J. THOMSON.

ZIGZAG CARBON ELECTRIC RESISTER.

APPLICATION FILED APR. 16, 1918.

1,298,421. Patented Mar. 25, 1919.

Fig. 2.

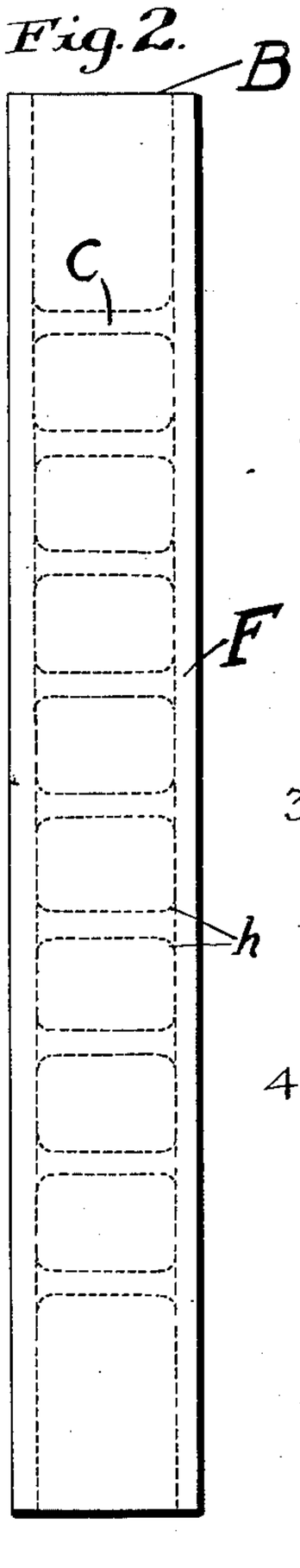


Fig. 1.

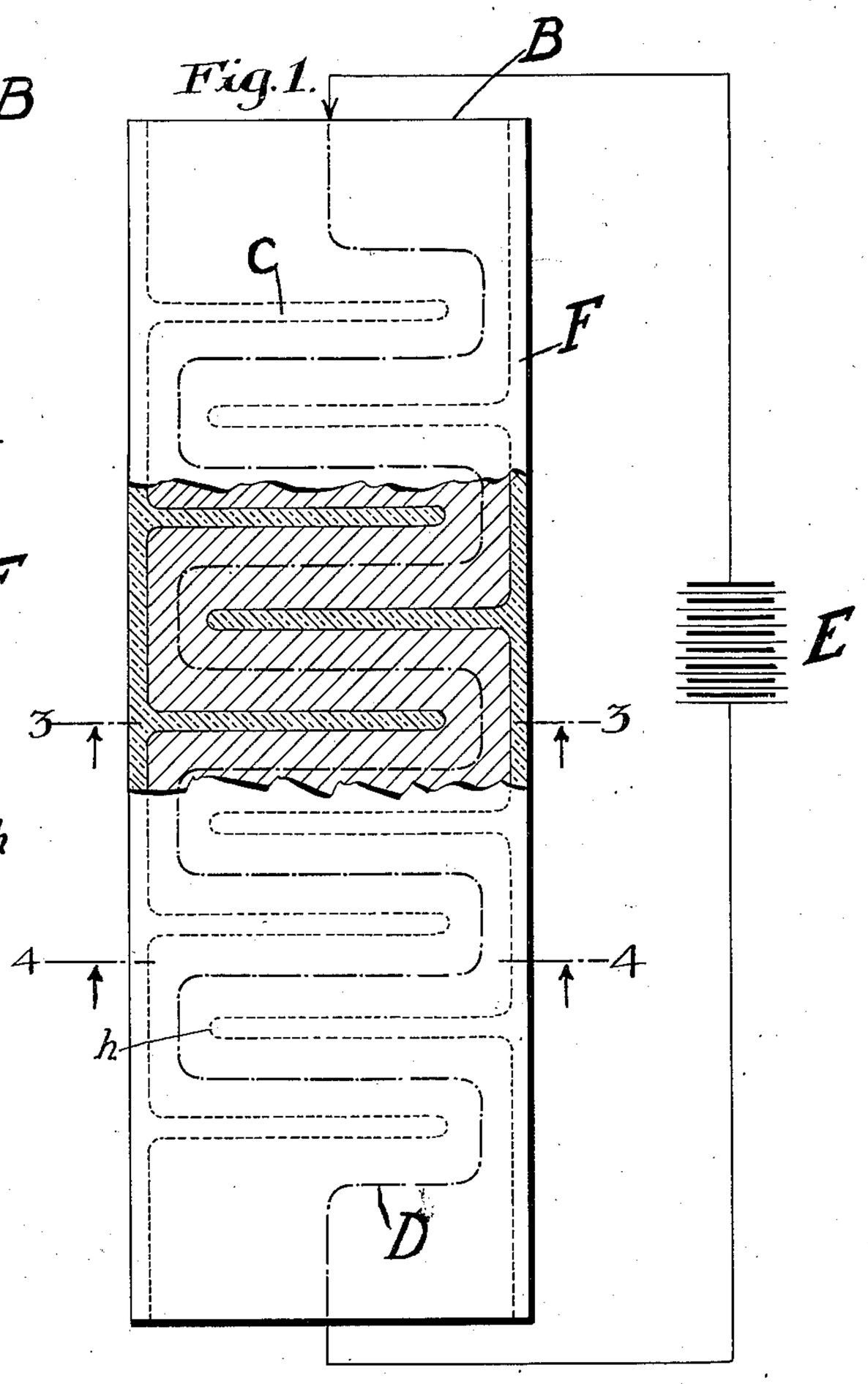


Fig. 3.

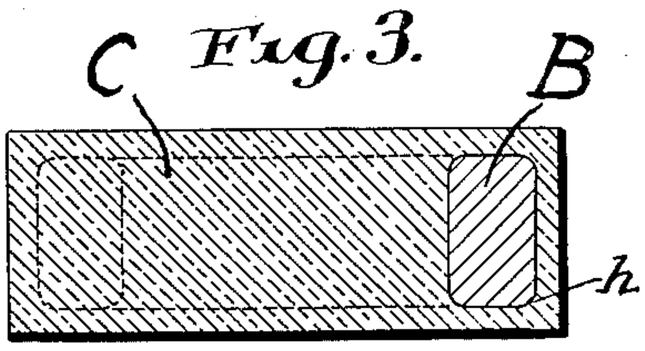


Fig. 5.

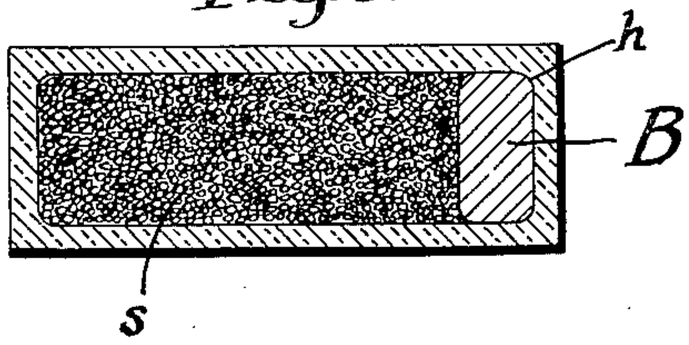
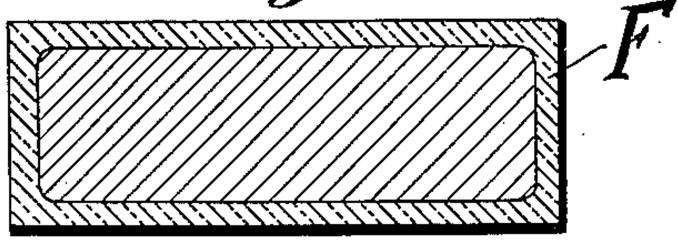


Fig. 4.



INVENTOR

John Thomson

BY

Kiddle & Thompson

HIS ATTORNEYS.

UNITED STATES PATENT OFFICE.

JOHN THOMSON, OF NEW YORK, N. Y.

ZIGZAG CARBON ELECTRIC RESISTER.

1,298,421. Specification of Letters Patent. Patented Mar. 25, 1919.

Application filed April 16, 1918. Serial No. 228,908.

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, city of New York, county and State of New York, have invented certain new and useful Improvements in Zigzag Carbon Electric Resisters, of which the following is a specification, reference being made to the accompanying drawings, forming a part thereof.

This invention relates to carbon resisters as employed in electric furnaces, usually in the form of rods, slabs or plates, in which a plurality of staggered slots are cut whereby to produce a lengthy sinuous circuit of restricted cross-section. A resister of this type is designated in common parlance a "zig-zag" resister.

An object of the present invention is to render the carbon element immune to oxidization or "air-burning", and to restore or maintain the stability of the slotted member so as to approximately equal that of the original rod, slab or plate from which it was formed.

In the accompanaying drawing forming a part of this specification there appear diagrammatic illustrations which denote how the invention may be realized. In said drawing,

Figure 1 is a plan view, partially broken away, of a zig-zag plate resister, such as might be used in various types of electric furnaces.

Fig. 2 is a side view thereof.

Fig. 3 is a transverse section through any of the slotted portions of the resister. It is a view taken as on the plane indicated by the line 3—3 of Fig. 1 looking in the direction of the arrows.

Fig. 4 is a transverse section through the solid portions of the resister; or, in other words, is a transverse view taken between the slotted portions of the resister. This figure is a view taken as on the plane indicated by the line 4—4 of Fig. 1 looking in the direction of the arrows.

Fig. 5 is a transverse section through a slotted portion of a resister and indicates a modification in the detail of carrying the invention into useful effect.

It is in accord with the facts to state that resisters of the type herein referred to possess a unique efficiency for transforming large units of power into heat and thence radiating or giving off said heat at high maintainable temperatures. The members from which they are made can be formed by die-squirting; viz., by squirting a mixture containing carbon through a die to form a longitudinally extending member, and either amorphous or graphitized carbon may be used. A resister made from a member thus formed has the utmost uniformity as to density and resistivity. But in order to employ such resisters in the arts, except in a few special instances, they must be placed within closed casings or chambers from which air is wholly excluded, else they will be quickly oxidized. Moreover, spacious chambers or protective casings present a more or less formidable obstruction to the rapid transfer therethrough of radiant heat. Then, too, the transverse stability of the slotted resister is manifestly much diminished over that of the member from which it was formed; so much so, in fact, that the slotted resisters usually require to be supported between their terminals.

According to the present invention the objectionable features are obviated and certain requirements are taken care of by filling the slots of the resister and by coating the surfaces of the resister, or such portions thereof as may be necessary, with a material, or mixture of materials, possessing the following characteristics:

The material or materials should have a coefficient of expansion and contraction nearly identical to that of the carbon of the resister. The material or materials should be of a character either to adhere or lie in close proximity to the carbon of the resister. The material or materials should be of a character which is a relatively good conductor of heat but a relatively good non-conductor of electricity, and it or they should be non-reactive with carbon and immune to oxidization.

The materials which have been ascertained as most fully meeting the requirements just specified are fused aluminum oxid and silicon carbid in its crystalline form, either of which may be mixed, to some minimum extent, with a binding substance of somewhat lesser refractability, such, say, as crucible-clays slightly moistened, as by water, silicate of soda, etc., whereby the mixture approximates the consistency of putty or a rather stiff paste or cement. All such mix-

tures, as when used for making crucibles, retorts or muffles, if the very best results are to be attained, must be subjected to a long period of low temperature curing and thereafter be baked in kilns, usually in an oxidizing atmosphere, yet it is seldom that the final kiln-temperature is as high as that to which the article is ultimately subjected.

Referring to the drawings, B represents a carbon plate in which a plurality of alternating slots C, have been formed, whereby the electric circuit becomes a zig-zag path, as shown by the line D, and thence passes to the source of energy E.

The protective coating F, having the physical characteristics already set forth, is then applied to such portions of the resister-surface as may be desired—in Figs. 1 and 2 the ends are shown exposed, as for connection with terminals—and the material is also packed into the slots, completely filling them, see Fig. 3. The next preferable step in the procedure is to somewhat dry the coating, as in a warm room or japanning oven. The final step is to place the resister in a power-circuit capable of voltage adjustment and progressively heating it, carrying the temperature up to a point which shall be somewhat higher than that to which the resister is to be subjected in service. In this wise, the final curing temperature is developed from within the coating, the moisture being expelled instead of being withdrawn, as in a kiln. As a consequence of this the effectiveness of the curing is enhanced and the period of time necessary for the treatment is much diminished. But the final curing of the sheathing, or envelop, needs not necessarily be carried out in the foregoing preferred manner in that it would be feasible to perform this operation in a kiln, because of the fact that the carbon would be protected from oxidization.

As the slots are filled with undisplaceable material, the transverse stability of the resister becomes substantially equal to that of the original plate, before the slots were formed; moreover, the material in the slots serves as very effective anchorages for the coating on the surfaces.

It is advantageous to remove all sharp edges from the carbon plate, leaving fillets or rounds, as *h*.

Normally, the electric resistance of a filled-in resister would be less than if the slots were open. However, this condition is satisfactorily adjustable to the requirements of practice by forming wider slots than would be necessary were they to remain unfilled; or, again, the slots may be filled with dry, unalloyed granular material, as *s*, Fig. 5, tamped into place before the cement is applied. Thus, the electric resistance across the slots is increased over that of a more solid substance, yet the broken particles in granular form, as sand, or in powdered form serve to support the sides of the slots and maintain the stability of the structure.

To justify the foregoing, it may be here stated, based upon various tests and performances, that, as the electromotive force from any single limb of the zig-zags crosswise of a slot to its contiguous member rarely exceeds from say, 1.5 to 2.5 volts, the drop in resistance, as a whole, is virtually negligible. Hence, it is both adequate and feasible, and in certain instances even more convenient, to first tamp or mold the material in the form of thin plates and then insert them in the slots, either dry or with a coating of cement to cause them to adhere. In this wise, even if an over-all coating or sheathing is not applied, the stability of the resister, especially when heated to a high temperature, is greatly increased.

In furnaces for melting non-ferrous metals, for heating steel billets to be forged, for refining zinc by redistillation and for various smelting operations the highest temperature required in the resister itself need not exceed, say 1500 degrees C. to 1700 degrees C., which is well within the capacity of a thin sheathing of aluminum oxid or silicon carbid to withstand without softening or setting-up a reaction with the carbon. The capacity of the carbon to transfer heat by conduction through such a shield and thence to the charge by radiation is theoretically diminished; but in a practical sense the amount of this diminution is a negligible quantity.

An important advantage of this invention is comprehended in the following:

The invention transposes a device of rather delicate construction of limited endurance and of restricted applicability into one which is robust in construction, is of long endurance and has a broad or well-nigh universal applicability.

What I claim is:

1. An electric, carbon, zig-zag resister whose slots are filled and whose exterior surfaces, or a major portion thereof, are coated with material relatively non-conductive to electricity, immune to oxidization and non-reactive with carbon.

2. An electric, carbon, zig-zag resister whose slots are filled with dry granular material and whose exterior surfaces, or a major portion thereof, are coated with the same material in the form of a baked cement, the said material being relatively non-conductive to electricity, immune to oxidization and non-reactive with carbon.

3. An electric, carbon, zig-zag resister, whose slots are filled and whose surfaces, or a major portion thereof, are coated with material which is relatively non-conductive to electricity, immune to oxidization and non-

reactive with carbon, the said material being cured or baked in place by heat developed in the resister.

4. An electric, carbon, zig-zag resister the slots of which are filled with relatively, electrically non-conducting material.

5. An electric, carbon, zig-zag resister the slots of which are filled with material relatively non-conductive to electricity and immune to oxidization.

6. An electric, carbon, zig-zag resister the slots of which are filled with material that is relatively non-conductive to electricity, the exterior of said resister or a major portion thereof being coated with material which is relatively non-conductive to electricity and immune to oxidization.

7. An electric carbon, zig-zag resister the slots of which are filled with material relatively non-conductive to electricity and which resister is surrounded substantially throughout its length by a coating of material relatively non-conductive to electricity, immune to oxidization and non-reactive with carbon.

8. An electric, carbon, zig-zag resister the slots of which have therein filling material and which resister has a surrounding coating that is relatively non-conductive to electricity, that is immune to oxidization and that is non-reactive with carbon.

9. An electric, carbon resister the slots of which are filled with fused aluminum oxid and silicon carbid in crystalline form.

10. An electric, carbon, zig-zag resister the slots of which are filled with material that is relatively non-conductive to electricity and which resister is surrounded by a coating of fused aluminum oxid and silicon carbid in crystalline form.

11. In the manufacture of electric resisters, the method which comprises squirting a mixture containing carbon through a die in order to form a longitudinally extending member, providing slots in said member in a manner that there results a zig-zag member, filling said slots with relatively electrically non-conducting material and surrounding said zig-zag member with a wet or moist material, partially drying moist material thus added, and finally passing electrical current through said zig-zag member and progressively heating it until the temperature reaches a point higher than that at which the resulting resister is to be used.

12. The method comprised in filling the slots of a carbon, zig-zag resister with material relatively non-conductive to electricity, non-oxidizable and non-reactive with carbon; enveloping the said resister with a sheathing which is also formed of material relatively non-conductive to electricity, non-oxidizable and non-reactive with carbon and curing the said sheathing in place.

This specification signed and witnessed this 13th day of April, A. D. 1918.

JOHN THOMSON.

Signed in the presence of—

J. R. AGNEW,

JOSEPH H. STEHN.