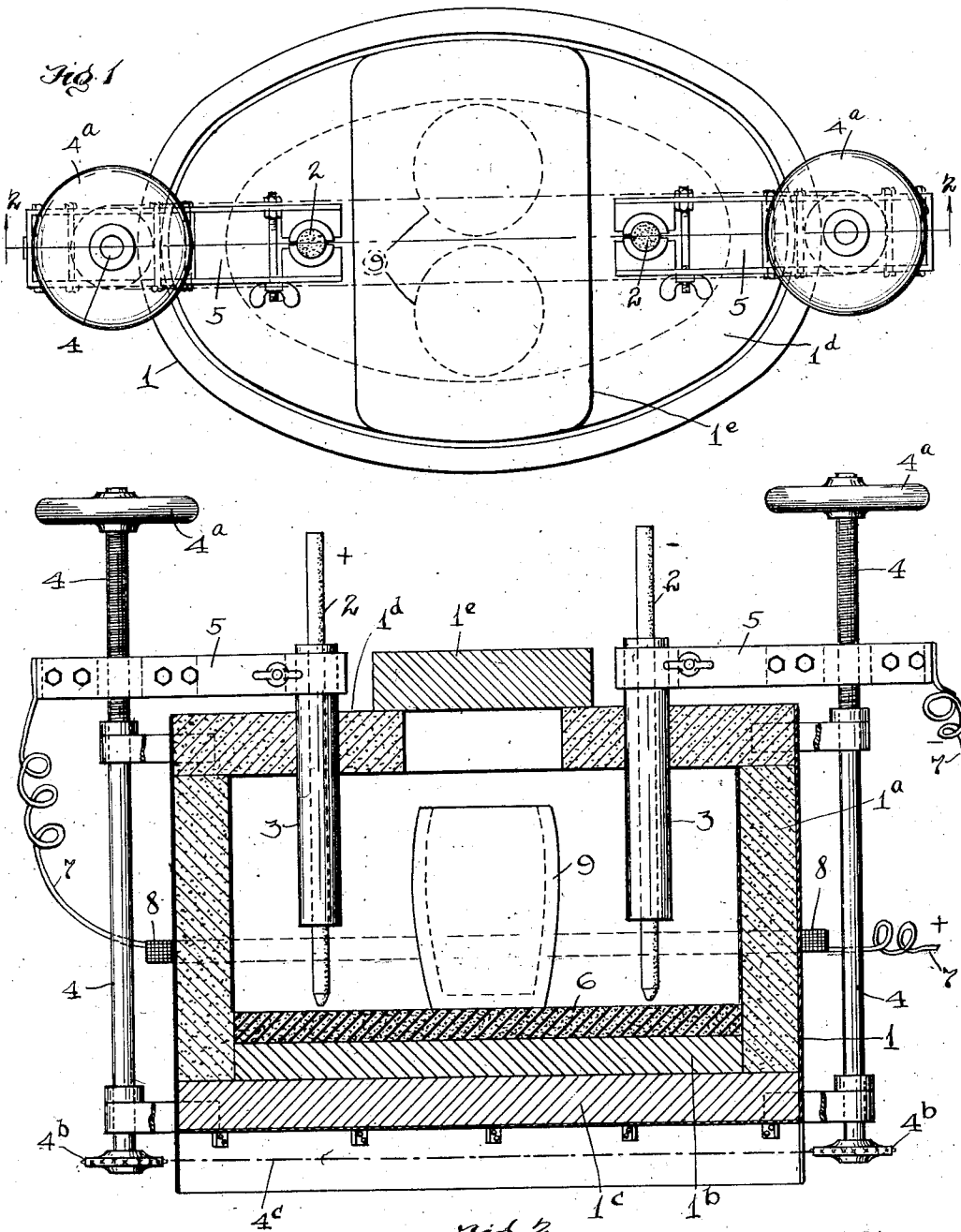


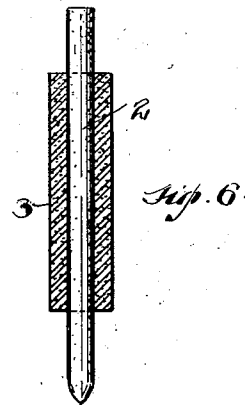
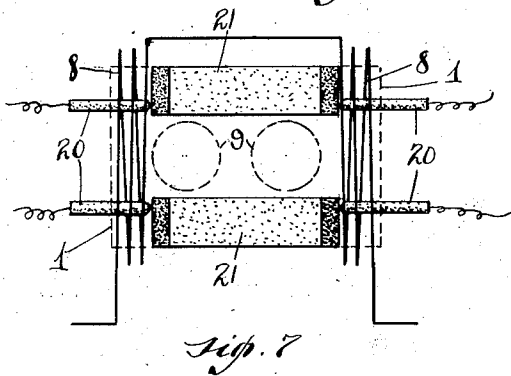
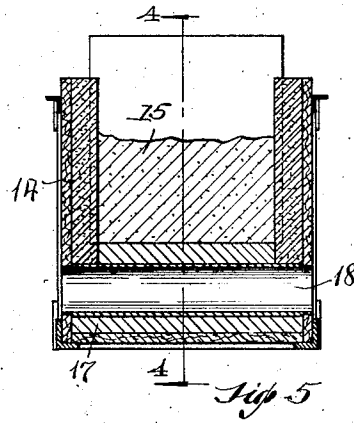
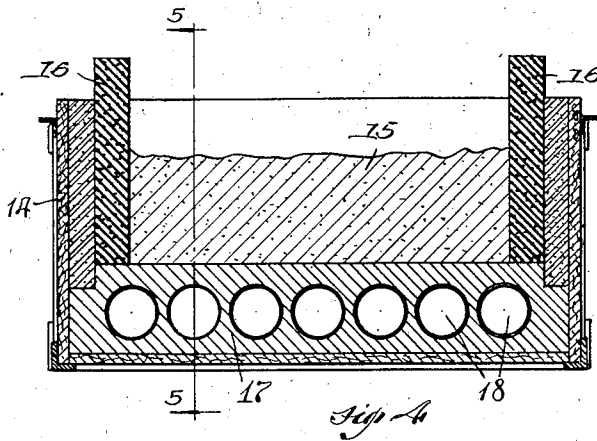
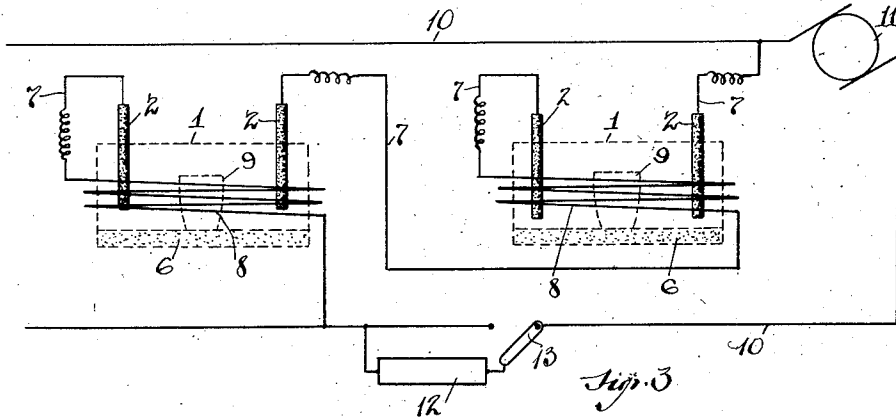
1,290,902.



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Fig. 2

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# UNITED STATES PATENT OFFICE.

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## ELECTRIC FURNACE.

1,290,902.

Specification of Letters Patent.

Patented Jan. 14, 1919.

Application filed May 1, 1915. Serial No. 25,151.

### *To all whom it may concern:*

Be it known that I, CHARLES A. CADWELL, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Electric Furnaces, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

The present improved furnace is particularly adapted for operating with an electric current of high voltage such as would naturally be employed in the melting and superheating of copper for bonding purposes, along the line of an electric railroad, and in other analogous situations. For such a purpose, a device of this type is highly desirable since the current can be obtained direct from the trolley wire or third rail of an electric railway, thus obviating the necessity of having an expensive bonding ear for welding the bonds to the rails, which is the prevailing method at present used where a permanent and homogeneous union between bond and rail is desired. The invention also relates to a method of using such improved furnace to secure the best economy and continuity of operation. To the accomplishment of the foregoing and related ends, said invention, then, consists of the means and steps hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain mechanism and steps embodying the invention, such disclosed means and steps constituting, however, but one of various mechanical forms in which the principle of the invention may be used:—

In said annexed drawings:—

Figure 1 is a plan view of my improved furnace; Fig. 2 is a central vertical section on the line 2—2 in Fig. 1; Fig. 3 is a diagrammatic view showing two furnaces suitably connected for operation by my preferred method; Fig. 4 is a longitudinal section through an improved type of resistance element adapted for use with my furnace on line 4—4 in Fig. 3; Fig. 5 is a transverse section through the same, as indicated by the line 5—5, Fig. 4; Fig. 6 is a longitudinal section through the electrode shown in Fig.

1; and Fig. 7 is a diagrammatic illustration 55 of a modified form of the furnace.

In such drawings, there is shown a casing 1, constituting the furnace chamber, such casing being of any desired shape although a convenient shape for this purpose would 60 be the elliptical one here shown. The sides of this casing will be lined with a suitable heat resisting medium, such as magnesite, for example, which forms the walls 1<sup>a</sup> proper, while a layer 1<sup>b</sup> of fire sand resting on a fire tile foundation 1<sup>c</sup> constitutes the 65 bottom of such chamber. The top of the latter is partially closed by a more or less permanent cover 1<sup>d</sup> having an aperture over which may be placed a removable cover 1<sup>e</sup>. 70 Suitably supported so as to depend within this chamber are two spaced electrodes 2, although more electrodes may be used, said electrodes being adjustable vertically by means of threaded spindles 4 provided with 75 hand wheels 4<sup>a</sup> and carrying clamp arms 5, in which the electrodes 2 are mounted. Desirably, said spindles 4 will be operatively connected as by sprockets 4<sup>b</sup> and a sprocket chain 4<sup>c</sup>, so that rotation of the one will 80 serve simultaneously to rotate the other. Other types of adjusting means may of course be employed for this purpose.

The bottom layer 1<sup>b</sup> of the furnace is covered in turn by a layer 6 of material, 85 preferably granular carbon, or some similar conducting material of relatively high resistance, which may be termed a resistor, and will continue to serve its proper function even though it may become caked by the 90 action of the heat, or it may be made in the form of a cake, as might for instance be preferable where carborundum is used as such resistor. Upon this resistor, there are placed one or more crucibles 9, adapted to 95 receive the metal which is to be melted.

The electrodes 2 will be connected in a suitable electrical circuit including any suitable source of current, either alternating or direct, (the latter being illustrated), such 100 for example as the generator for supplying current to the wires of an electric railway. Only the leads 7 of this circuit appear in Fig. 2, but the complete connection for one approved arrangement of the furnace is 105 shown in Fig. 3, as will be presently explained. The lead to one such electrode, is passed a number of times around the fur-

nace 1, as indicated, forming a coil 8. By virtue of this coil, which is designated as a magnetic means in the claims, the arcs which occur between the carbon electrodes and the granular carbon layer 6 forming the bottom of the furnace, are affected in such a way that the resistance of the arc path of the current is greatly increased, the arc is steadied and any tendency to deviate from the direction of the path designed is overcome, as also the tendency for such arc to become extinguished owing to sudden variations in voltage in the current supplied, or from variations in the resistance of the furnace path, due to the resistor.

Regulation of the intensity of such magnetic field likewise serves to bring the lengths of the arcs under control, and permits such lengths to be varied by the direct adjustment of the electrodes 2 through operation of the hand wheels 4.

Since the electrodes of course become very highly heated at their own ends, their upper ends, which are exposed to the air, may also approach a temperature where slow combustion will take place. I accordingly find it advantageous to inclose the same in a protecting coat 3 of fire-resisting material, as for example a mixture of fire-clay and graphite which will serve as a conductor and at the same time burn away at the lower end, as the carbon core, forming the electrode, proper, is slowly consumed.

It is desirable that the carbon, which is a conductor of heat as well as electricity, and which is consumed by combustion if exposed to the air when heated, be protected in some such manner.

In Fig. 3, I illustrate diagrammatically the method of connecting up two of my furnaces as they will ordinarily be used. As there shown, the leads 7 of the furnaces are connected in series in a circuit 10 supplied with current from a suitable generator 11, or other source of current. In such circuit, I connect a resistance 12 of any desired type, although a very compact and satisfactory type, shown in Figs. 4 and 5, will preferably be employed. This resistance may be optionally connected into the circuit, or left out, by a switch 13, as will be readily understood.

When it is desired to start such two furnaces, this resistance is put into the circuit and all of the electrodes 2 are lowered so as to make contact with the resistor 6. The current is then turned on and its flow is controlled by the resistance of the granular material of the bottoms of the furnaces and the outside resistance 12, there being no arcs. The flow of current being thus established, the quantity of current flowing may be varied by increasing or decreasing the resistance 12, which may be in the form of a standard rheostat with its resistance sub-

ject to switchboard control. When the flow is satisfactory, all the electrodes are raised a portion of the normal amounts, which action adds to the total resistance of the circuit and reduces the amount of the current flowing. The beneficial effect of the coil is here much in evidence in that the amount of current flowing may be reduced to a remarkable minimum without danger of extinguishing the arcs and breaking the circuit.

The resistance 12 is then disconnected from the circuit by means of switch 13 and the amount of current is thereby increased and is brought to any desired amount by regulating the lengths of the arcs, all of the energy of the circuit being transferred into useful heat within the walls of the furnace after such resistance is disconnected. If, however, it is found that the voltage available is not sufficient to operate both furnaces at maximum efficiency, the electrodes of only one at a time will be raised to produce arcs of greatest intensity. Thus the furnaces may be adjusted to utilize current of any kind and of any voltage. The usual case for the purpose of bonding rails will be the utilization of 600 volt DC current, the most useful form being two furnaces in series, each utilizing one half the 600 volt pressure. If, however, two furnaces, adjusted to utilize 600 volt current, be in service along the line of a railroad and it is found that the voltage is lower than the amount above stated, in one of the furnaces, the electrodes may be not raised, but left in contact with or relatively close to the granular resistor. The total resistance of the circuit when the furnaces are in full operation would, in such a case, be less than that of the original design, by the amount of the resistance of the arcs of this furnace. The amount of heat generated in this furnace would be small; while the second furnace would be meanwhile in normal operation, with a resistance measured by 300 volts for which the furnace was originally designed.

The first furnace, operated in this manner, may be called a preheating furnace, and the operations within the two furnaces will be interchanged or alternated at the pleasure of the operator. In case one furnace becomes unfit for use, the other may be continued in operation by raising the electrodes so that arcs of maximum length and resistance are obtained and allowing the resistance 12 to remain in the circuit.

Resistance 12 preferably comprises an open box 14 lined with suitable non-conducting material and having a filling 15 of granular carbon in amount depending upon the amount of resistance desired. Carbon electrodes 16, adapted to be connected in the circuit as previously described in connection

with Fig. 3, are placed in the respective ends of the box and these electrodes furnish means by which the resistance unit is placed into the electric circuit. The heat generated by the passage of the electric current is greatest along the bottom of the box. For this reason, the bottom lining 17 of the box is preferably made of magnesite, which is a conductor of heat and provision is made for dissipating the heat of the bottom of the box by circulation of air through apertures 18 disposed transversely of the box just below the surface of the bottom as shown in the figure. The total radiating surface of the resistance unit is thus largely increased and the radiation may take place with these surfaces at a red heat without injuring any part.

In using the furnace with direct current, the direction of the current will preferably be reversed after each heat in order to secure even wear on the electrodes and on the walls of the furnace chamber, but as hereinbefore indicated, an alternating current can be used, in which event this will not be necessary. The present apparatus is adapted to operate with arcs from 2 to 6 inches long depending on the voltage drop across the furnace. The crucibles and metal contained therein are heated by radiation from the furnace walls and from the top and bottom of the furnace, by radiation from the arcs direct, and by conduction from the resistor bed upon which the crucibles are placed. It has been found in actual practice that two crucibles each containing 20 lbs. of copper can be brought to a temperature of 2500 degrees in 20 minutes, which makes the furnaces peculiarly adapted for melting copper for the purpose of bonding where it is essential that no time be lost in bring the metal to a welding heat.

Although in the preferred design shown, the electrodes enter at the top of the furnace and are placed in a vertical position, I do not limit myself to such an arrangement as they could be introduced at the ends or sides and might be horizontal or inclined. Also in the design shown, the resistor is upon the bottom of the furnace, but I do not limit myself to such location as the walls may be made of a suitable material so as to act wholly or in conjunction with the material on the bottom of the furnace in the present design, as the resistor. Both these modifications in construction are illustrated in Fig. 7, where two electrodes 20, it will be seen, enter each end wall of the furnace chamber, while two resistor bodies 21 are disposed along the respective sides of such chamber.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism and steps herein disclosed, provided the means or steps stated by any

of the following claims or the equivalent of such stated means or steps be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. In a furnace, the combination of a suitable chamber; electrodes extending therein; a resistor within said chamber, said electrodes and resistor being so disposed relatively to each other that arcs are formed from one electrode to said resistor and from the latter to the other electrode; and an electro-magnetic coil surrounding said furnace so as to produce a magnetic field adapted to direct and steady such arcs.

2. In a furnace, the combination of a suitable chamber; electrodes extending therein; a resistor within said chamber, said electrodes and resistor being so disposed relatively to each other that arcs are formed from one electrode to said resistor and from the latter to the other electrode, said electrodes and resistor being adjustable with respect to each other so as to vary the lengths of said arcs; and means for directing and steadying such arcs.

3. In a furnace, the combination of a suitable chamber; electrodes extending therein; a resistor within said chamber, said electrodes and resistor being so disposed relatively to each other that arcs are formed from one electrode to said resistor and from the latter to the other electrode, said electrodes being adjustable toward and from said resistor so as to vary the lengths of said arcs; and means for directing and steadying such arcs.

4. In a furnace, the combination of a suitable chamber; electrodes extending therein; a resistor within said chamber, said electrodes and resistor being so disposed relatively to each other that arcs are formed from one electrode to said resistor and from the latter to the other electrode, said electrodes being simultaneously adjustable toward and from said resistor so as to vary the lengths of said arcs; and magnetic means for directing and steadying such arcs.

5. In a furnace, the combination of a suitable chamber; electrodes extending therein; a resistor within said chamber, said electrodes and resistor being so disposed relatively to each other that arcs are formed from one electrode to said resistor and from the latter to the other electrode, said electrodes being simultaneously adjustable toward and from said resistor so as to vary the lengths of said arcs; and an electro-magnetic coil surrounding said furnace so as to produce a magnetic field adapted to direct and steady such arcs.

6. In a furnace, the combination of a suitable chamber having a bottom of granular high-resistance conducting material; electrodes adjustably mounted in said chamber above such bottom; means for supplying

current to said electrodes, whereby arcs are formed between said electrodes respectively and the bottom of said chamber; and means for directing and steadying such arcs for increasing the electrical resistance of the same.

7. In a furnace the combination of a suitable chamber having a bottom of granular high-resistance conducting material; electrodes adjustably mounted in said chamber above such bottom; means for supplying current to said electrodes, whereby arcs are formed between said electrodes respectively and the bottom of said chamber; and magnetic means for directing and steadying such arcs, thus permitting them to be lengthened and for increasing the electrical resistance of the same in addition to the increase produced by lengthening.

8. In a furnace, the combination of a suitable chamber having a bottom of granular high resistance conducting material; electrodes adjustably mounted in said chamber above such bottom; means for supplying current to said electrodes, whereby arcs are formed between said electrodes respectively and the bottom of said chamber; a coil mounted around said chamber to give a magnetic field for directing and steadying such arcs; and means for simultaneously adjusting said two electrodes.

9. In a furnace, the combination of a suitable chamber having a bottom of granular high-resistance conducting material; electrodes adjustably mounted in said chamber

above such bottom; means for adjusting said electrodes simultaneously; means for supplying current to said electrodes, whereby arcs are formed between said electrodes respectively and the bottom of said chamber; and magnetic means for directing and steadying such arcs, thus permitting them to be lengthened and for increasing the electrical resistance of the same in addition to the increase produced by lengthening.

10. In electric furnace operations, the combination of two furnaces connected in series, said furnaces having adjustable electrodes, one of said furnaces being adapted to be used as a rheostat and having only a low degree of heat generated therein, and being adapted for use as a preheating furnace.

11. In electric furnace operation, the combination of two furnaces connected in series, said furnaces having adjustable electrodes whereby the amount of heat generated may be varied, one of said furnaces being adapted to act as a rheostat and preheating furnace during heating operation of second furnace, said second furnace then being adjusted to act as rheostat and preheating furnace during final heating operation of said first furnace.

Signed by me, this 30th day of April, 1915.

CHARLES A. CADWELL.

Attested by—

D. F. DAVIS,

JNO. F. OBERLIN.