode in case the furnace is subjected to vibration.

In practicing my invention, I provide a suitable metal container lined with suitable refractory material and enclosing a furnace chamber. I provide a refractory resistor located in the upper part of said chamber and at a substantial distance from the walls, said resistor comprising a plurality of separate elements, and means for compressing these elements, said compressing means being resilient and adjustable. I provide resilient suspending means for the outer ends of the terminal electrodes which extend through one of the walls of the chamber and mount a water-cooled terminal at the end of the electrode. I provide, further, a substantially stationary water-cooled metal collar located in the outer part of the wall for further cooling said electrode.

I provide means for creating hydro carbon vapor in the furnace chamber comprising a receptacle for oil and means for introducing said oil into the chamber and for permitting it to drop upon a heated refractory member located below said resistor and so arranged as to reflect the drops of oil against the under surface of said resistor.

I provide resistor elements made of a carbonaceous material, in which the center of gravity of the lateral area of cross-section is below the center line of compression, and I further provide means for restricting

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the contact area of adjacent elements to an area relatively less than the lateral area of cross-section of the element itself.

In the accompanying drawings:

Figure 1 is a view, in horizontal cross-section, on the line I—I of Fig. 2, of a furnace embodying my invention;

Fig. 2 is a view, in vertical cross-section, on the line II—II of Fig. 1 of the furnace;

Fig. 3 is a view, in lateral cross-section, on the line III—III of Fig. 2;

Fig. 4 is a view, in front elevation, of the resilient suspending means for the water-cooled terminal and the outer end of the electrode;

Figs. 5 and 6 are views, in front elevation and in section respectively, of a resistor element used in the resistor;

Figs. 7 and 8 are views, in side elevation and in end elevation, respectively, of a modification of a resistor element;

Figs. 9 and 10 are views, in front elevation and in section, respectively, of another modification of a resistor element, and

Figs. 11 and 12 are views, in front and in side elevation respectively, of a portion of a built-up heating element illustrating still another modification of the resistor element.

An electric furnace 1 comprises a suitable metallic container 2 in which is built up an outer wall 3 of heat-insulating material which may be of the material known as silocel, an intermediate wall 4, which may be made of fire brick, and an inner heat-resisting wall 5 which may be made of carborundum. It is to be understood that the materials named are illustrative only and may be varied to suit the individual requirements of the work to be done in the furnace.

The refractory linings of the furnace are so arranged as to provide a furnace chamber 6 which may be of any desired contour but is here shown as substantially rectangular in form. In the upper part of the chamber 6, I mount a heating element 7 which is here shown as comprising two sets of carbonaceous resistor elements to be hereinafter described in detail. The heating elements 7 are shown resiliently compressed by means of a spring-pressed electrode 8, substantially circular in cross section and extending through one of the furnace walls, substantially as indicated in Figs. 1 and 2. I provide a graphite back plate 9 against which one end of each of the resistors 7 may be placed, and I provide a graphite plate 10 at the front end of each of the heating elements 7 which is slightly hollowed out in its outer face to receive, and cooperate with, the rounded inner end of the electrode 8.

A metallic member 11 of substantially U-shape is secured to the metallic casing 2 to provide a means to co-operate with a spring 12, a spacing member 13, a threaded rod 14, a nut 15, and a washer 16 to resiliently press against the outer end of the electrode 8 and thereby maintain the electrode 8, end plates 9 and 10, and the built-up heating element 7 in proper operative positions. The threaded rod 14 may be permitted to project through the member 11 in order to maintain it in substantial alinement with the electrode, and suitable means may be provided to insulate this rod, either from the member 11 or from the outer end of the electrode 8, so that a proper current path may be provided through the resistors 7.

Massive contact terminals 17 are provided on each of the electrodes 8, and provision is made for water-cooling the same, the said provision comprising a tube 18 to conduct the water to and from the terminals 17 which are suitably cored out to permit of water or other cooling fluid circulating therethrough.

A member 19, of substantially U-shape, is secured to the member 11, and a spring member 20 is provided suspended from the member 19 and suitably engaging the water-cooled terminal 17 to resiliently support the same.

Suitable means, such as a nut 21, is provided on the threaded upper end of the member 20 to permit of properly adjusting the position of the member 17 and the electrode 8 to which the member 17 is secured, so that the electrode may be permitted to move freely in the opening 22 in the wall of the furnace.

During the operation of the furnace, shrinkage may occur in the furnace walls or in the resistor members 7 which make it necessary that the electrode 8 be permitted to move freely to follow such shrinkage or relative movement of the walls and the resistor.

As the temperature which may be attained in the furnace chamber 6 is relatively high, (2500° C. or even higher) it may happen that the electrode 8 becomes heated to a relatively high temperature and, in order to protect the same and to reduce the temperature of the same at the outer wall of the furnace, an auxiliary cooling means 23, comprising a substantially stationary collar, is located at the outer surface of the wall to surround the electrode 8, with a relatively small clearance space therebetween. The member 23 may be suitably cored so that water cooling may be employed, this cooling being in addition to that due to the water cooled terminal members 17.

The heating element 7 comprises a plurality of substantially flat plates of carbonaceous material of a form to be hereinafter set forth in detail, and I have used plates of carbon with excellent results.

While I have illustrated a two-part heating element, I do not desire to be limited thereto, as I may use only one of the resistor members 7 and locate the terminal elec-

trodes at opposite sides of the furnace and of the single resistor.

Inasmuch as it is desired to provide an electric-resistance furnace for heating metal objects, an opening, indicated diagrammatically at 24 in Figs. 1 and 2, is provided in the lower part of the chamber through which the metal objects to be heated may be introduced. This opening, of course, permits air to enter and, as this entering air contains oxygen, it will affect the heated resistor and cause the affected surfaces to oxidize and waste away. In order to reduce the effect of this oxidization, I provide resistor elements, the vertical dimension of which is greater than the horizontal dimension, and I further so arrange the relative location of the resistor elements and of the electrode 8 as to bring the center line of compression well above the center of gravity of the lateral area of the resistor elements.

In order to obtain the proper contact area which, in general, determines the resistance to the flow of current through one of the resistors 7, I may provide integral means on one surface of each element to reduce the contact area, or I may provide alternate elements of relatively small cross-section, in order to reduce the area of contact through which the heating current flows.

Figs. 5 and 6 illustrate one form of element comprising, in general, a member 25 of substantially trapezoidal area, the lower dimension being greater than the upper dimension. Integral raised portions 26 are provided on one surface of the member 25, of relatively small area, and are arranged in substantially X-form, the crossing point of the two parts being substantially the center line of compression of the assembled resistor 7.

Figs. 7 and 8 indicate another form of resistor element and comprise a substantially flat member 27 of rectangular area, on one surface of which are two spaced and parallel raised portions 28 extending from one edge to a point a little beyond the center of area of the member 27.

Figs. 9 and 10 indicate still another form of resistor element, comprising a substantially rectangular flat plate 29, one surface of which is provided with a raised portion 30 of substantially X-shape, similar to that illustrated in Fig. 5. The crossing point of the two parts of the raised portion 30 is well above the center of gravity of the member 29 and coincides substantially with the center line of compression which, in general, in all of these forms, is coaxial with the electrode 7.

Figs. 11 and 12 indicate a slightly different form of resistor and comprise a plurality of thin substantially rectangular plates 31 alternating with thin and relatively small rectangular plates 32, the lower edge of the plates 31 extending substantially below the lower edge of the plates 32.

In order to permit of varying the current input into any given size of furnace and with a substantially constant voltage of the supply circuit, I vary the area of contact between the successive elements of the heating member 7, increasing, for instance, the area of the raised portions 26, 28 or 30, respectively, or the area of the alternate sections 32. In general, the greater the area, the less is the resistance of the built-up resistor 7 and, therefore, the higher will be the temperature obtained in the furnace chamber 6 for a given voltage.

In order to provide a relatively simple means for quickly removing a damaged resistor and quickly inserting a new resistor, I provide a removable section in one of the walls of the furnace, this removable section being indicated in general, as 33 in Fig. 1. This removable section is located substantially opposite to, and laterally of, the resistor member 7 and may be arranged to be removed as a unit, or the individual portions of the walls 3, 4 and 5 may be removed separately, as may be found most convenient. In case the resistor member 7 should become damaged to such an extent as to require renewal, the wall section 33 may be removed, providing a suitable opening 34 in the wall of the furnace and a suitably-shaped scoop or handled tray may be introduced through the opening 34 and so held as to support one of the resistor members 7, the nut 15 may be backed off sufficiently to permit of withdrawing the electrode 8 and thus permit of removing the resistor member 7, as a unit, laterally and outwardly through the opening 34. A new resistor member 7 may be built up of the proper number of elements 25, 27, 29 or 31 and 32, the elements being temporarily glued together by means of a suitable binder, such as glue, pitch or fluid tar or molasses, then supported on the tray and introduced into the furnace chamber through the opening 34 until it is in substantially its operative location with regard to the graphite back plate 9, after which the nut 15 may be again turned on the stud 14 to force the electrode 8 against the resistor member 7 and properly compress the same.

As hereinbefore stated, a certain amount of air enters through the opening 24 and causes oxidation of those surfaces of the resistor member 7 with which it comes in contact, and, in order to reduce this oxidation, I provide means for creating a sooty vapor in the furnace chamber adjacent to those surfaces of the resistor which are most affected by the oxidizing action of the incoming air. A container 35 is mounted at the top of the furnace in which may be placed oil, which is permitted to drop into a receiving tube 36

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having a return bend. The lower end of the tube 36 projects into a refractory tube 37 of relatively large diameter and this permits the drops of oil to fall into the furnace chamber upon a projecting ledge 38 which is made of a suitable refractory member adapted to withstand the high temperature to which it is subjected. As indicated in Fig. 2, the member 38 may be part of a removable wall section 39, so that it may be easily and quickly removed and cleaned if it becomes too deeply covered with soot to perform properly and efficiently its desired function. The drops of oil traversing the tube 37 will fall upon, and be reflected from, the upper surface of the projecting ledge 38, thus being deflected against the lower surface of the resistor members 7. As the temperature of the refractory ledge 38 is substantially that of the resistor member 7, the drops of oil will be volatilized and "cracked" immediately upon striking the ledge, and the oil, after striking the ledge 38, is in reality, a sooty vapor which has a tendency to flow toward the under surface of the resistor member 7, and, in general, tends to fill the upper portion of the chamber.

I am aware that electric resistance furnaces are known, in which a neutral atmosphere is maintained, but I wish to point out that the method here disclosed provides what may be termed an "accretive" atmosphere, as I have found that not only is oxidation of the surfaces of the resistor elements substantially entirely prevented, but, under certain conditions, as for example, by the use of a relatively large quantity of oil, I am able to build up these surfaces as they become covered with a sooty deposit which may eventually harden and become a part of the resistor element itself.

The top of the furnace comprises a separate metallic casing 40 to facilitate its quick removal from the top of the furnace, should this become necessary. An inner wall comprises suitable heat-resisting refractory bricks 41 which may be fire bricks or, if desired, of carborundum slabs or blocks. This wall is so arranged as to leave a substantially open space 42 in which is placed a plurality of carbon bricks or slabs 43.

The space between the top of the slabs 43 and the top of the casing 40 may be filled with finely divided granular material which may comprise coarsely powdered coke next to the slabs 43 and more finely divided powdered coke at the top of the casing 40, the general idea being to provide not only a heat-resisting covering for the top of the furnace, but also a self-sealing porous covering in which the openings become rapidly choked by the sooty vapors created, as heretofore described, so as to seal the top of the furnace practically air-tight. In this connection, it may be noted that the sooty vapors will strike not only the lower surface of the resistor members 7 but also the walls of the furnace so that all cracks or open joints will be sealed in a relatively short time and become practically air-tight. In order to provide means for permitting any excess of sooty vapor to escape, an opening 44 is provided in the lower part of the chamber and is connected to a suitable removable box 45 secured to the outside of the wall in which is provided a suitable opening through which any excess of sooty vapor may flow into the atmosphere.

As a furnace of this type may be installed in a location where it will be subjected to vibration, as by reason of a steam hammer being operated to work on the materials heated by the said furnace, I provide a resilient mounting means for the entire furnace. A plurality of supporting members 46 may be placed on a proper foundation into which project threaded rods 47, surrounding which are suitable helical springs 48 which may be adjusted by means of suitable nuts 49 and washers 50. Where such furnace is subject to vibration, it may cause the resistor elements to slip and fall and may also cause damage to the electrodes 8, inasmuch as it is advisable to make the clearance between the electrode 8 and the walls surrounding the opening 22 and between the electrode 8 and the collar 23 as small as possible, to prevent an inflow of oxidizing air, and the resilient mounting of the furnace co-operates with the resilient electrode suspending means 20 to support the outer end of the electrode 8 and the terminal member 17 mounted thereon.

As hereinbefore set forth, a certain amount of movement of the electrode, relative to the wall through which it projects, will occur by reason of the shrinkage of the walls after continued operation of the furnace and also by reason of shrinkage and expansion of the resistor members 7, and the resilient compression means, in combination with the resilient suspending means, will permit such relative movement of the electrodes as may be required.

The center line of compression of the resistor members 7 is located well above the center of gravity of the lateral area of the individual elements for the reason that, if the means for creating a sooty vapor in the chamber should fail to operate properly or be disconnected by the operator, oxidation of the lower surface of the resistor would take place rapidly, with a resultant wearing away of the lower part of the area of the individual elements and, if this were continued for any substantial length of time, it might happen that the entire resistance member 7 would tend to buckle in an upward direction, a tendency which is delayed to a considerable extent by the adop-

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tion of the forms hereinbefore described and which may, under certain conditions, be entirely prevented if the generation of sooty and accretive vapors is maintained at all times during the operation of the furnace.

It may be noted that the device embodying my invention provides a resilient suspending means for the outer ends of the electrodes which permits of free movement of the electrodes and substantially constant compression of the resistor elements themselves. Resilient supporting means for the entire furnace is provided, which cooperates with the resilient electrode-suspending means to prevent breakage of the electrode when the furnace is subjected to vibration.

The device embodying my invention provides cooling means for the outer end of the terminal electrode and additional cooling means for an intermediate portion of the electrode.

The resistance element used in the device embodying my invention is relatively simple and easily manufactured and has inherent means for reducing the oxidizing effect of incoming air, thus insuring a relatively long life of the resistor under operating conditions. The same inherent means also permits of locating the center line of compression of the resistor above the center of gravity of the element, thus tending to prevent an upward buckling of the resistor member in case the lower portion of the elements is reduced by oxidation. The resistor member is maintained in operative position entirely free from the surrounding walls and supported entirely at its ends by compression means.

The device embodying my invention provides a roof for a furnace chamber which is non-heat-conducting and which cooperates with means inside the chamber to seal itself against the passage therethrough of air.

The device embodying my invention provides relatively simple means for permitting the removal of a damaged resistor member and the insertion of a new resistor member without dismantling the entire top of the furnace.

The device embodying my invention provides a relatively simple means for creating an accretive atmosphere in the furnace chamber in which a resistor member comprising a plurality of carbonaceous elements is used, which vapors will, to a great extent, protect the resistor elements against the oxidizing action of entering air.

The device embodying my invention provides relatively simple means for varying the resistance of the resistor member in accordance with the desired kilowatt capacity of the furnace and, hence, permits of obtaining any desired predetermined temperature in the furnace chamber under given conditions of operation.

Various modifications may be made in the device embodying my invention without departing from the spirit and scope thereof, and I desire that only such limitations shall be placed thereon as are imposed by the prior art or are specifically set forth in the appended claims.

I claim as my invention:—

1. An electric-resistance furnace comprising a carbon-plate resistor, carbonaceous terminal plates therefor, carbonaceous electrodes engaging said terminal plates and cooling means surrounding the outer ends of said rods.

2. In an electric-resistance furnace, the combination with a chamber, a resistor in said chamber, and carbonaceous terminal plates operatively engaging said resistor, of elongated terminal electrodes operatively engaging said terminal plates and resilient suspending means for the outer ends of said electrodes.

3. In an electrode-resistance furnace, the combination with a chamber, and a resistor located in said chamber, of elongated terminal electrodes operatively engaging said resistor and extending outside the wall of said chamber, combined contact terminals and cooling means engaging said electrodes and resilient suspending means for said contact terminals and cooling means.

4. In an electric-resistance furnace, the combination with a furnace chamber, and terminal electrodes operatively engaging said resistor and projecting through a wall of said furnace, of combined contact terminals and cooling means secured to the outer ends of said electrodes and a stationary cooling means surrounding said electrodes and located intermediate said resistor and said terminals.

5. In an electric-resistance furnace, the combination with a chamber, of a resistor in said chamber comprising a plurality of elements disposed face to face in a direct line between the terminals, and means to compress said elements, the line of compression being located above the center of gravity of said plates.

6. In an electric-resistance furnace, the combination with resilient compression terminals, of a resistor operatively engaging said terminals and comprising a plurality of elements disposed in a direct line between said terminals, the larger portion of the area of each element being located substantially below the center line of compression.

7. In an electric-resistance furnace, the combination with a casing enclosing a furnace chamber and having an opening in one of its walls, a carbonaceous sectionalized re-

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sistor in said chamber, an elongated electrode operatively engaging said resistor and projecting through a wall of said casing and movable relatively to said wall, and resilient compression means for said electrode and said resistor, of adjustable and resilient means for facilitating the movement of said electrode in said wall.

8. An electric furnace comprising a casing enclosing a furnace chamber and having an opening therethrough at the lower part of said chamber, and a carbonaceous resistor located in the upper part of said chamber and having integral means for reducing oxidation of the resistor.

9. In an electric furnace, the combination with a casing enclosing a furnace chamber, said casing having an opening therethrough at the lower part of said chamber, of a carbonaceous resistor located in the upper part of said chamber and comprising a plurality of elements in contact with each other and embodying means on said elements for reducing oxidation of the contact surfaces.

10. In an electric-resistance furnace, the combination with a housing enclosing a furnace chamber and having an opening in one of its walls adjacent the upper part of the chamber, a carbonaceous sectionalized resistor in said chamber, an elongated electrode operatively engaging said resistor and projecting through said wall opening and removable relatively to said wall, a contact terminal secured to the outer end of said electrode and resilient compression means for said electrode and said resistor, of resilient suspension secured to said contact terminal and resilient supporting means for said furnace housing co-operating with said resilient suspension means for permitting said electrode to move freely in said opening.

11. An electric-resistance furnace comprising a furnace chamber, a carbonaceous resistor located in the upper part of said chamber, means for introducing oil into the chamber at the top thereof, and means in said chamber for vaporizing said oil and for causing said vapor to strike the lower surface of said resistor.

12. An electric-resistance furnace comprising a furnace chamber, a carbonaceous resistor located in the upper part of said chamber, means for introducing oil into the upper part of said chamber, and means located in said chamber below said resistor for receiving and vaporizing said oil.

13. In an electric furnace, the combination with a housing open at the top and enclosing a furnace chamber, a carbonaceous resistor located in the upper part of said chamber, of means for generating sooty vapors in said chamber, and a covering for the top of said chamber comprising material which is non-heat conducting and self-sealing against said sooty vapors.

14. An electric-resistance furnace comprising an enclosing chamber, hydro-carbon vapors therein, a carbon-plate resistor in said chamber, carbonaceous electrodes operatively engaging said terminal plates, and contact terminals secured to the outer end of said electrodes.

In testimony whereof, I have hereunto subscribed my name this 15th day of March, 1921.

GEORGE M. LITTLE.