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A. L. BROUGHAM.

HEATING BAR FOR ELECTRIC FURNACES.

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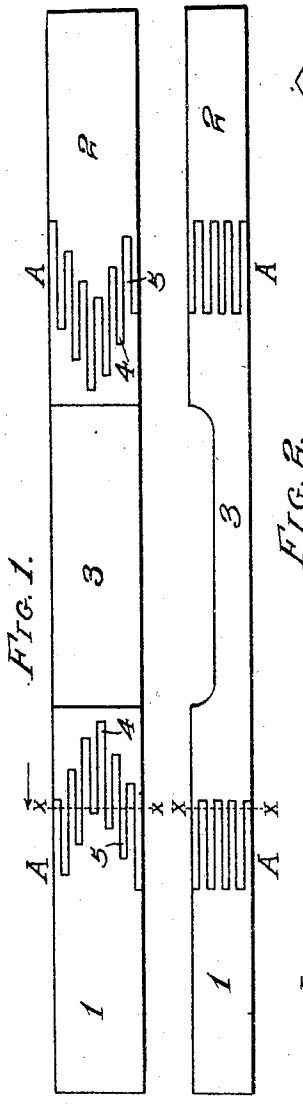


FIG. 1.

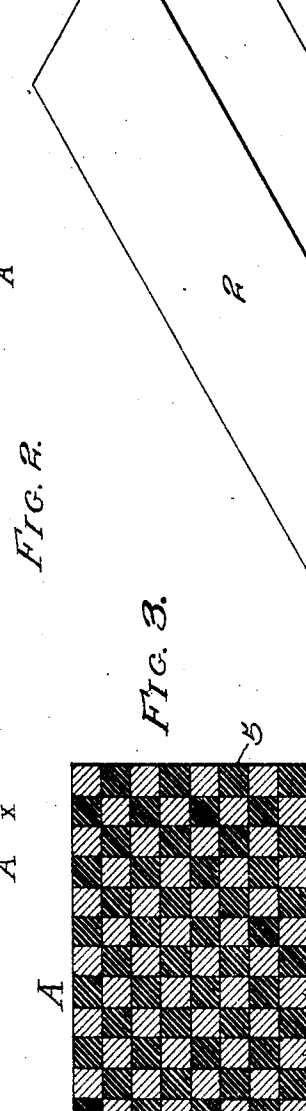


FIG. 2.

FIG. 4.

FIG. 3.

WITNESSES

John C. Kopf

K. Frankfort

INVENTOR

Archibald L. Brougham

BY HIS ATTORNEY

R. B. Stuckney

UNITED STATES PATENT OFFICE.

ARCHIBALD L. BROUGHAM, OF NEW YORK, N. Y.

HEATING-BAR FOR ELECTRIC FURNACES.

No. 857,381. Specification of Letters Patent. Patented June 18, 1907.

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To all whom it may concern:

Be it known that I, ARCHIBALD L. BROUGHAM, a citizen of the United States, residing in the borough of Brooklyn, New York city, in the county of Kings and State of New York, have invented certain new and useful Improvements in Heating-Bars for Electrical Furnaces, of which the following is a specification.

This invention relates to the construction of heating bars for use in electric heaters, ovens, furnaces, etc., particularly those in which it is desired to produce a very high degree of heat. In such furnaces, each heating bar usually comprises a heating portion and terminal portions joined thereto, the heating portion having high electrical resistance, so that it may be readily brought to an incandescent condition, and the terminal portions having relatively high conductivity. Considerable difficulty has been experienced in attempting to unite the terminal portions to the heating portion, owing to the liability of separation at the joints with consequent sparking or formation of arcs across the breaks, and loss of electrical power, as well as liability of destruction of the bar. Even when the terminal and heating portions of the bar have been carefully attached or united, it has been found that the unequal expansion at the joints, due to the greater heat of the resisting material over the material of the terminals, causes separation at the joints with resulting damage and inefficiency.

To overcome these and other objections, I have devised a bar in which the heating portion is anastomosed to the terminal portions, preferably by means of numerous oscula-tions, whereby the heating and terminal portions are not only well knit together, but whereby also numerous contacting surfaces are secured between the members.

In the preferred form of the invention, the members or parts of the bar have digitiform ends which are interdigitated, whereby opportunity is given for the electric current to pass not only from the ends, but also from the sides of the digitations of one member, into the ends and sides of the digitations of another member. These digitations are preferably about square in cross-section, and may readily be arranged to give between the members several thousand per cent more area of contacting surface than has been attained by the ordinary butt-joints heretofore attempted to be employed. Owing to the enormous area of contacting surface thus secured, the resistance to the flow of current between the members of the bar is reduced to a minimum, and it also results that if separations should occur at different points in the interdigitations, there would still remain more than ample contacting surface which would be unimpaired, so that no sparking would occur at the breaks.

The bar is preferably formed of carbon mixed with a binder, such as clay. For the terminals seventy per cent may be carbon and thirty per cent clay; and for the intervening heating portion of the bar thirty per cent may be carbon, and seventy per cent clay, the clay serving not only as a binder, but also as a resisting material in said intervening portion, whereby the latter may readily be brought if desired to incandescence. It will be understood that at the interdigitated portions of the bar, the general resistance to the current is less than in the body of the heating portion or member, said interdigitated portion being about half terminal and half heating portion. This portion of the bar therefore does not become incandescent, or heated by the current so much as the body of the heating portion, and hence there is little or no inequality in expansion of the material at the joints, and hence no consequent rupture sufficient to cause concern.

The interdigitations of each member consists preferably of numerous series of rows, and these are preferably arranged in echelon in such a manner that the digits of the terminals extend gradually farther and farther into the heating portion of the bar from the sides to the middle thereof, whereby the resistance of the bar, considered as a whole, is caused to increase gradually between the body of the terminal and the body of the heating portion, thus avoiding altogether abrupt gradations in the heat of the bar with consequent liability to rupture and injury, due largely to unequal expansion. In practice the middle of the bar when constructed according to my invention may at times be incandescent, while as the joints are ap-

proached, the color of the bar grows gradually duller, there being no color at or in the immediate vicinity of the joints, while the interdigitations remain relatively cool.

Other objects and advantages will hereinafter appear, by which I overcome the difficulties aforesaid, as well as other difficulties in the construction and operation of grate-bars.

In the accompanying drawings, Figure 1 is a plan or face view, and Fig. 2 a side or edge view of one form of an electric heating bar embodying my improvements. Fig. 3 is a section on an enlarged scale taken from the lines X—X of Figs. 1 and 2. Fig. 4 is a perspective view or diagram of a terminal to illustrate the rows of digits arranged in echelon.

The terminals are designated as 1 and 2, and the intervening portion or heating member as 3. Said members are interdigitated end to end at A. The digitations in the terminals are in the form of rectangular bars 4 projecting from the bodies of the terminals and meshing with corresponding digitations 5 projecting from the ends of the intervening member 3. The digitations are arranged preferably in a series of vertical rows of substantially uniform lengths, as illustrated. The rows are disposed in echelon, Figs. 1 and 4, with the digitations of the terminals projecting farthest into the heating members 3 midway between the sides of the latter, Fig. 1, for purposes already explained. Other conducting material and other resistance material may be used in forming the bar, and the invention is adapted for other than heating purposes. I find that in a bar 82 inches long, 6 inches wide, and 4 inches deep, the digitations may be six inches long, and half an inch thick with excellent results. There are preferably numerous digits in each of the rows, said digits or digitations being attenuated to permit the use of a large number thereof within the compass of the bar, thereby to secure the desired extensive area of contacting surfaces. The digits, each being preferably homogenous and hence strong throughout its length, conduce to the strength of the bar, while the terminal digitations are enabled to conduct the electric current directly into the body of the heating portion or member. Relatively high conductivity is necessary in the terminals, so that metal fastenings can be put upon their free ends without danger of becoming melted from the heat of the heating portion of the bar; whereby the current may be led into and out of the bar. The terminals are of sufficient length, so that the heat which is converted from the heating member to the terminals may have opportunity to dissipate by radiation without injuriously affecting the terminals or the metal fastenings at the ends thereof. At Fig. 3 the terminal digitations are equal in number and area to the others; the joining portion of the bar being hence well balanced electrically as well as structurally.

The entire bar is preferably molded. It may be built up from several layers, each of a depth or thickness equal to that of its digitations. The first layer B with its digitations is placed upon a suitable support, then the second layer C is placed upon the first with its digitations alternating with those of the first layer, and so on until the entire bar is built up, layer on layer, as at Fig. 3. By subsequent treatment, the material is solidified and hardened, and forms a strong, solid bar well adapted for the purpose.

The preferred method of making the bar, is to arrange the digits, while in a plastic state but sufficiently hard to permit them to be handled, in a mold, in the manner illustrated at Fig. 3, and arranged in echelon as indicated in the other figures, thus building up the joining portions only of the bar. The digits when in this condition are a little over-size, so as to allow for their reduction to normal size by squeezing the moisture out of them. After the digits are arranged in the mold, the latter is filled up by liquid mixtures suitable to form the terminal and heating portions of the bar. The terminal portions of the liquid integrate with the terminal digitations, and the middle portion with the other digitations. The bar is completed by hydraulic pressure. There is some integration between the terminal digitations and those of the heating portion of the bar, because all may be made of mixtures of clay and carbon, although in different proportions.

Other variations may be resorted to, within the scope of the invention, and portions of the improvements may be used without others.

Having thus described my invention, I claim:

1. A heating bar having terminal portions and an intervening heating portion anastomosed to said terminal portions.

2. A heating bar comprising a heating portion of low conductivity united at each end to a terminal portion by numerous inosculations.

3. An electrical heating bar comprising three parts, namely, two terminals and an intervening heating portion, said parts having digitiform ends which are interdigitated.

4. A heating bar comprising three parts, namely, two terminals of relatively high conductivity and an intervening portion of relatively low conductivity; each end of said intervening portion formed with a plurality of rows of digits, the terminals having corresponding rows of digits and being interdigitated with said intervening portion.

5. A heating bar comprising three parts, namely, two terminals of relatively high con-

ductivity and an intervening portion of relatively low conductivity; each end of said intervening portion formed with numerous rows of digits, each row including numerous digits, the terminals having corresponding rows of digits and being interdigitated with said intervening portion.

6. A heating bar comprising three parts, namely, two terminals of relatively high conductivity and an intervening portion of relatively low conductivity; each end of said intervening portion formed with numerous rows of digits, each row including numerous digits, the terminals having corresponding rows of digits and being interdigitated with said intervening portion, each of said digits being about square in cross-section.

7. A heating-bar comprising three parts, namely, two terminals of relatively high conductivity and an intervening portion of relatively low conductivity; each end of said intervening portion formed with numerous rows of digits, each row including numerous digits, the terminals having corresponding rows of digits and being interdigitated with said intervening portion, all of said digits being attenuated, and the digits in the respective sets being firmly joined together so that the entire structure forms a rigid bar.

8. A heating-bar having terminal portions and an intervening portion of lower conductivity anastomosed to said terminal portions; the anastomosis extending farther into said intervening portion at the middle than at the sides of the bar.

9. A heating-bar comprising a heating portion of low conductivity united at each end to a terminal portion by numerous inosculations, which, beginning at the sides of the bar, extend to gradually increasing distances longitudinally of the bar, the middle inosculations projecting the most into said heating portion.

10. A heating-bar comprising a terminal portion of relatively high conductivity and a heating portion of relatively low conductivity; said portions having digitiform ends which are interdigitated, and the digitations projecting from the terminal into the heating portion more at the middle than at the sides of the bar, and projecting from the heating portion into the terminal more at the sides than at the middle of the bar.

11. A heating-bar comprising a terminal of relatively high conductivity and a heating portion of relatively low conductivity; said parts having digitiform ends which are interdigitated, the digitations being graduated in a manner to gradually decrease the conductivity of the bar considered as a whole, from the terminal end to the heating-portion end of the interdigitated portion of the bar.

12. A heating-bar comprising a terminal portion of relatively high conductivity and a heating portion of relatively low conductivity; the end of said terminal portion formed with a plurality of rows of digits, the terminals having corresponding rows of digits and being interdigitated with the terminal digits, all of the digits being about equal in length and all arranged in echelon with the terminal digits projecting gradually farther into the heating portion from the sides to the middle of the bar.

13. A heating-bar comprising a terminal portion of molded material and a heating portion of molded material of lower conductivity and anastomosed to said terminal portion, said terminal portion and heating portion molded together.

14. A molded heating-bar consisting principally of carbon and clay and comprising a heating portion and a terminal portion united by numerous inosculations, the proportion of clay being much greater in the heating portion than in the terminal portion, and said portions molded together.

15. A molded heating-bar formed of carbon and a resistance material, and comprising terminal portions and an intervening portion, said portions having digitiform ends which are interdigitated, the proportion of carbon being greater in said terminal portions than in said intervening portion.

16. An electrical bar having terminals and an intervening portion united to the terminals by means of interdigitated structures.

17. As a means for effecting connection between two bodies of varying electrical resistances, a set of digitations of high conductivity united to one of said bodies, and a set of digitations of low conductivity united to the other of said bodies; said digitations interdigitated.

18. An electrical heating bar comprising two terminals and an intervening portion, said parts having digitiform ends which are interdigitated and integrated.

19. A molded electrical heating bar having terminal portions of high electrical conductivity, an intervening portion of high electrical resistance, and connecting portions merging said terminals gradually into said intervening portion.

ARCHIBALD L. BROUGHAM.

Witnesses:
B. C. STICKNEY,
K. FRANKFORT.