W. E. MOORE.

ELECTRIC FURNACE AND PROCESS OF OPERATING SAME.

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1,309,045.

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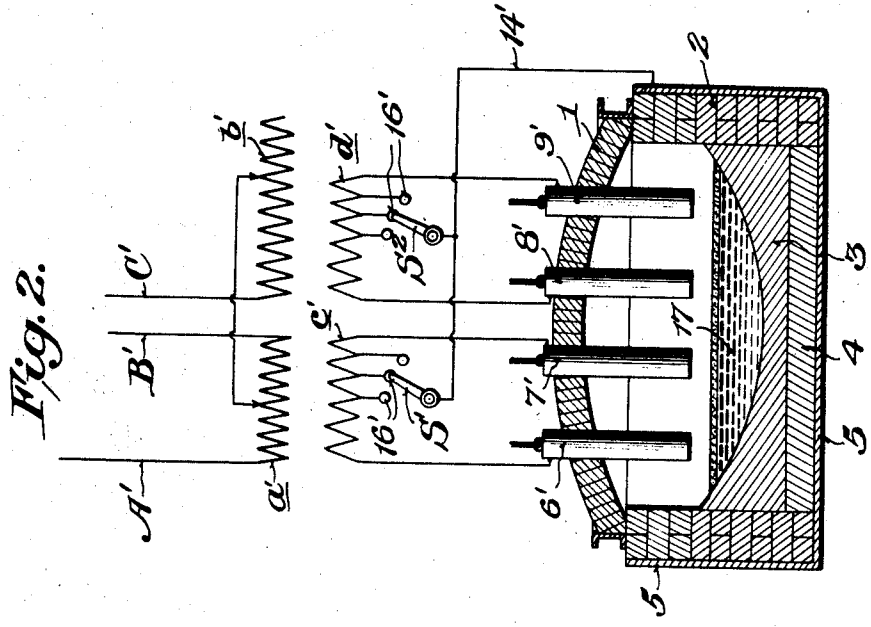


Fig. 2.

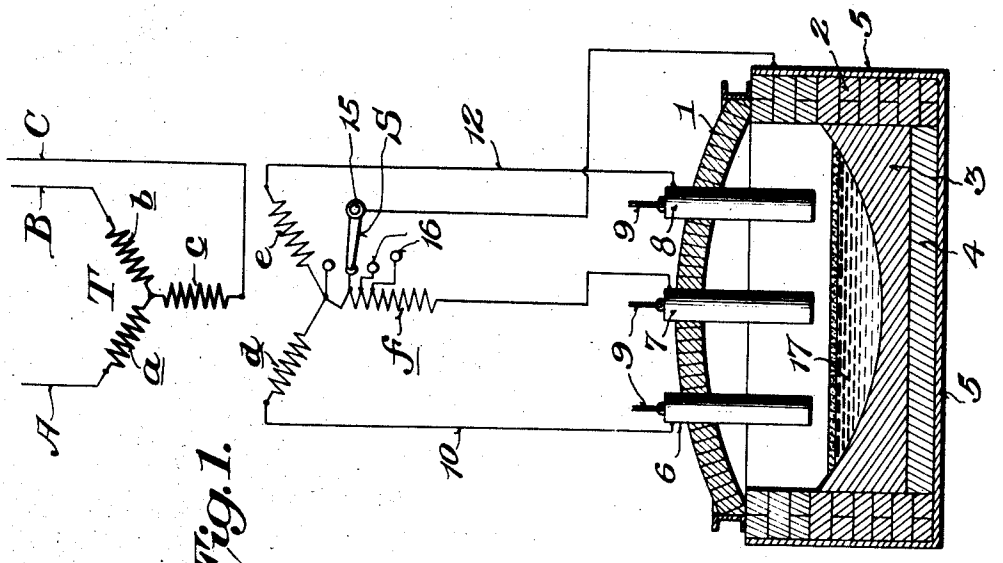


Fig. 1.

Witness

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To all whom it may concern:

Be it known that I, WILLIAM E. MOORE, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Electric Furnaces and Processes of Operating Same, of which the following is a specification.

My invention relates to improvements in electric furnaces and the method of operating the same, and it consists in the constructions, combinations and arrangements hereinafter described, and in the steps for controlling the heat as hereafter indicated.

In the manufacture of steel, its alloys and other metals, in an electric furnace of the arc type, in which the current, or part of it, passes through the molten mass and through the bottom of the furnace, it is an advantage to be able to readily effect a variation in the current to meet varying operating conditions, and to provide for a reasonably wide variation in the current without having to manipulate heavy current carrying leads.

In those electric furnaces of the type mentioned where the entire current returns through the bottom of the furnace, portions of the charge may become overheated. On the other hand, in furnaces where no part of the current is returned through the bottom of the furnace, difficulties are experienced at times due to sluggish circulation in the bath which prevents a rapid diffusion of the alloys, and often forms a "skull" on the bottom. At other times the bottom fills up from an accumulation of oxids and slag, making the bath shallow, as for instance, in running a basic lime furnace in making high carbon steel.

The primary object of the present invention is to provide a furnace of the arc type, having a conducting bottom by means of which the current may be passed through the bath, and having comparatively simple means for varying the amount of current passing through the bath.

A further object of my invention is to provide a novel process or method of varying the current and thereby regulating the heat, by unbalancing one or more of the polyphase arcs. As will be seen hereinafter, this may be done in a number of ways, the effect in each case being to regulate the current flow through the bottom of the furnace and through the bath.

Other objects and advantages will appear in the following specification, and the novel features of the invention will be particularly pointed out in the appended claims.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram illustrating one embodiment of my invention; and

Fig. 2 is a diagram illustrating another embodiment thereof.

Referring now particularly to Fig. 1, I have shown therein a furnace comprising, among other parts, an arched top 1, and side walls 2 of suitable refractory brick. The bottom of the furnace comprises a lining formed preferably of two layers 3 and 4, the former being composed of magnesite, dolomite, chromite, ganister, or other suitable refractory materials, and the latter of a mixture of refractory material and better electrically conducting material, such, for example, as carbon, graphite, or other suitable conducting materials, the mixture preferably increasing in conductivity toward the bottom and being rammed or sintered in. My invention, however, is not limited to any particular construction of furnace crucible further than that the said construction shall embody characteristics which will permit the carrying out of my invention. The sides and bottom of the furnace are inclosed in a metal casing or shell 5.

In the present instance the furnace is provided with three arcing electrodes 6, 7 and 8 respectively, which extend vertically through the furnace roof, and are supported in the usual, or in any desired manner, for vertical adjustment, as by means of the cables 9. The electrical power for the furnace is supplied from a three phase circuit A, B and C, which is connected with the primaries *a*, *b* and *c* respectively, of the transformer T. It will be understood that this arrangement is for purposes of illustration only, since series or multiple primaries may be used. The secondary windings *d*, *f* and *e*, are connected to the electrodes 6, 7 and 8, by the conductors 10, 11 and 12 respectively.

A conductor 14 is connected to the bottom of the furnace through the medium of the metal casing 5, at one end, and at the other end to a switch arm S which is pivotally mounted at 15, and which may be moved to engage stationary contacts 16, each contact being connected at a different point to one

of the coils of the secondary of the transformer, such as the coil *f*.

From the foregoing description of the various parts of the device the operation thereof may be readily understood.

During the operation of the furnace current will pass through the bath 17 and through the bottom of the furnace by way of the conductor 14. By shifting the switch arm S to the various contacts 16, more or less of the coils of the secondary winding *f* are affected. This produces an unbalancing of the neutral terminal, *i. e.*, it makes it eccentric to the terminal voltage. By this adjustable means of tapping the neutral connection in a variable eccentric position as related to the terminal voltages of the star connected secondary polyphase transformer winding, a heavy current may be thus maintained in one or more of the electrodes, thus forcing the unbalanced current to return through the bottom to the neutral connection on the transformer. At the same time a uniform power flow is maintained through each electrode, thus balancing the load on each of the phases of the power supply system which feeds the furnace.

In addition to the means for regulating the current flow through the bottom of the furnace and through the bath, a greater current flow may be produced by unbalancing the power through the variation of the individual arc lengths of one or more phases of the power system. This may be done by shortening the arc, that is to say, by adjusting the distance of one of the electrodes from the surface of the bath. It may also be done by the manipulation of the switch arm S and the shortening of the arc.

While in each case a variation in the current flow to the bottom of the furnace and the bath is produced, it will be noted that the variation is effected under three distinct conditions; first, by making the length of the arc of one electrode relatively less while supplying the electrode with voltage equal to that supplied to the others; second, by varying the voltage in one or more of the arcs and maintaining the length of the arcs equal or balanced; and third, by unbalancing both the length of the arc and the voltage.

In Fig. 2 I have shown an arrangement in which a three-phase circuit A^1, B^1 and C^1 is connected up with the primary windings *a'*, *b'*, to change from three phase to two phase. The secondary coils, *c'*, *d'*, are connected with the four electrodes 6', 7', 8', and 9', in the manner indicated. The conductor 14' is connected with two switch arms S^1 and S^2 which are arranged to engage contacts 16' connected with the coils *c'* and *d'* respectively at one end of the latter.

The operation of this form of the device is substantially the same as that illustrated in Fig. 1. The current may be varied by the manipulation of one or both of the switch arms so as to unbalance the voltage. As in the arrangement shown in Fig. 1, the electrodes may be adjusted so as to cause the variation of the current through the bottom of the furnace and of the bath by varying the length of arc.

It will be seen from the description that I have provided a furnace having relatively simple means for effecting a comparatively wide variation in the flow of the current through the bottom of the furnace and through the bath. Furthermore, by using the means described I attain a flexibility of adjustment which permits the regulation of the current to the exact point to suit operating conditions.

I claim:

1. A polyphase arc electric furnace comprising a plurality of arcing electrodes, and means for unbalancing the current or voltage of one or more of the polyphase arcs.

2. A polyphase arc electric furnace comprising a plurality of arcing electrodes, a conducting bottom arranged to hold a metal bath, a conductor connected with said conducting bottom, and means for varying the current through said conductor and through said bath, by unbalancing the voltage or current in one or more of said arcing electrodes.

3. A polyphase electric furnace comprising a plurality of arcing electrodes, a conducting bottom arranged to hold a metal bath, a conductor connected with said conducting bottom, and means for varying the current through said conductor and through said conducting bottom, said means comprising an adjustable device for unbalancing the voltage supplied to one of said electrodes.

4. A polyphase electric furnace, comprising a plurality of arcing electrodes, a polyphase circuit connected with said electrodes, and means for unbalancing the voltage supplied to one of said electrodes.

5. An electric furnace comprising a plurality of electrodes, a conducting bottom arranged to hold a molten bath, said electrodes being spaced from the bath to form arcs, a source of polyphase current and means for unbalancing the voltage of one of said arcs while maintaining the length of the arc uniform.

6. In an electric furnace, a plurality of arcing electrodes, a conducting bottom, a conductor connected with said bottom, a secondary source of polyphase current comprising a plurality of transformer windings, each of said windings being connected with one of said electrodes, and means for adjustably connecting said conductor with different points along one of said transformer windings.

7. In an electric furnace, a plurality of arcing electrodes, a conducting bottom arranged to hold a metal bath, a conductor connected with said conducting bottom, a plurality of secondary transformer coils, each of said coils being connected with one of said electrodes, contacts connected with one of said secondary coils at different points therealong, and a switch connected with said conductor and movable to connect any of said contacts.

8. The herein described process of controlling the current flow through the bottom of a polyphase arc electric furnace of the neutral star connected type, which consists in unbalancing the current or voltage of one or more of the polyphase arcs.

9. The herein described process of controlling the current flow through the bottom of a polyphase arc electric furnace of the neutral star connected type, which consists in unbalancing the voltage in one or more of the arcs while maintaining the length of the arcs equal or balanced.

10. The herein described process of controlling the current flow through the bottom of a polyphase arc electric furnace of the neutral star connected type, which consists in unbalancing both the voltage and the length of the arc of one or more of the electrodes.

11. The herein described process of controlling the current flow through the bottom of a polyphase arc electric furnace of the neutral star connected type, which consists in varying the length of the arc of one or more electrodes while maintaining an equal voltage on all electrodes.

12. The herein described process of controlling the current flow through the bottom of a polyphase arc electric furnace of the neutral star connected type, which consists in varying the voltage between the electrode and the bath on one or more of the arcs while maintaining a uniform power flow through each electrode, between the electrode and the bath.

13. The herein described process of controlling the current flow through the bottom of a polyphase arc electric furnace of the neutral star connected type, which consists in varying the voltage on one or more of the arcs while maintaining the load on each of the phases of the power supply system balanced.

In testimony whereof I affix my signature.

WILLIAM E. MOORE.