J. THOMSON.

ELECTRIC FURNACE.

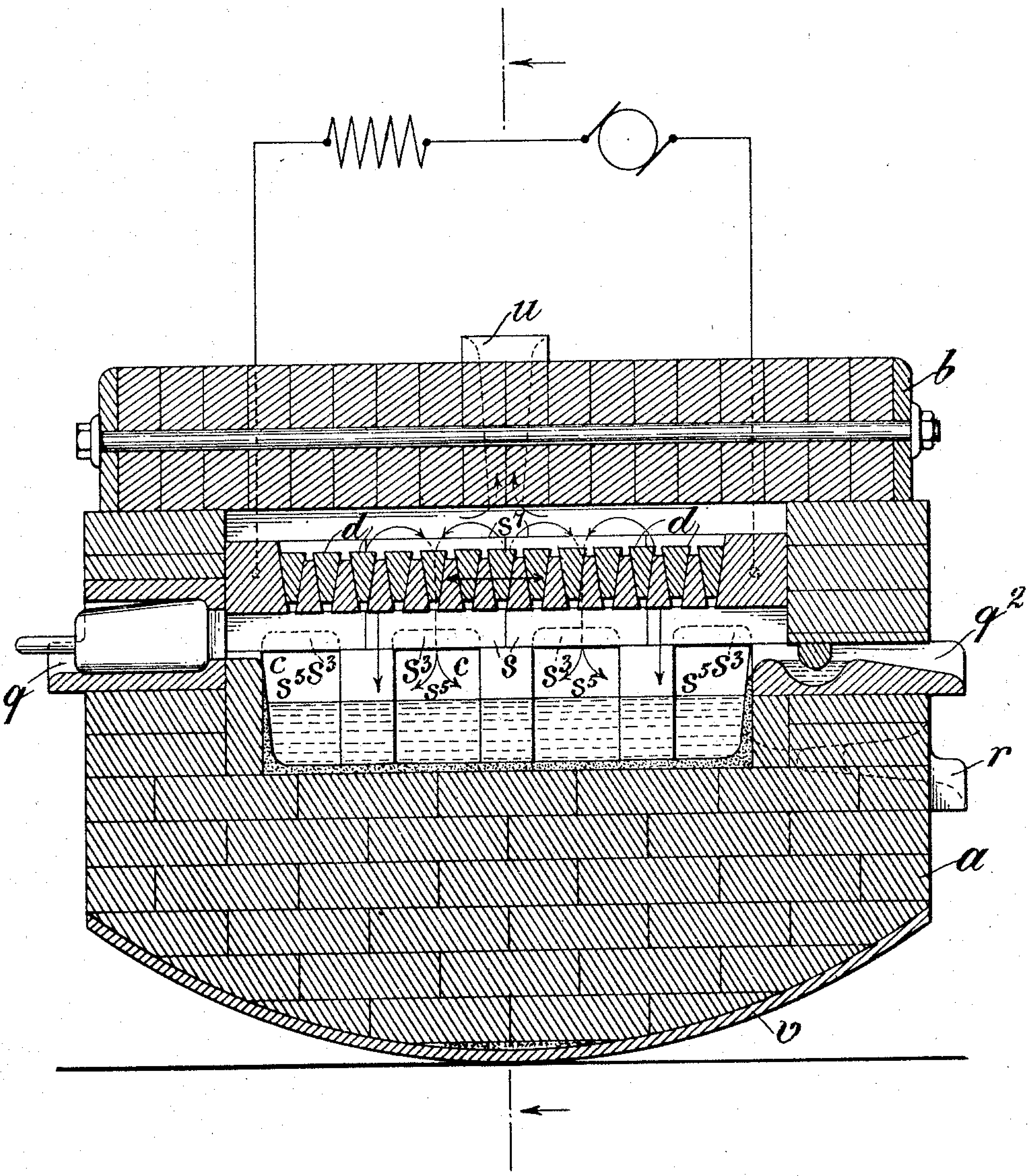
APPLICATION FILED MAY 13, 1909.

950,877.

Patented Mar. 1, 1910.

5 SHEETS—SHEET 1.

Fig. 1.



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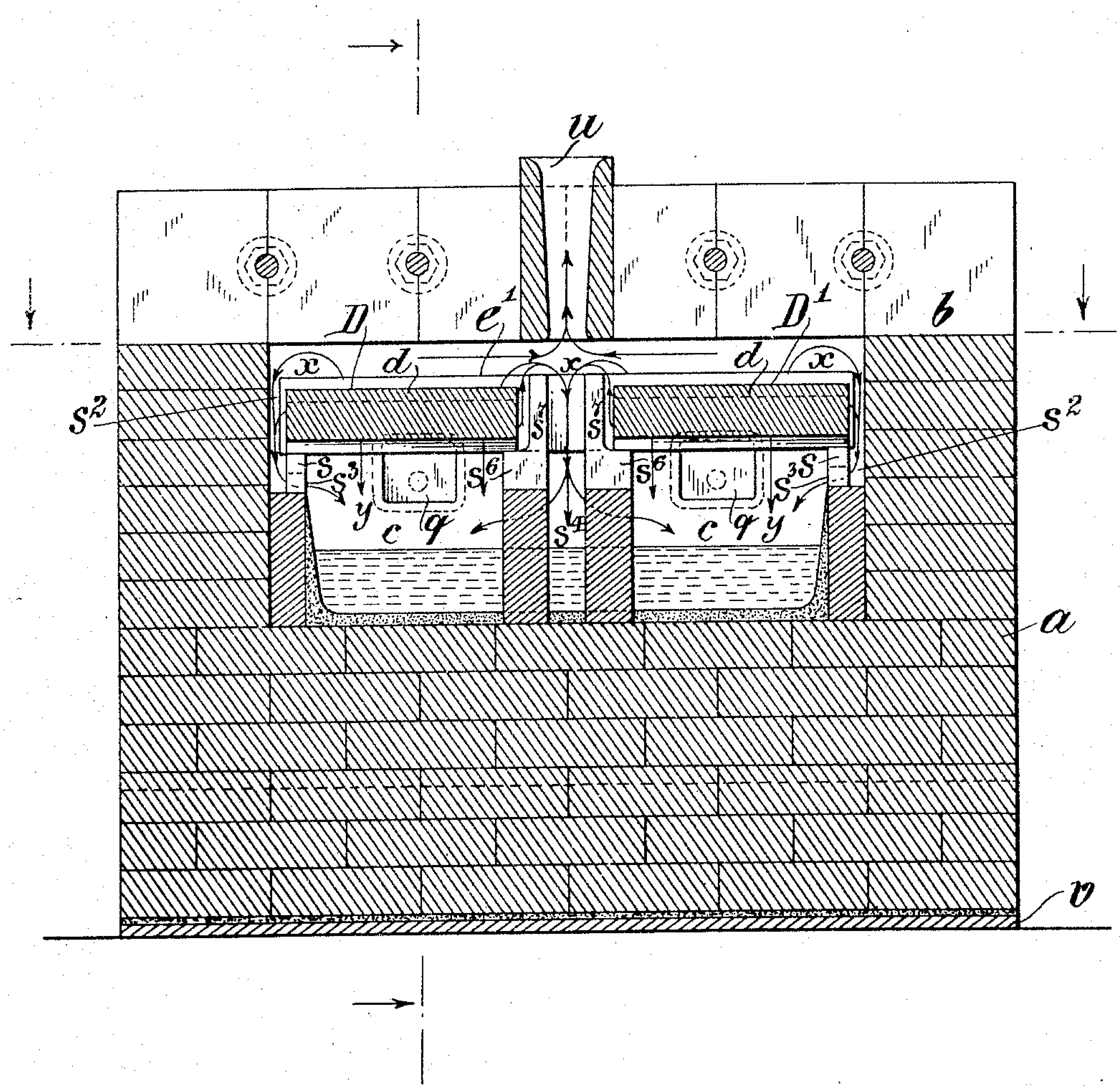
5 SHEETS—SHEET 2.

Fig. 2.



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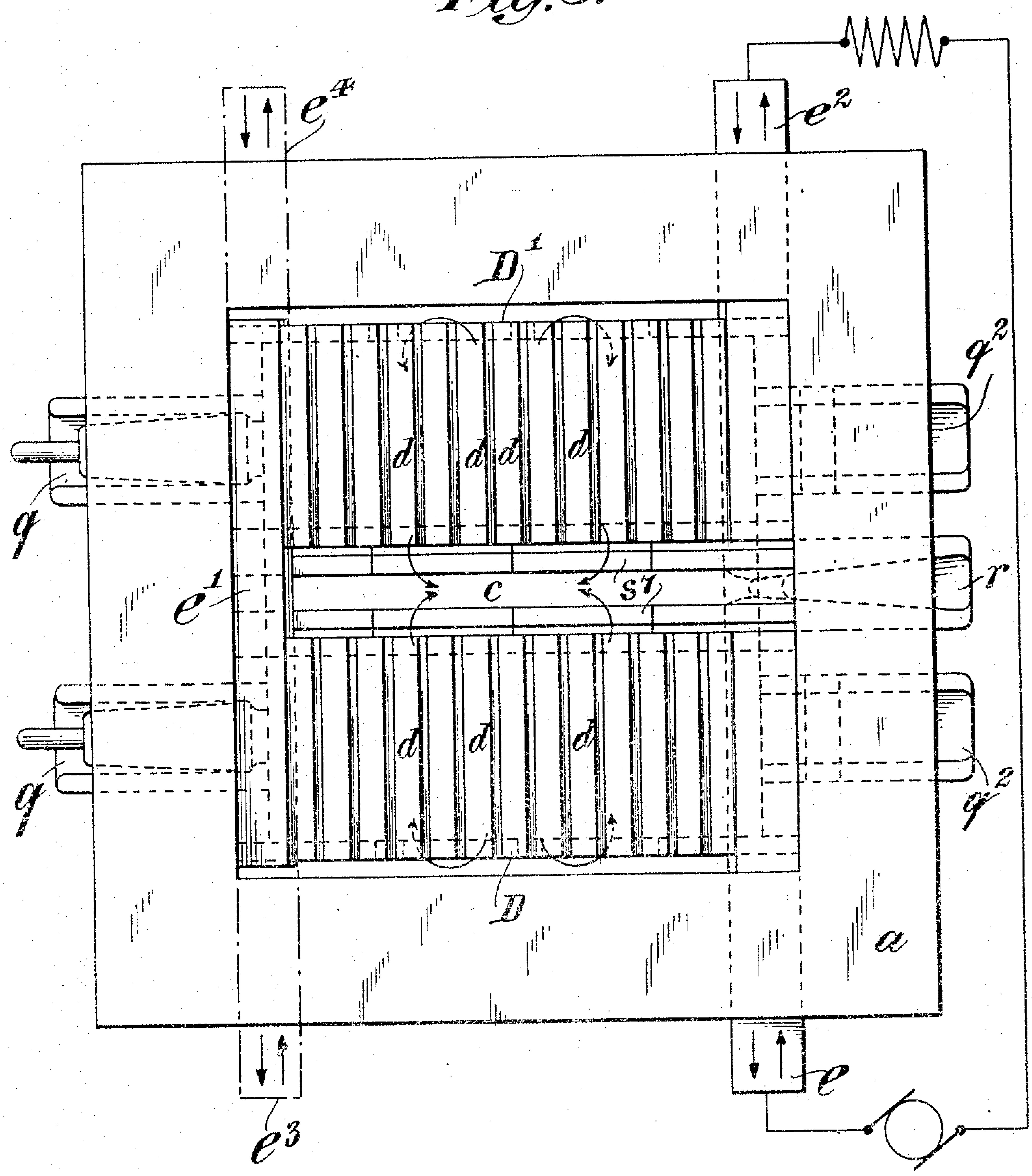
5 SHEETS—SHEET 3.

Fig. 3.



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5 SHEETS—SHEET 4.

Fig. 4.

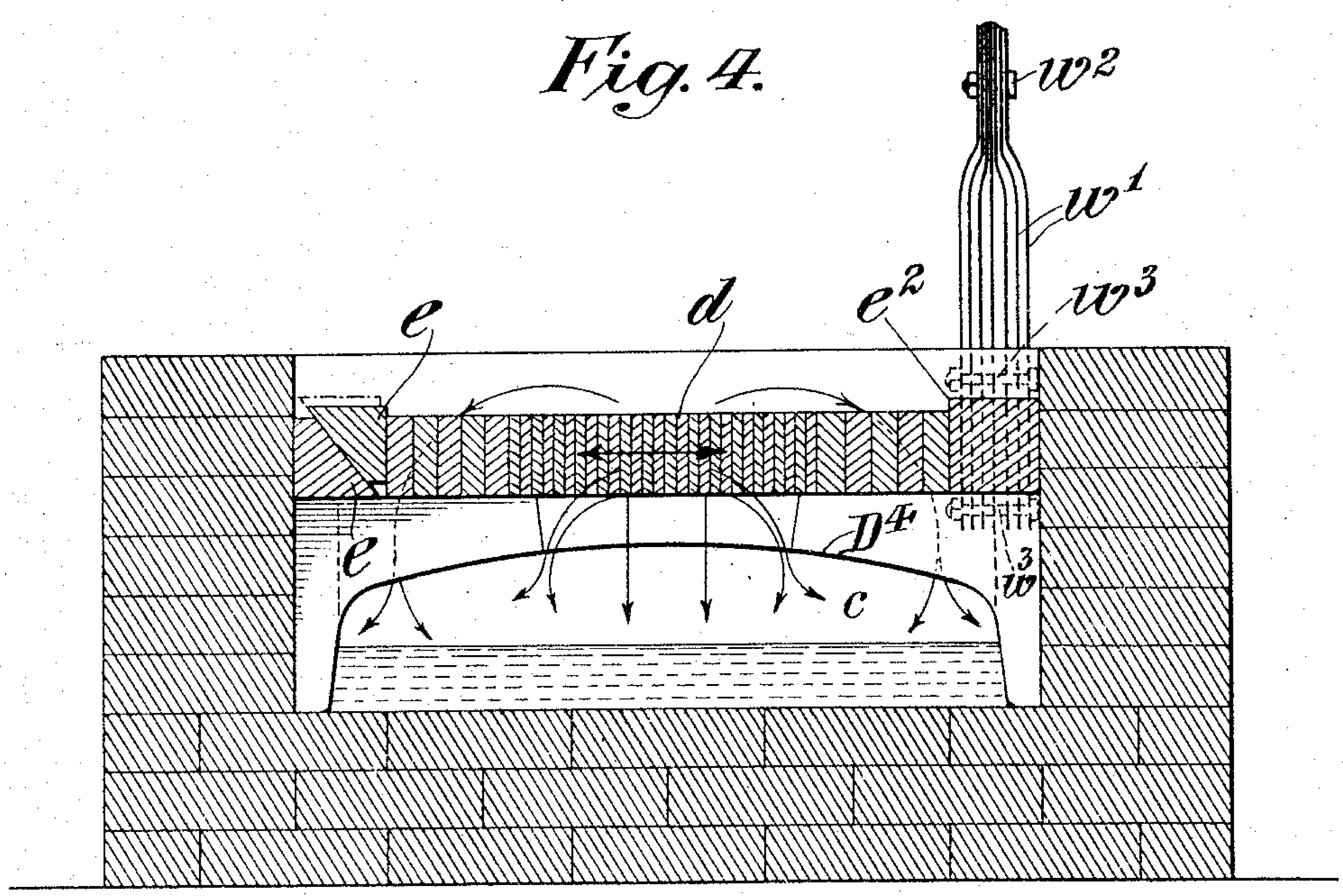
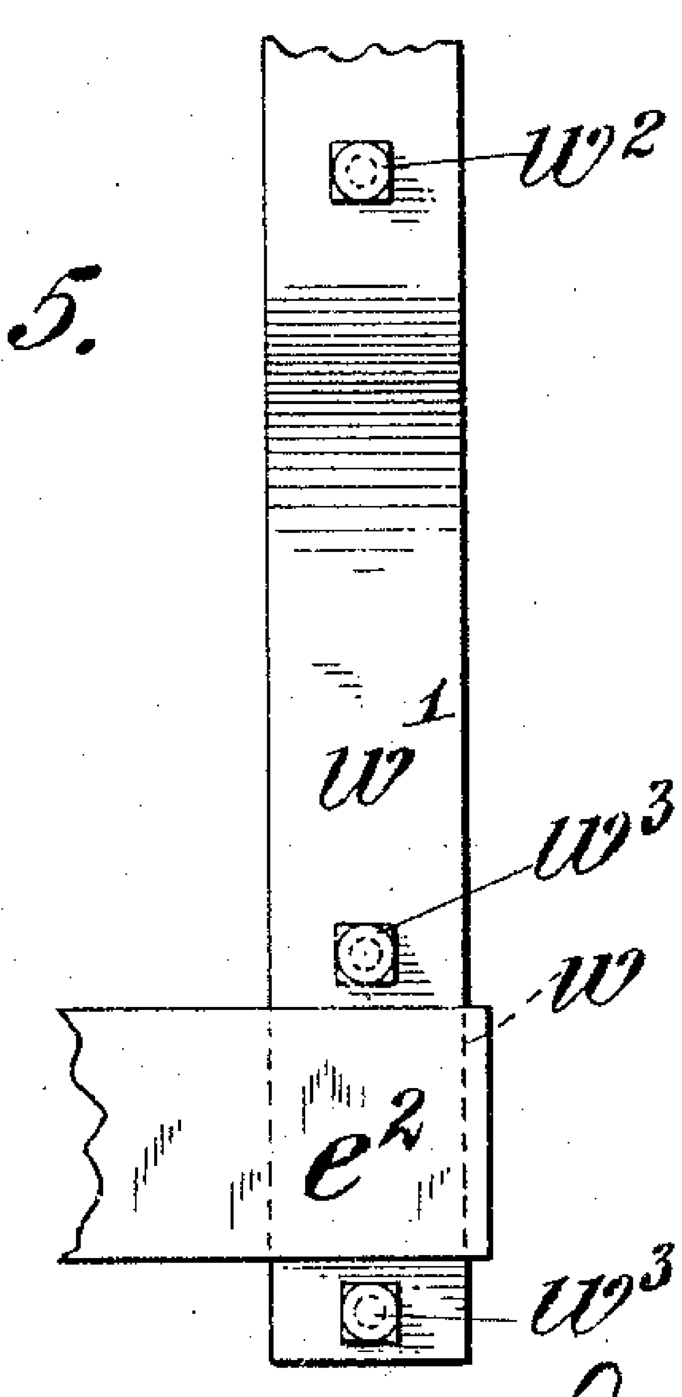


Fig. 5.



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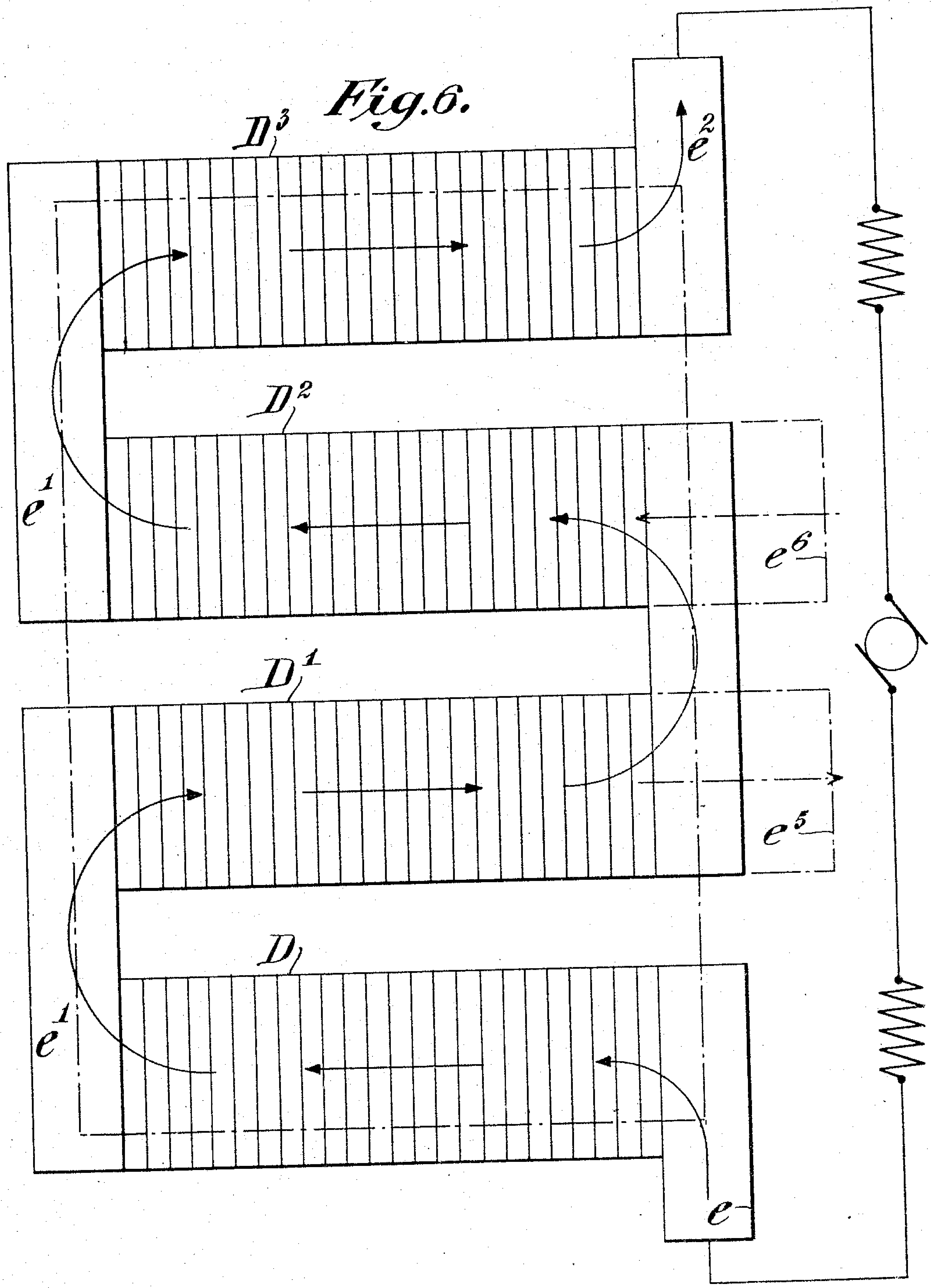
5 SHEETS—SHEET 5.

Fig. 6.



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UNITED STATES PATENT OFFICE.

JOHN THOMSON, OF NEW YORK, N. Y., ASSIGNOR TO IMBERT PROCESS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRIC FURNACE.

950,877. Specification of Letters Patent. **Patented Mar. 1, 1910.**

Application filed May 13, 1909. Serial No. 495,577.

To all whom it may concern:

Be it known that I, JOHN THOMSON, a citizen of the United States, and a resident of the borough of Manhattan of the city of New York, in the county and State of New York, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

The invention relates more particularly to improvements in resisters for electric furnaces and has to do not alone with the construction of the resister but also with its arrangement in and relation to the other parts of the furnace.

The general object of the invention is to provide a resister which by its construction and location shall be capable of maintaining substantially constant current conditions in and throughout the furnace or melting chamber. Such object is realized, in accordance with the present improvements, by forming the resister from a plurality of parts, preferably of carbon, which are superimposed above the furnace chamber and which parts are arranged so as to be displaceable with respect to each other or capable of being articulated as a whole in order that, notwithstanding fluctuations of heat or current, a practically uniform intensity of pressure or intimacy of contact may be preserved within and between said elements respectively; by providing for the free escape from the entire surface of the resister of the heat as well as its circulation to the furnace chamber; by adapting the resister to any of the usual commercial ranges of voltage or to safe limitations of current density; and by adapting the resister and its coördinating elements for a wide range of application in any desired capacity of charge whether operated intermittently or continuously.

In the drawings, Figure 1 is a view in longitudinal vertical section of a furnace embodying the invention. Fig. 2 is a view in transverse central section. Fig. 3 is a plan view with the cover removed. Fig. 4 is a view in longitudinal vertical section showing the modification. Fig. 5 is a detail view, on a slightly larger scale, of one of the terminals with its metallic connection secured thereto, and Fig. 6 is a sort of diagrammatic view showing in plan how the resister may be multiplied or divided, as will be referred to more particularly hereinafter.

It is contemplated that the elements or parts which are employed to form the resister will be made of carbon, and while the invention is not limited to the use of any particular substance for this purpose, the improvements will be explained and described with particular reference to a carbon resister. The carbon of commerce used for electrical purposes and produced by extrusion and by molding usually expands and may somewhat distort when heated. Hence, if a number of carbon plates are rigidly confined and heated by passing through them an adequate electric current the condition of the circuit, electrically, will be changed by the compression acting upon the material itself and also by increasing or decreasing the intimacy of the contacts. Or, as it has been formulated, the electrical resistivity will vary inversely as the pressure. The consequence of this is that the expansion and contraction of the resister will in itself act to increase the difficulty of accurately controlling the temperature.

In the resister the foregoing objection is obviated by forming its elements or parts of wedge-shaped sections (Figs. 1, 2 and 3), alternately reversed, so that a direct right and left hand thrust due to expansion will cause the parts marked *d* to rise, and upon re-contraction to fall. In Fig. 4, the parts or elements which comprise the resister are parallel plates which abut against beveled conductor blocks *e;* hence the effect of expansion will cause one of the blocks to rise, as shown in dotted outline, and *per contra* it will fall, thrusting the plates laterally and maintaining the initial contacts. In the manners just described the constancy of the resistivity is well maintained; that is to say it becomes feasible, with ordinary electrical apparatus, to maintain a practically constant temperature, and moreover, as the resister is thereby receptive to a uniform delivery of heat units, its endurance is greatly enhanced.

To obtain the utmost compactness of structure and thus minimize the loss of heat by radiation, to use the higher range of voltages, whereby the operation may be conducted with ordinary commercial apparatus, and to avoid the construction of resister-sections of excessive length, which would be more expensive and difficult to produce with accuracy, I prefer to dispose the resister in the general form of a loop or a series of loops folded back and forth and generally connected in direct circuit. Thus, as shown in its simplest form when compounded, the resister D (Figs. 2 and 3) has a parallel and corresponding resister D′ having a connector block e' preferably of pure graphite, and two terminal blocks e, e^2 preferably of amorphous carbon. Assuming the current as entering at e it will then pass forwardly through the resister D then transversely through the connector e' then backwardly through the resister D′ and finally out at the terminal e^2. In this wise the furnace a and the melting chamber c may be square in plan and yet the length of the resister-circuit, and consequently its resistivity, will be as great as if the furnace were about twice the length and half the width of that shown. On the other hand, if the conditions are such that a lesser resistance is desirable, this compactness of structure may still be retained by substituting two additional terminals, as denoted by the dotted outlines e^3, e^4 (Fig. 3). In this instance, current would enter, say at e, pass through the resister D and out at e^3; and entering at e^2, pass through the resister D′ and out at e^4, that is the two resisters would then be in multiple circuit. Again, for furnaces of large capacity, or where still higher resistivity is desired, a number of resisters, as D, D′, D^2, D^3 (Fig. 6) may be double compounded in direct circuit, the current flowing as indicated by the arrows; and still again the resistance of this circuit may be divided by substituting for the connector two intermediate terminals e^5, e^6 denoted in dotted outlines, whence two sets of compound resisters would then be operative in multiple circuit, the currents flowing as shown by the broken arrows.

To utilize the heat given off by the resister is a matter of prime importance and this is effectively realized by the method of superimposing or suspending the resister immediately above the furnace or melting chamber c. This can be realized, in a practicable manner, by supporting the outer ends of the resister parts on refractory bricks s (Figs. 1 and 2) resting on projections of the furnace walls the inner ends correspondingly resting on refractories s^6 supported by a sub-series of refractories rising from the furnace hearth. It is to be particularly observed that the refractories just referred to are so spaced, disposed and formed as to leave free spaces s^2 at the ends of the resister, wide openings s^3 through the side refractories, a free longitudinal space s^4 between the intermediate supports, and lateral openings s^5. In addition, the upper surface of the resister is situated sufficiently below the lower face of the cover b to leave a free space. The result of this design is that all portions of the surface of the resister, excepting the limited areas in contact with the supporting refractories, are in space and that the radiated heat is free to flow and fill the furnace chamber, as denoted by the arrows x which indicate the flow from the ends and upper surface, and arrows y which indicate the direct radiation from the lower surface. The two dominant advantages are that direct conduction of heat by physical contact of the highly heated resister with the brickwork is avoided, and, the flow of heat being uniform and alike from all portions of the resister, its electrical resistivity in so far as relates to the temperature of its mass is more readily maintained and is more promptly responsive to extraneous electrical control.

The inner supports s^6 are shown (Figs. 1, 2, 3) with upwardly extending portions s^7 which may be employed when the voltage is quite high serving as an insulating medium against cross-currents between the ends of the parallel resisters. So, too, if there should be a sensible leakage loss of current through the intermediate refractories downwardly to the bath and thence to ground, this may be avoided by using a refractory arch, as D^4 (Fig. 4).

An important practical detail in electric furnaces is the connection between the metallic cable and the carbon terminals. This feature is provided for by the simple expedient of sawing a series of slots w in the ends of the terminals e^2 (Figs. 4 and 5) into which thin bands of metal, as w' are inserted. These bands are caught together above w^2 and their ends preferably project through the terminals. By inserting bolts w^3 through the metal bands, above and below, no other machining of the terminals is required, and the intimacy of contact, together with the area thus obtained, insures a most perfect and enduring electrical connection. Moreover, a large surface area of the metallic conductor immediately contiguous to the terminal is thus exposed, quite sufficient under ordinary conditions to radiate the outwardly conducted heat without water-cooling.

It remains to be pointed out that in the aggregate the foregoing elements lend themselves admirably to the most important metallurgical operations. For instance, if the furnace is to be used in carrying on the reaction in the extraction of zinc, then the free spaces provided for the flow of heat afford equally effective passages for the evolving zinc vapor whose exit may be through the tubular opening u shown in the cover, and thence to suitable means for condensing. If it is desirable to withdraw melted metal from the top of the bath, or to introduce pre-fused metal, excluding the entrance of air, then the trapped spout q^2 may be employed. To charge the furnace or rake off slags, the openings q are available and to remove fused metal from the bottom of the bath is the function of the tap spout r.

To facilitate the foregoing manipulations, or to oscillate and mix the charge, the furnace may be mounted upon a curved metallic casing v resting upon a suitable foundation and provided with means to reciprocally rock the furnace or hold it at any angle desired. If, for any purpose, it is desirable to obtain a higher or a lower temperature in one or the other of the parallel resisters, this may be readily accomplished as in the manner shown in Fig. 4, where the central plates of the resister d are thinner than the end plates; the effect of which is to present greater resistance in the central section and consequently produce higher temperature.

The thermal efficiency of this furnace has been proven to be very high and the endurance of the resister, under long runs at high temperatures, is such that the cost of the carbons, comparative to the duty, is ordinarily negligible. As usually operated there is little or no tendency for air to enter the furnace chamber and hence oxidizing disintegration of the resister does not take place to a detrimental extent; and mechanical injury to or the gradual fritting away of the faces of the resister plates may go on to a considerable extent without materially affecting or interfering with the operation.

I claim as my invention:

1. An electric furnace provided with a resister of a constant length having a plurality of elements and means for preserving a substantially constant contact resistivity between the elements irrespective of expansion or contraction due to thermal changes.

2. An electric furnace provided with a resister of a constant length having a plurality of electrodes and constructed to adjust itself automatically to thermal expansions or contractions for the purpose of maintaining a substantially constant intimacy of contact between said elements.

3. An electric furnace having a plurality of resister elements transversely displaceable with respect to each other under changes of temperature.

4. An electric furnace provided with a resister of a constant length having a plurality of elements at least one of which is automatically movable with changes of temperature to preserve a substantially constant intimacy of contact throughout the aggregate.

5. An electric furnace provided with a resister having a plurality of wedge-shaped elements alternately reversed whereby any variation of pressure through the resister may be compensated for by relative movement between the elements.

6. An electric furnace provided with a resister of a constant length having a plurality of elements and means for preserving a substantially constant resistivity between said elements, the said resister being disposed above the melting chamber.

7. An electric furnace provided with a resister having a plurality of wedge-shaped elements alternately reversed and superimposed over the melting chamber.

8. In an electric furnace, the combination of a resister, and refractory supports for the same provided with openings for the circulation of heat.

9. In an electric furnace, the combination with the melting chamber of a cover therefor, said cover containing the resister which is thus superimposed over the chamber and is removable with the cover.

10. In an electric furnace, the combination of a resister having a plurality of elements, refractories along each side of the resister to support the ends of the resister elements, and a cover, said cover being formed with a free space above the resister, and the refractories having openings to connect the space above the resister with the melting chamber around the ends of the resister elements.

11. An electric furnace having two parallel resisters each formed of a plurality of elements through which the current passes transversely connected up in series and superimposed over the melting chamber.

12. In an electric furnace, the combination of two parallel resisters superimposed above the melting chamber, supports therefor on the sides of the chamber, and intermediate supports rising from the furnace hearth.

13. In an electric furnace, the combination of two parallel resisters each having a plurality of elements, refractories along the sides of the melting chamber to support the outer ends of said elements, and intermediate refractories supported from the furnace hearth to sustain the inner ends of said elements, said outer refractories having openings and said inner refractories being spaced apart so as to connect the spaces above and around the ends of said elements with the melting chamber.

14. In an electric furnace, the combination of a resister having a plurality of elements and a refractory arch to support the same over the melting chamber.

This specification signed and witnessed this 11th day of May, A. D., 1909.

JOHN THOMSON.

Signed in the presence of—
G. McGrann,
Lucius E. Varney.