J. W. BROWN.

ELECTRIC FURNACE.

APPLICATION FILED JAN. 8, 1912.

1,100,709.

Patented June 23, 1914.

4 SHEETS—SHEET 1.

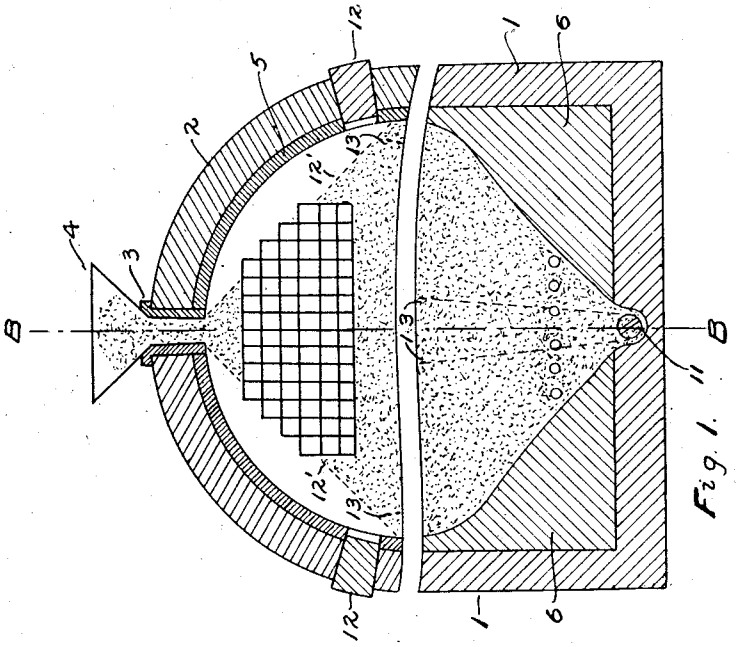


Fig. 1.

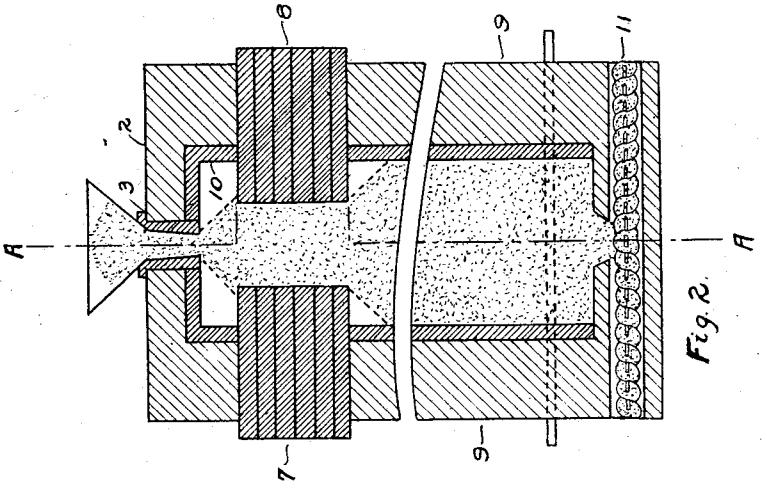


Fig. 2.

WITNESSES

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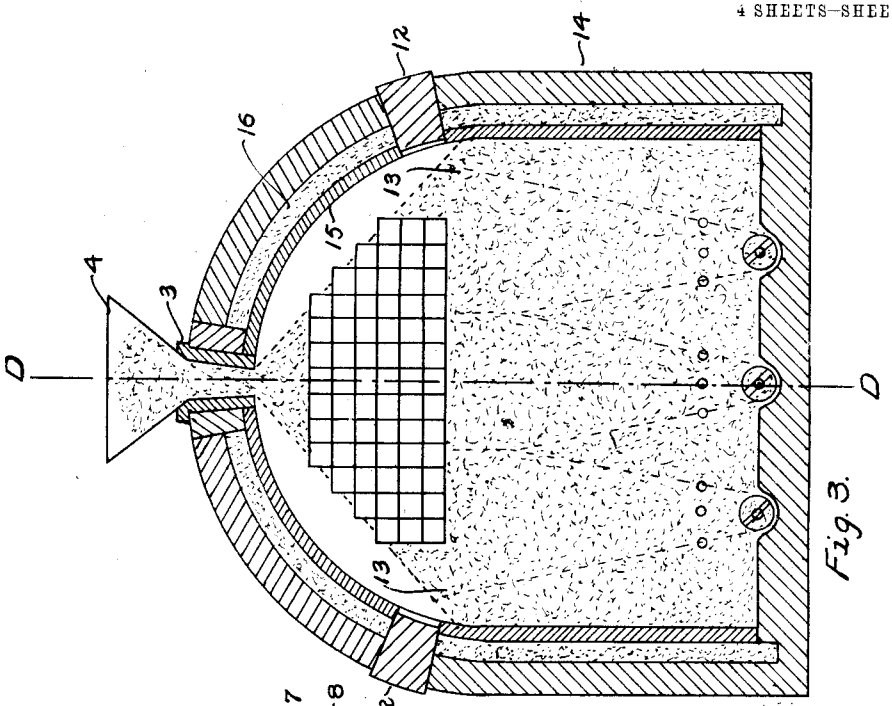


Fig. 3.

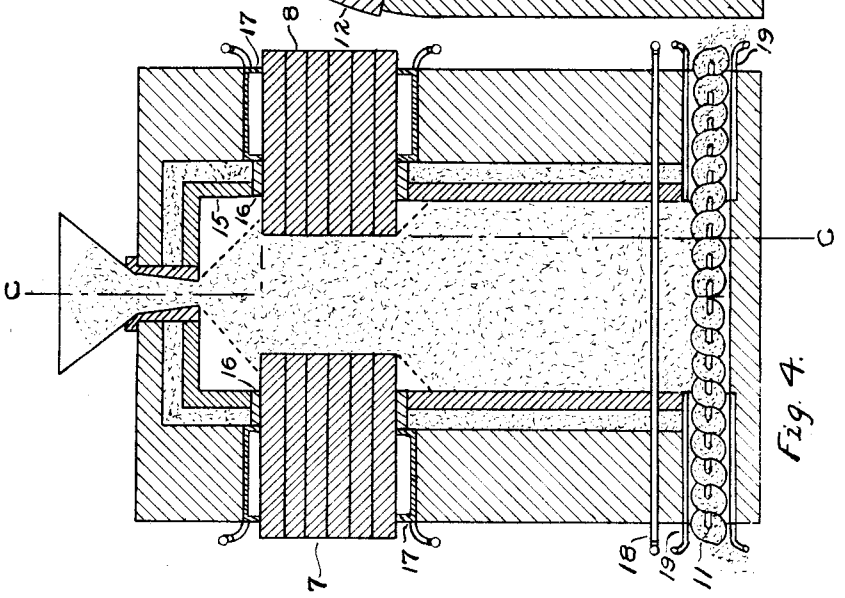


Fig. 4.

WITNESSES

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4 SHEETS—SHEET 3.

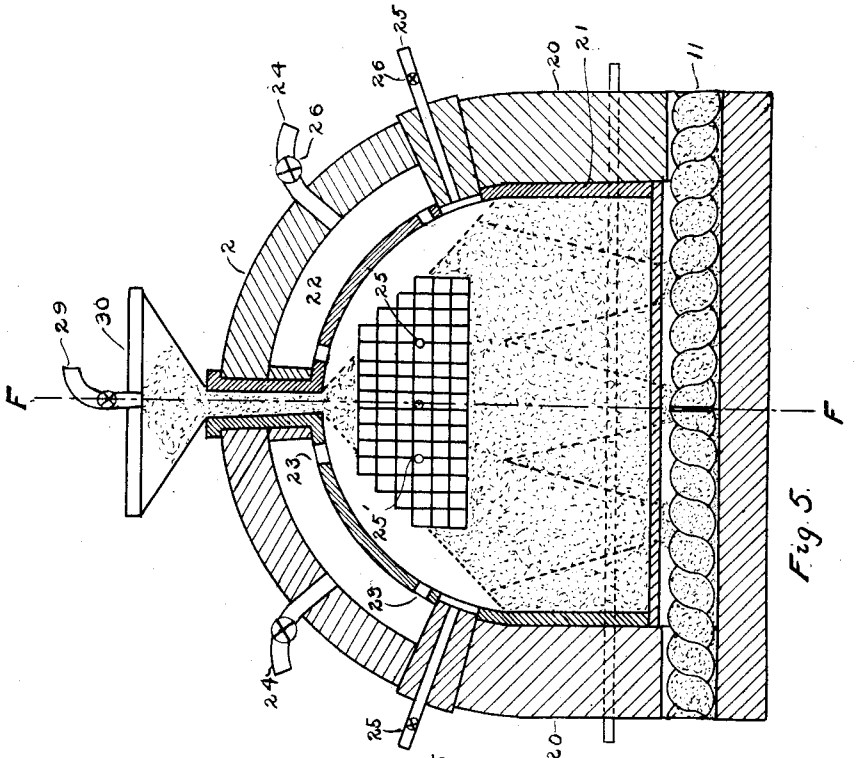


Fig. 5.

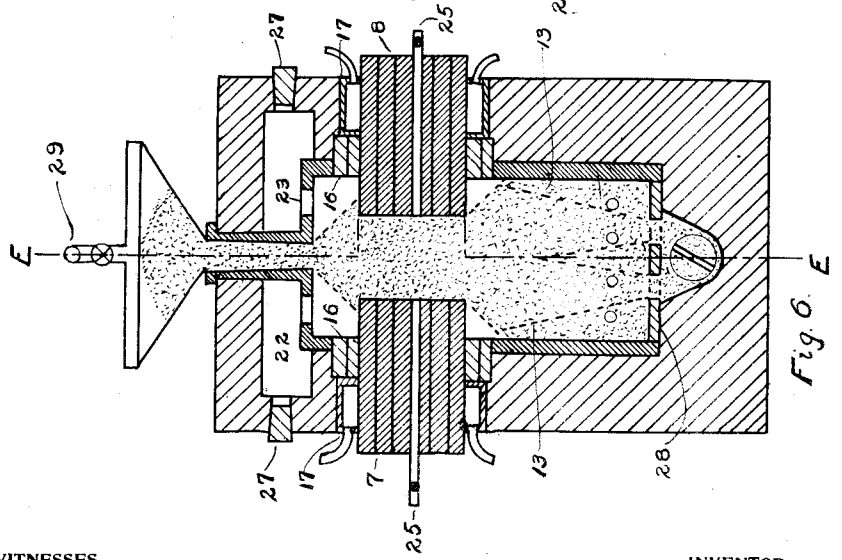


Fig. 6.

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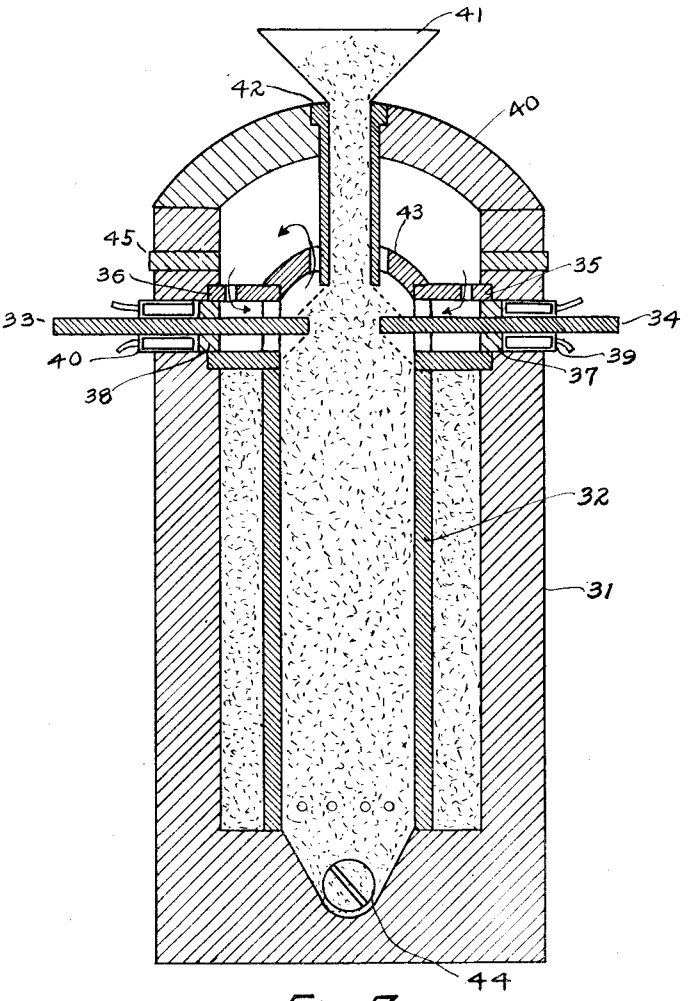


Fig. 7.

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ELECTRIC FURNACE.

1,100,709. Specification of Letters Patent. **Patented June 23, 1914.**

Application filed January 8, 1912. Serial No. 670,073.

To all whom it may concern:

Be it known that I, JOHN W. BROWN, a resident of Lakewood, in the county of Cuyahoga, in the State of Ohio, have invented new and useful Improvements in Electric Furnaces, of which the following is a clear and exact description.

This invention is an improvement in continuous electric furnaces for heating granular material.

The invention is particularly adapted for the calcination of granular carbon and for converting carbon into graphite, though it may be used to treat any granular material that will conduct an electric current.

One object of my invention is to construct a furnace so that the material to be treated moves at a more uniform rate through the zone between the heating electrodes.

Another object is to arrange the electrodes and regulate the current so that the granular charge is quickly raised to an intense heat so that, if the material does not move at all times uniformly through the heating zone it will nevertheless be intensely heated.

Another object of my invention is to arrange the condensers in the furnace in a manner that volatile matter arising from the heating zone will be condensed in these chambers and will not pass into the charge and be condensed thereon.

Other objects will appear in the following description, particular reference being had to the drawings in which:

Figure 1 is a sectional elevation of a furnace in which parts are broken away for the purpose of illustration. This figure is a section on the line A—A of Fig. 2. Fig. 2 is a sectional elevation taken on the line B—B of Fig. 1. Fig. 3 is a sectional elevation of a modification taken on the line C—C of Fig. 4. Fig. 4 is a sectional elevation taken on the line D—D of Fig. 3. Fig. 5 is a sectional elevation of a modification taken on the line E—E of Fig. 6. Fig. 6 is a sectional elevation taken on the line F—F of Fig. 5. Fig. 7 is a sectional elevation through another modified type of furnace.

Referring to Fig. 1 the outer walls of the furnace are indicated by 1. These walls may be made of any heat insulating material. The walls are arched over to form a roof 2, and extending through this roof is a member 3, preferably made of carbon or some other good heat resisting material. A hopper 4 is placed so as to feed material through the member 3 into the furnace. The roof of the furnace should be preferably lined as at 5, with some good heat resisting material such as carborundum or carbon. The lower part 6 of this furnace is also composed of some good heat resisting material. I have shown two electrodes 7 and 8, extending through the side walls 9. These electrodes may be made of any shape, and I have shown them made up of a plurality of carbon columns. If desired the electrodes may be molded in one piece. The side walls 9 of the furnace should be lined with some good heat resisting or refractory material 10 such as carborundum or carbon. If carbon is used to line the furnace walls it will be necessary to leave a space between the lining and the electrodes 7 and 8 so that the current will not be short-circuited therethrough. A conveyer 11 removes the treated material from the base of the furnace. This conveyer is made up of two parts having right and left handed spirals so that the material is fed out at both sides of the furnace. If desired, the conveyer may be arranged to take the material only from one side. The material at the base of the furnace is preferably cooled by means of water pipes extending therethrough. These pipes are shown in Fig. 1. In the end walls 1, I have shown two removable blocks 12, so that the interior of the furnace can be reached if necessary.

As has been stated Figs. 1 and 2 are broken away and shown much shorter than the furnace would actually be. This is for the purpose of illustration. If the top portion of the furnace be considered as resting upon the bottom portion, and not broken away as in Fig. 1, a type of furnace would be shown that is old in the art. My furnace is an improvement of this type.

To thoroughly understand my improvement, it will be necessary to consider first the prior type of furnace previously referred to. That type of furnace was constructed with the idea that the material would flow down the sloping sides of the members 6, as well as down the center parts of the furnace, and be drawn out by the conveyer 11. The sloping sides of the member 6 were made at substantially the same angle as the slanting surface of the charge at 12′. The surface 12′ makes an angle

with the horizontal that depends upon the coefficient of friction between the granular particles, and it would seem obvious that the bounding lines of the moving charge, as it moves from the heating zone to the conveyer, would make the same or approximately the same angle with the horizontal. The prior furnace was constructed in accordance with this apparent, though mistaken, idea.

I have found by experiment that the material flowing downward into the conveyer 11 travels in a narrow channel only slightly converging downward. The lines of flow are approximately indicated at 13. With this explanation it will be plain why the old type of furnace is inoperative. The initial carbon charge between the electrodes 7 and 8 might be uniformly heated. The lines of flow 13, would, however, only intersect part of the material flowing between the electrodes. The remainder of the material would be substantially stationary, and would soon become so highly heated that most of the current would be conducted through this portion of the charge, due to the fact that carbon has a negative temperature coefficient of resistance. Most of the current would thereby be shunted around the portion of the charge moving down between the electrodes within the lines 13. The moving portion would therefore cool down. The colder the moving charge became the greater would be its resistance and the less current would it conduct. Thus I have found that that type of furnace cannot be operated for any length of time as the stationary part of the charge between the electrodes soon becomes so hot that it takes practically all the current and the charge descending down to the conveyer 11 receives only a small percentage of the heat, and hence the material taken out by the conveyer is in substantially the same condition as when it entered through the hopper 4. I get around the aforesaid difficulty by several different ways. In Fig. 1 the furnace is made operative by building it of such height in comparison to the size of the conveyer that the lines 13 will diverge enough to take in all the material that is between the two electrodes. The angle of the diverging lines will depend somewhat upon the material and also upon the degree of fineness. The difference, however, between this angle and the angle of friction is very marked. With "nut size" coke the angle will be between 70 degrees and 90 degrees. When the furnace is built in this way all of the material will flow between the electrodes at substantially the same rate, so that no part of the charge will take more than its share of the current. Hence there will be substantially equal heating of all the material flowing through. By controlling the speed of the conveyer 11, the charge may be drawn through the furnace at any desired rate, and the current sent through the electrodes may be regulated to any desired value. It is thus apparent that my improved furnace can be used to heat the granular material until graphitization takes place, or it may be heated to any temperature below this point depending upon the regulation of the conveyer and also of the current input if desired.

In Figs. 3 and 4, I have shown another modification in which the afore-mentioned difficulty is obviated, by using a plurality of conveyers, so spaced that the lines of flow of adjacent conveyers intersect at points below the electrodes. In this way all of the material between the electrodes is caused to move downward at a substantially uniform rate.

In Fig. 3 the outer walls are indicated at 14. The interior of the furnace is lined with some refractory material 15, such as carborundum or carbon. If carbon is used the electrode should be insulated from the lining by members 16, which may be made of carborundum. The lining is spaced from the outer walls and in the space is placed granular carbon to serve as a heat insulating medium. The electrodes in this modification are cooled by water jackets 17 through which a supply of water is circulated. The fluid used need not necessarily be water, as low melting alloys may be used to keep the temperature of the electrodes down. Water pipes 18 are also placed in the lower part of the furnace to cool the charge. The conveyer 11 also has water cooling jackets 19, to aid in cooling the treated charge and prevent the conveyer from being destroyed.

Fig. 5 and Fig. 6 discloses another modification for accomplishing the purpose stated in the description of the previous figures. The outer walls are indicated by 20. The furnace is lined by a refractory material 21 that may be either carborundum or carbon. The roof 2 of this furnace is so arranged that there is a space 22 between it and the lining 21. This space is for condensing the volatile matters as will be subsequently explained. The electrodes 7 and 8 in this modification are cooled by water jackets 17, as in Figs. 3 and 4. I have shown insulating members 16 upon the electrodes 7 and 8. These are necessary if the lining 21 is made of carbon to prevent the electrodes from being short-circuited. However, if carborundum is used the insulating members may be dispensed with, as carborundum is practically a non-conductor of electricity. The member 21 has holes 23 at various places to permit the volatile matter arising from the heating zone to pass out into the condensing chambers 22. If desired pipes 24, 25, and

25′ may be connected up to a fan or other arrangement, so as to force an inert gas through the pipes 25 and 25′, and pump it back through pipe 24. This would aid in drawing the volatile matters into the condensing chambers where they would be condensed. Valves 26 are shown so that if desired the gas system need not be used. The material condensed in the chamber 22 can be taken out by appropriate tools on removing the blocks 27, shown in Fig. 6. The condensing chamber 22 is essential if the charge consists of any material that has a high percentage of ash. While the condensing arrangement would be preferable, it would not be absolutely necessary if the charge consisted of petroleum coke, as this coke has a low percentage of ash. In this modification I have shown a conveyer 11 placed in the center of the furnace and extending at right angles to the electrodes. Above the conveyer I have shown a member 28 having openings therethrough so that the material can flow through to the conveyer. The member 28 is for the purpose of partially supporting the weight of the charge so that the weight upon the conveyer will not be too great. If desired this member may be omitted. The important feature of this modification is the placing of the conveyers at right angles to the electrodes. By doing this the lines 13 which denote boundaries of the moving charge, take in the entire region between the electrodes. A pipe 29 extends through a cover 30 of the hopper in this modification, so that gases that may come up through the charge may be drawn away. If desired an inert gas may be forced down through these pipes as in the pipes 25 and 25′ to prevent fumes from rising and condensing in the downcoming charge. A valve is shown in this pipe so that if desired it may be closed.

In the previous figures I have disclosed modifications that entirely obviate the difficulties encountered in the prior type of furnace, but I prefer to construct a furnace as shown in Fig. 7. In this figure the ratio between the height of the furnace and the width is greater than in the previous figures. In those figures there is a tendency for the charge to descend in the furnace while the material in the hopper remains stationary, and after an interval of time the material will flow through the hopper and fill the furnace to a certain point, then the material will quit flowing into the furnace until a certain amount of treated material is removed by the conveyer. This results in an intermittent surging of material through the hopper and along the natural slanting surface of the charge as at 12′ in Fig. 1. The surges of material past the electrode prevent its being as intensely heated as the remainder, and I have so constructed a furnace so that the cone-shaped pile of material has a small base and a narrow heating zone. A large enough current is then sent through the electrodes to very quickly heat the material up to the desired point. In this way I can continuously draw a rapidly moving charge through the furnace and the surges are substantially eliminated. This is very important as it is more desirable to heat a small amount of the charge by sending a very large current through it so that it will be raised to an intense heat in a very short time, than it is to heat a large amount of the charge by a smaller current, and move the charge at a slower rate through the heating zone. This will be evident when it is recalled that the amount of heat lost by radiation is proportional to the time. If therefore, the time for heating the material is cut down the heat loss during the heating process is cut down in the same proportion.

In Fig. 7, 31 indicates the outer walls. The cross-section of the furnace may be square, circular or in any desired shape, as the shape is not material to my invention. 32 indicates an inner channel preferably made of carbon, though it may be made of carborundum if the temperatures to be attained are below the graphitizing point. Electrodes 33, 34 extend through the furnace walls and the inner channel whereby the granular charge between the channel and the outer walls is prevented from contacting with the electrodes. The granular charge in this space remains stationary and is for heat insulating purposes. Blocks 37, 38 made of insulating material such as carborundum or magnesia close the openings in the members 35, 36. These blocks have central openings to permit of the electrodes being insulated therefrom. Water jackets 39, 40 encircle the electrodes, and abut against the blocks 37, 38 to cool the electrodes, and the blocks. The fluid circulated in the jackets need not necessarily be water as it could be a low melting alloy and accomplish the same purpose. A cover 40′ incloses the upper part of the furnace and prevents the radiation of heat in an upward direction. A hopper 41 feeds material down through a carbon tube 42 that extends through an opening in the roof 40′ and the carbon cap 43. The cap 43 rests on the upper part of the carbon channel 32. The space above the cap 43 and the spaces in the members 35 and 36 form chambers for condensing volatile matter arising from the heating zone. The accumulation may be removed from the members 35 and 36 by withdrawing the water jackets and blocks 37 and 38, and from the chamber above cap 43 by withdrawing block 45. These blocks may be spaced at various places around the furnace.

A conveyer 44 extends through the base of the furnace to remove the treated material

which may be either graphite or carbon heated to any point below graphitization, depending upon the current sent through the electrodes, and upon the rate at which the material is taken through the furnace. This conveyer may be extended parallel with the electrodes or at right angles to the electrodes, or in any direction as the furnace is built high enough and of small enough diameter to permit the charge in the electric heating zone to be in the line of movement irrespective of the direction in which the conveyer is placed. I have shown it, however, as being extended at right angles to the electrodes. The amount of material that passes down through the tube 42 is small as compared to the current sent through the electrodes, and since the material in the electric heating region is in the shape of the apex of a cone it is intensely heated, since all the current has to go through a very constricted portion. The sides of the cone above the electrodes and of the cone below the electrodes are very short as compared to those in the other figures in this case; hence at each surge of the charge comparatively little of the granular carbon will pass through the heating zone.

By increasing the height of the furnace and constructing it so that a small stream of granular material is rapidly fed past the electrodes which carry a very high current, I am enabled to obtain a uniformly heated product in the form of graphite or any other product heated to any temperature desired.

If it is desired to bake carbon below the temperature of graphitization, gas heating could be substituted for electrical heating and my improvements would obtain like advantages.

Having described my invention what I claim is:

1. In an electric furnace of the continuously operating type, heating electrodes spaced apart whereby a charge passing therebetween may be treated, and means for removing the treated charge below the electrodes, said means being spaced at such distance from the electrodes that all of the descending treated charge is included within lines of movement having a slope greater than 70 degrees.

2. In an electric furnace of the continuously operating type, heating electrodes spaced apart so that the furnace charge may pass therebetween, and means for removing a treated charge at a point spaced below the electrodes, so that all the moving material may be included within a cone having a slope greater than 70 degrees.

3. In an electric furnace of the continuously operating type, inclosing means, heating electrodes spaced apart and extending into said inclosing means adapted to treat a charge passing therebetween, and means for removing the treated charge, said means being spaced from the electrodes at such distance that all of the moving charge is included within lines of movement having a slope greater than 70 degrees.

4. In an electric furnace of the continuously operating type, horizontal heating electrodes spaced apart, and means for feeding the furnace charge between the electrodes, means for removing the treated charge at such distance below the electrodes that all of the charge between the electrodes is included within lines of movement having a slope greater than 70 degrees.

5. In an electric furnace of the continuously operating type, co-lineal heating electrodes adapted to treat a charge passing therebetween, and means for removing the treated charge, said means being spaced from the electrodes at such distance that all of the moving charge is included within lines of movement having a slope greater than 70 degrees.

6. In an electric furnace of the continuously operating type, heating electrodes spaced apart so that the furnace charge can pass therebetween, and means for removing the treated charge said means extending at right angles to the heating electrodes.

7. In an electric furnace of the continuously operating type, heating electrodes spaced apart to permit the furnace charge to pass therebetween, means for condensing volatile matters arising from the heating zone, and a conveyer for removing the treated charge, said conveyer extending at right angles to the heating electrodes.

8. In an electric furnace of the continuously operating type, inclosing walls, electrodes extending therethrough and spaced apart, means for condensing volatile matters arising from the heating zone, and a conveyer for removing the treated charge at the base of the furnace, said conveyer extending at right angles to the electrodes.

9. In an electric furnace of the continuously operating type, inclosing walls, heating electrodes spaced apart and extending therethrough, condensing means, means for feeding the furnace charge into the heating zone, and means for removing the treated charge at the base of the furnace, said means extending in a direction at right angles to the electrodes.

10. In an electric furnace, furnace walls, a channel extending into the furnace for feeding material therein, electrodes extending at right angles to the channel, and a conveyer for removing the treated charge at such distance below the electrodes that the zone of moving material includes all the charge between the electrodes.

11. In an electric furnace, inclosing walls, a feeding channel of relatively small diameter extending into the top of the furnace

whereby the top of the charge assumes substantially the shape of a cone, electrodes extending at right angles to the axis of the cone and spaced apart to include the apex thereof, and means adapted to continuously remove all the material between the electrode ends, said means being spaced below the electrodes at such distance that all of the descending charge is included within lines of movement having a slope greater than 70 degrees.

In testimony whereof I have hereunto signed my name.

JOHN W. BROWN.

Witnesses:
F. D. LAWRENCE,
R. H. HANEY.