No. 771,250. PATENTED OCT. 4, 1904.

W. S. HORRY.

APPARATUS FOR ELECTRIC HEATING.

APPLICATION FILED JUNE 28, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

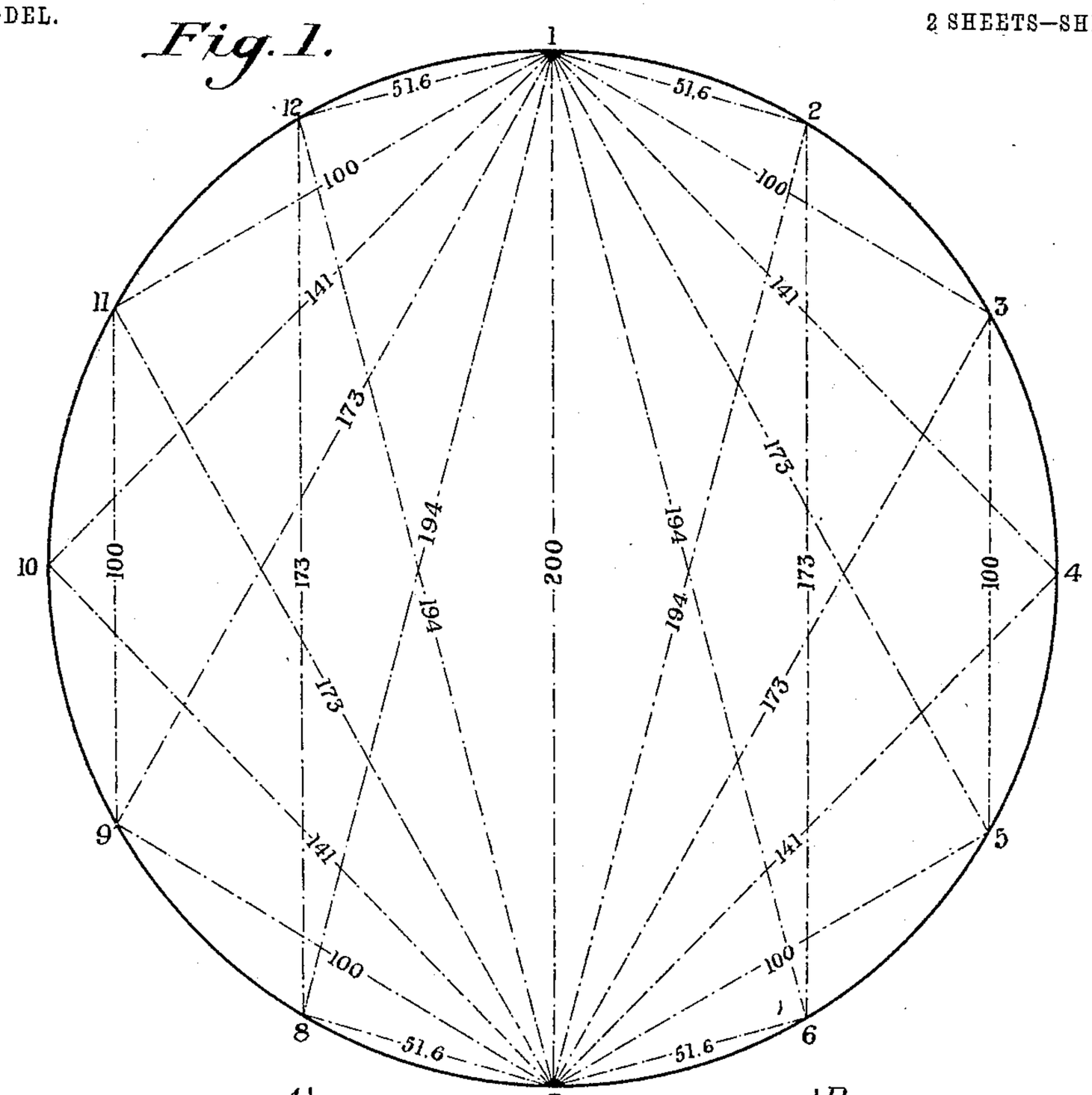
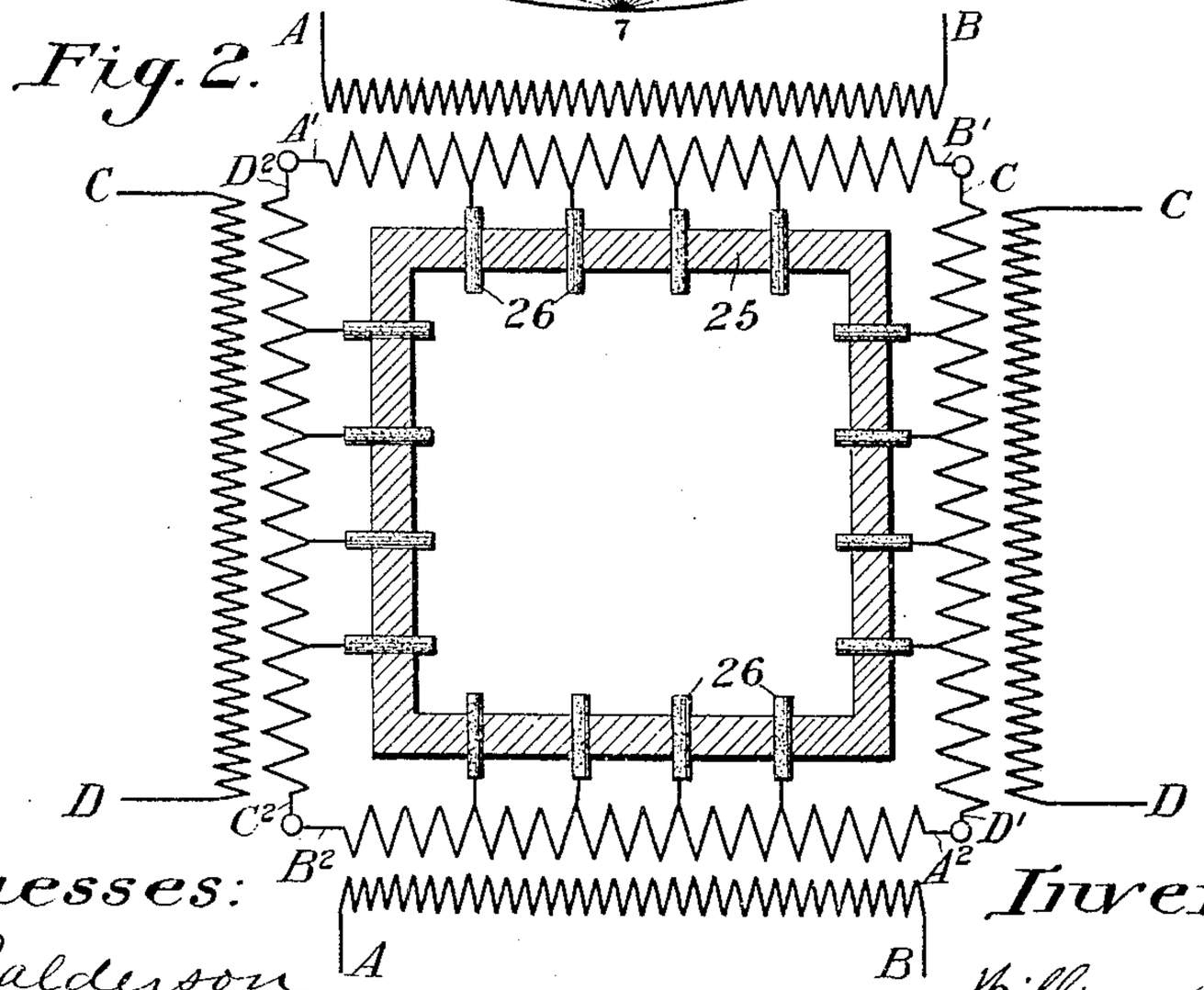


Fig. 2.



Witnesses:
R. A. Balderson.
J. B. Hill.

Inventor:
William Smith Horry,
by Byrnes & Townsend,
Att'ys.

No. 771,250. PATENTED OCT. 4, 1904.

W. S. HORRY.

APPARATUS FOR ELECTRIC HEATING.

APPLICATION FILED JUNE 28, 1904.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

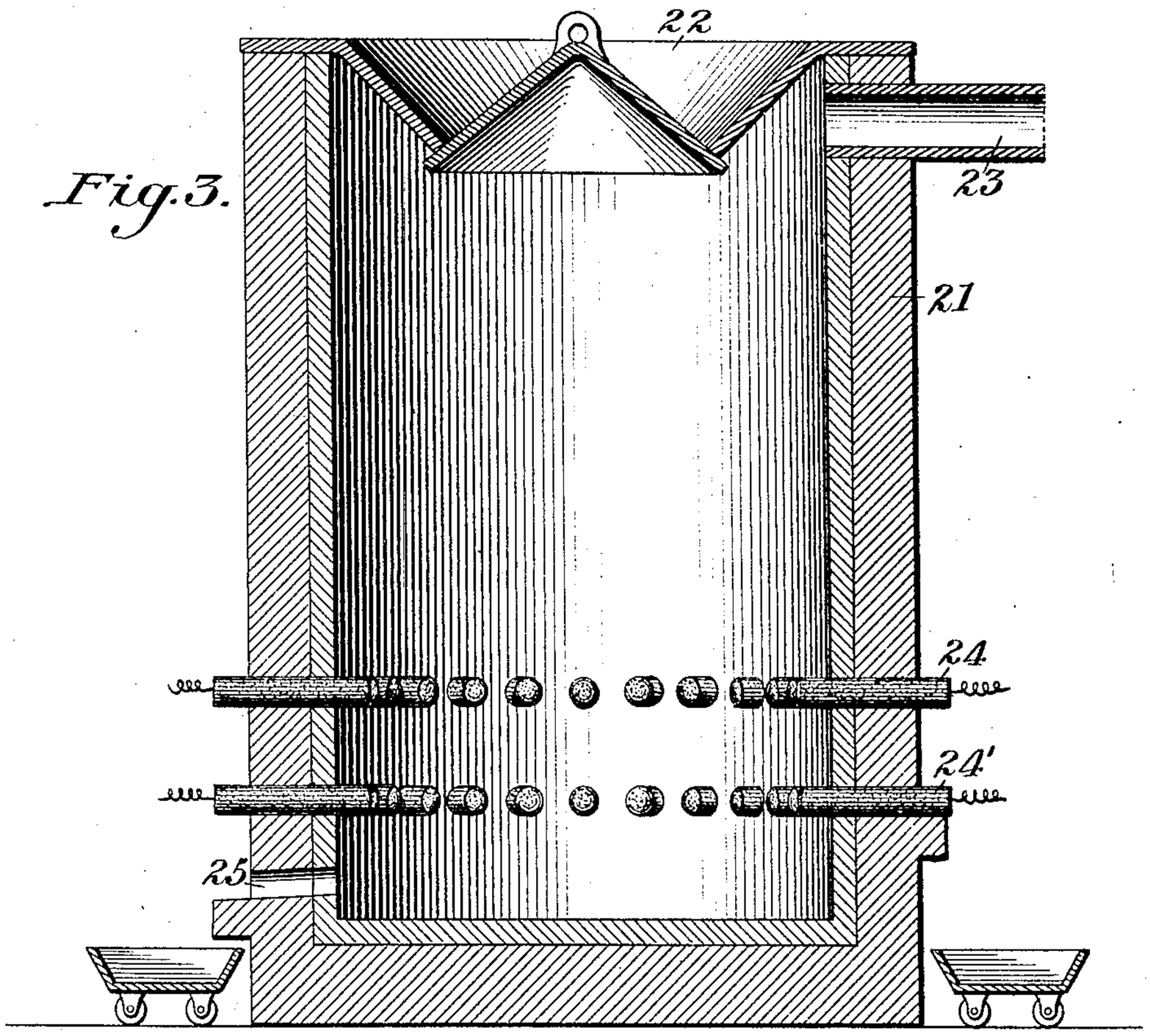
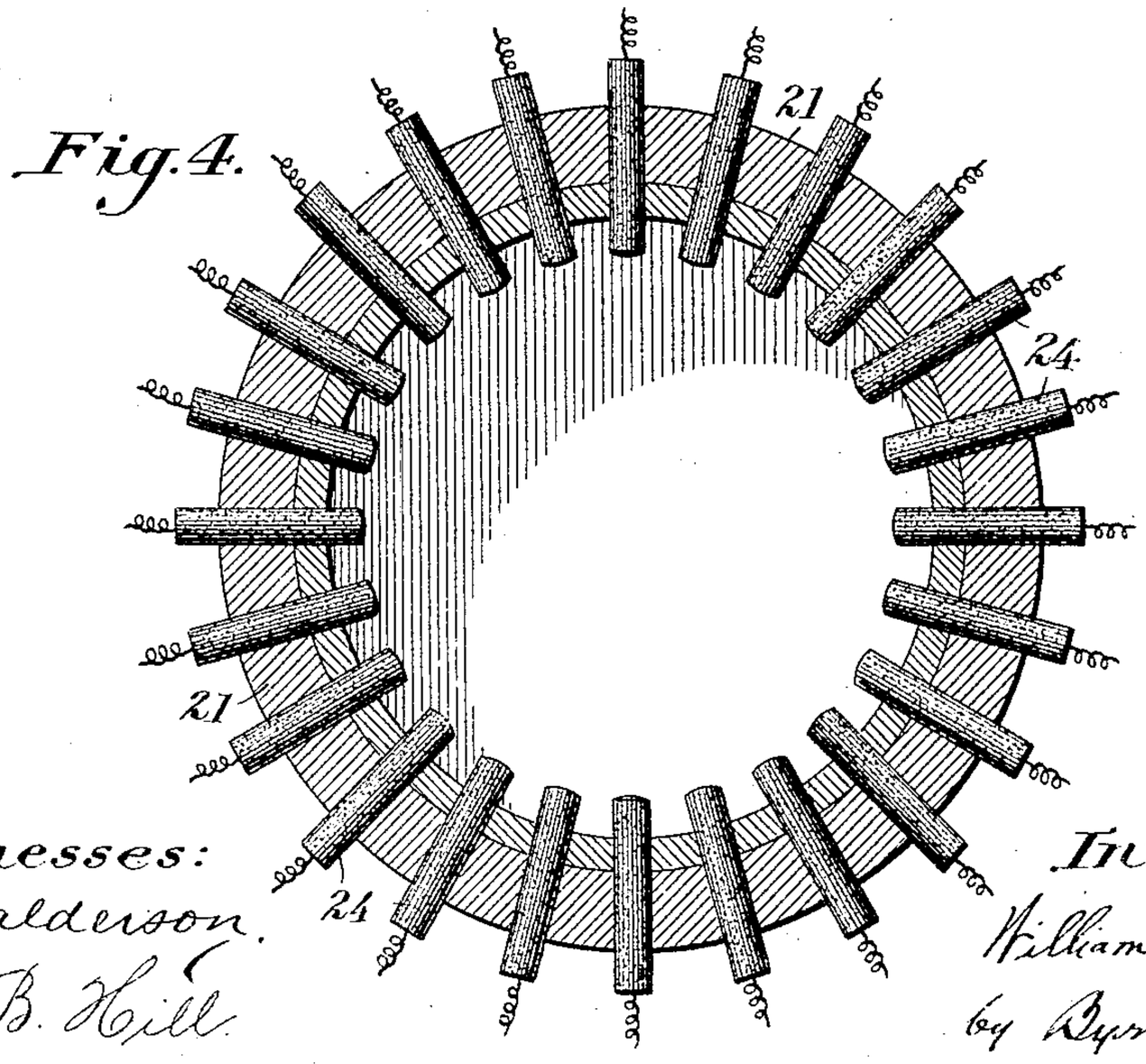


Fig. 4.



Witnesses:
R. A. Balderson.
J. B. Hill.

Inventor:
William Smith Horry,
by Byrnes & Townsend,
Att'ys.

No. 771,250. Patented October 4, 1904

UNITED STATES PATENT OFFICE.

WILLIAM SMITH HORRY, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO UNION CARBIDE COMPANY, OF NIAGARA FALLS, NEW YORK, A CORPORATION OF VIRGINIA.

APPARATUS FOR ELECTRIC HEATING.

SPECIFICATION forming part of Letters Patent No. 771,250, dated October 4, 1904.

Application filed June 28, 1904. Serial No. 214,484. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM SMITH HORRY, a subject of the King of Great Britain, residing at Niagara Falls, in the county of Niagara and State of New York, have invented certain new and useful Improvements in Apparatus for Electric Heating, of which the following is a specification.

This invention relates to apparatus for electrically heating a body of conducting material, especially a mixture of a metallic compound and a reducing agent and specifically a mixture of lime and carbon, for the production of calcium carbid.

The invention contemplates the use of a polyphase alternating current, preferably one with many phases, the paths of the several phases being so distributed within the conducting-body as to effect an even heating thereof.

The invention is carried out by causing different phases of the current to simultaneously flow along paths which cross each other through the body and causing each phase to traverse a path of resistance corresponding to the electromotive force of that phase.

The body to be heated is preferably a circular disk, the active terminals of the source of polyphase current being placed substantially in contact with the body at various equidistant points around its periphery and the terminals between which the maximum potential difference is set up being arranged at opposite ends of a diameter of the circular disk, this diameter successively shifting between successive pairs of opposite terminals following the shifting phases in the windings of the dynamo or other source of current.

Referring to the accompanying drawings, Figure 1 is a diagram illustrating the heating of a circular disk by a current of six phases having twelve active terminals arranged in contact with the edge of the disk. Fig. 2 is a horizontal section of a square electric furnace employing a current of two phases, the current being distributed to the electrodes by transformers whose windings are shown in diagram; and Figs. 3 and 4 are a vertical axial section and a horizontal section, respectively, of an electric stack-furnace designed for the commercial utilization of the invention.

The circular body to be heated (shown in Fig. 1) may be a disk of metal or a metallic crucible, but is more especially a layer of calcium carbid or of carbid-forming materials, such as exists in the lower part of the furnace shown in Figs. 3, 4 when in normal working operation. The terminals of the source of polyphase current, here shown as twelve in number, are placed substantially in contact with the edge of the disk at equidistant points, (numbered 1 to 12.) The source of current may be a dynamo having a fixed external armature consisting of a circular Gramme ring with continuous winding, leads being taken out from the winding at twelve equidistant points to the several terminals in contact with the disk. Within the armature is a bipolar revolving field. The maximum electromotive force of this generator is assumed to be two hundred volts and the current carried by the maximum volts to be passing between the terminals 1 and 7 of Fig. 1, fall of potential in the dynamo and conductors being neglected. A number of currents will then simultaneously flow through the disk along paths indicated by the broken lines, the potential difference between the terminals at the end of each path of current-flow being indicated by the numerals applied to the several lines. It will thus be seen that the electromotive force tending to drive a current along each path substantially corresponds to the resistance of that path, thus giving an equal current along every line. As the field revolves within the dynamo the phase of maximum electromotive force shifts from terminals 1 7 to 2 8 and then to 3 9, and so on. It will thus be seen that the disk is heated to a practically uniform temperature throughout.

Figs. 3 and 4 show a furnace for the production of calcium carbid designed to receive a current of two thousand kilowatts or more. The furnace comprises an annular stack 21, of refractory material, such as firebrick, having at its upper end a suitable mechanism 22 for introducing raw material

and preventing the escape of gas, here shown as a bell and hopper. Through the side of the stack, near its upper end, passes a flue 23 for withdrawing the waste gases. Near the lower portion of the stack are arranged one or more horizontal series of radial electrodes 24, here shown as cylindrical carbon-rods passing adjustably through the sides of the stack. Each horizontal series comprises twenty-four electrodes, each connected to one terminal of a dynamo or transformer giving a current of twelve phases. A tap-opening 25 for the molten carbid extends through one side of the stack near its lower end. This tap-opening, however, may be closed and the carbid maintained at or above the level of the electrodes, in which case it can be tapped off through one of the openings which receives an electrode upon withdrawing the latter, such as the lower right-hand electrode 24′ in Fig. 3. In employing this furnace to produce calcium carbid an initial charge consisting of lime and carbon is fed in through the top of the furnace. This charge may be the well-known one containing large pieces of coke, which lie in contact with each other at various points, and thereby afford direct paths for the flow of current, the lime being distributed in the interstices between pieces of coke. If the normal charge, however, consists of a non-conducting mixture of coke and lime, the furnace must be first put in operation by the use of a conducting charge or by otherwise providing initial paths for the flow of current. As soon, however, as current passes through a conducting-body in the lower part of the furnace the temperature soon rises to a point where the charge above is preheated by conduction and radiation and by the waste gases rising from the zone of reduction to a temperature which will enable it to act as a resistance-conductor when it descends into the paths of current-flow. In normal working condition the body of material between the electrodes may consist of molten or partly-molten carbid or of incandescent but unreduced material, or in part of both. The reduction is carried out in a continuous manner by tapping out the molten carbid and supplying fresh material as required. As the current density for each electrode cannot be carried above a certain limit, the total energy which can be employed in heating the charge depends on the number of electrodes, which may be increased as desired either by arranging a greater number in the same horizontal series or by using any desired number of superposed horizontal series. The use of a large number of electrodes is a desirable feature, since it permits the use of relatively small electrodes without unduly heating them or their terminal connections. The use of a current of a large number of phases avoids certain difficulties incident to a single-phase current. Practically the maximum voltage of the generator is always maintained between one pair of electrodes, the working current thus being the maximum current of the generator instead of varying from zero to a maximum. For the same reason the total cross-section of the electrodes may be smaller than for a furnace of the same capacity using single-phase current, effecting a saving in this respect of about thirty per cent., by weight. Any electrode may also be removed and replaced by another without noticeably interfering with the operation of the furnace. It is evident that by this invention the advantages of the direct current are retained without subjecting the furnace charge to the electrolytic effect that accompanies such current.

A circular furnace is preferred, since it exposes a minimum periphery for the loss of heat by radiation. The furnace may, however, be polygonal or square. Fig. 2 shows a square furnace 25 in horizontal section through the electrodes. A group of four electrodes 26 is shown passing through each side of the furnace. The current for this furnace is furnished by a system of transformers the windings of which are shown in diagram. Two distinct single-phase transformers are employed each receiving a separate current at a potential difference of, say, two thousand volts. Each of these transformers has two independent secondary windings arranged to generate an electromotive force of, say, fifty volts. In the figure, A B indicates the single primary winding of one transformer, A′ B′ the first secondary winding, and A^2 B^2 the second secondary winding. The single primary winding of the second transformer is marked C D and the corresponding first and second secondary windings C′ D′ and C^2 D^2, respectively. The current through primary C D should lag one quarter-phase behind that through primary A B. The two transformers are thus equivalent to a single one receiving two-phase current. Terminals are led out from the ends of the first secondary of one transformer to the end electrodes of one group of four and from the ends of the other secondary of the same transformer to the end electrodes of the opposite group of four. The intermediate electrodes of each group are connected to intermediate points of the corresponding secondary. The maximum electromotive force is thus applied to opposite electrodes; but current also flows across the furnace from each electrode to all the others. The two transformers thus furnish substantially an eight-phase current and a fairly uniform heating of the furnace charge is effected.

I claim—

1. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to flow along paths which cross each other through said body, as set forth.

2. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to simultaneously flow along paths which cross each other through said body, as set forth.

3. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to flow along paths which cross each other through said body and for progressively shifting the path of the phase of maximum electromotive force, as set forth.

4. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to simultaneously flow along paths which cross each other through said body and for progressively shifting the path of the phase of maximum electromotive force, as set forth.

5. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to flow along paths which cross each other through said body and for causing each phase to traverse a path of resistance corresponding to the electromotive force of that phase, as set forth.

6. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to simultaneously flow along paths which cross each other through said body and for causing each phase to traverse a path of resistance corresponding to the electromotive force of that phase, as set forth.

7. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to flow along paths which cross each other through said body, for progressively shifting the path of the phase of maximum electromotive force, and for causing each phase to traverse a path of resistance corresponding to the electromotive force of that phase, as set forth.

8. An apparatus for electrically heating a body of conducting material, comprising means for causing different phases of a polyphase current to simultaneously flow along paths which cross each other through said body, for progressively shifting the path of the phase of maximum electromotive force, and for causing each phase to traverse a path of resistance corresponding to the electromotive force of that phase, as set forth.

9. An apparatus for electrically heating a body of conducting material, comprising a source of polyphase current and active terminals placed substantially in contact with the body at such points that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other through said body, as set forth.

10. An apparatus for electrically heating a body of conducting material, comprising a source of polyphase current and active terminals placed substantially in contact with the body at such points that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other through said body, and that each phase traverses a path of resistance corresponding to the electromotive force of that phase, as set forth.

11. An apparatus for electrically heating a circular body of conducting material, comprising a source of polyphase current and active terminals placed substantially in contact with the body at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other through said body, as set forth.

12. An apparatus for electrically heating a circular body of conducting material, comprising a source of polyphase current and active terminals placed substantially in contact with the body at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other through said body, and that each phase traverses a path of resistance corresponding to the electromotive force of that phase, as set forth.

13. An apparatus for electrically heating a circular body of conducting material, comprising a source of polyphase current and active terminals placed substantially in contact with the body at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other through said body, and that each phase traverses a path of resistance corresponding to the electromotive force of that phase, with the phase of maximum electromotive force passing substantially along a diameter of the circular body, as set forth.

14. An apparatus for electrically reducing a circular body consisting of a mixture of a compound and a reducing agent, comprising a source of polyphase current and active terminals placed substantially in contact with the body or the products of reduction thereof at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other, as set forth.

15. An apparatus for electrically reducing a circular body consisting of a mixture of a compound and a reducing agent, comprising a source of polyphase current and active terminals placed substantially in contact with the body or the products of reduction thereof at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other, and that each

phase traverses a path of resistance corresponding to the electromotive force of that phase, as set forth.

16. An apparatus for producing carbids by electrically heating a body of carbid-forming materials, comprising means for causing different phases of polyphase current to pass through said body or the carbid produced therefrom, along paths which cross each other, as set forth.

17. An apparatus for producing carbids by electrically heating a body of carbid-forming materials, comprising means for causing different phases of polyphase current to pass through said body or the carbid produced therefrom, along paths which cross each other, and for causing each phase to traverse a path of resistance corresponding to the electromotive force of that phase, as set forth.

18. An apparatus for producing carbids by electrically heating a circular body of carbid-forming materials, comprising a source of polyphase current and active terminals placed substantially in contact with the body or the carbid produced therefrom, at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other, as set forth.

19. An apparatus for producing carbids by electrically heating a circular body of carbid-forming materials, comprising a source of polyphase current and active terminals placed substantially in contact with the body or the carbid produced therefrom, at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other, and that each phase traverses a path of resistance corresponding to the electromotive force of that phase, as set forth.

20. An apparatus for producing carbids by electrically heating a body of carbid-forming materials, comprising means for causing different phases of polyphase current to pass through said body or the carbid produced therefrom, along paths which cross each other, and means for tapping off the molten carbid and feeding in fresh materials as required, as set forth.

21. An apparatus for producing carbids by electrically heating a body of carbid-forming materials, comprising means for causing different phases of polyphase current to pass through said body or the carbid produced therefrom, along paths which cross each other, and for causing each phase to traverse a path of resistance corresponding to the electromotive force of that phase, and means for tapping off the molten carbid and feeding in fresh materials as required, as set forth.

22. An apparatus for producing carbids by electrically heating a circular body of carbid-forming materials, comprising a source of polyphase current and active terminals placed substantially in contact with the body or the carbid produced therefrom, at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other, and means for tapping off the molten carbid and feeding in fresh materials as required, as set forth.

23. An apparatus for producing carbids by electrically heating a circular body of carbid-forming materials, comprising a source of polyphase current and active terminals placed substantially in contact with the body or the carbid produced therefrom, at such points around its periphery that different phases of the current simultaneously flow between several of said terminals and along paths which cross each other, and that each phase traverses a path of resistance corresponding to the electromotive force of that phase, and means for tapping off the molten carbid and feeding in fresh materials as required, as set forth.

24. An apparatus for electrically heating a body of conducting material, comprising a series of removable electrodes placed substantially in contact with the body at various points around its periphery, and means for causing different phases of a polyphase current to simultaneously flow between several of said electrodes and along paths which cross each other through said body, as set forth.

25. An apparatus for electrically melting a body of conducting material, comprising retaining-walls, a series of removable electrodes passing through the walls and substantially in contact with the body at various points around its periphery, and means for causing different phases of a polyphase current to simultaneously flow between several of said electrodes and along paths which cross each other through said body, the arrangement being such that the removal of one of the electrodes permits the molten product to escape through the opening left thereby, as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM SMITH HORRY.

Witnesses:
E. F. PRICE,
GEO. H. DANFORTH.