J. L. DIXON.

ELECTRIC FURNACE.

APPLICATION FILED FEB. 23, 1915.

1,241,351.

Patented Sept. 25, 1917.

4 SHEETS-SHEET 1.

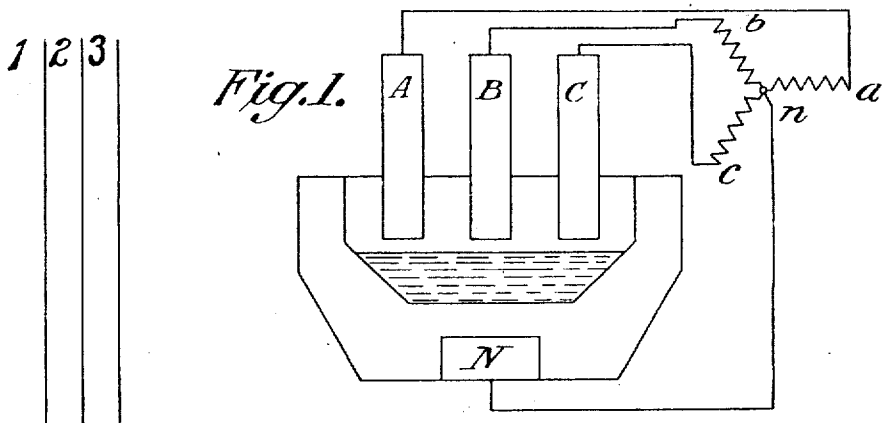


Fig. 1.

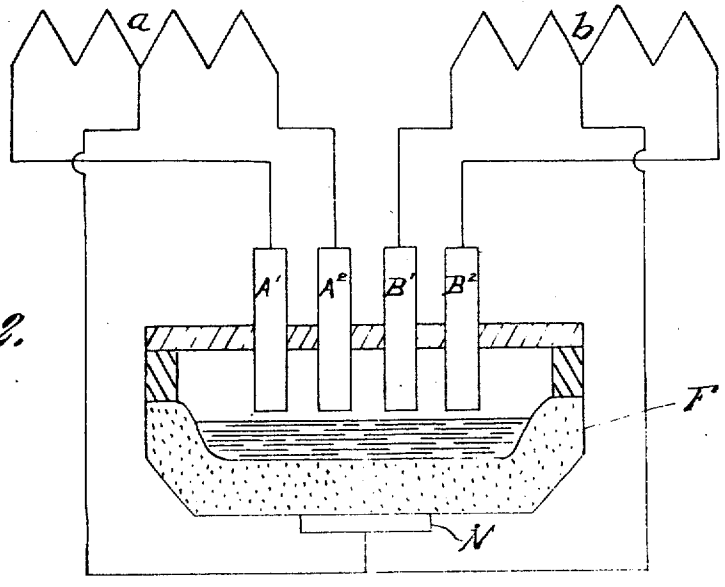


Fig. 2.

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4 SHEETS—SHEET 2.

Fig. 3.

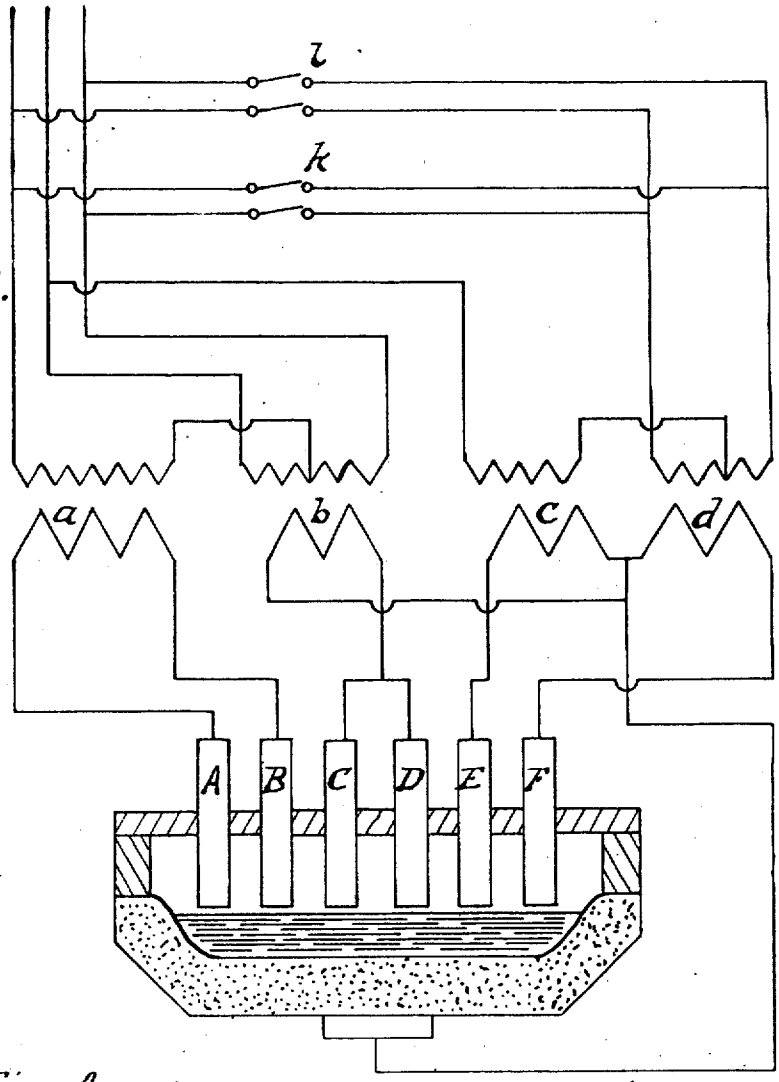


Fig. 4.

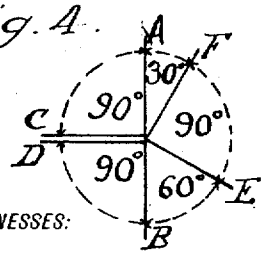
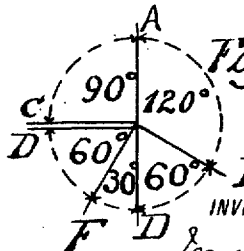


Fig. 5.



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4 SHEETS—SHEET 3.

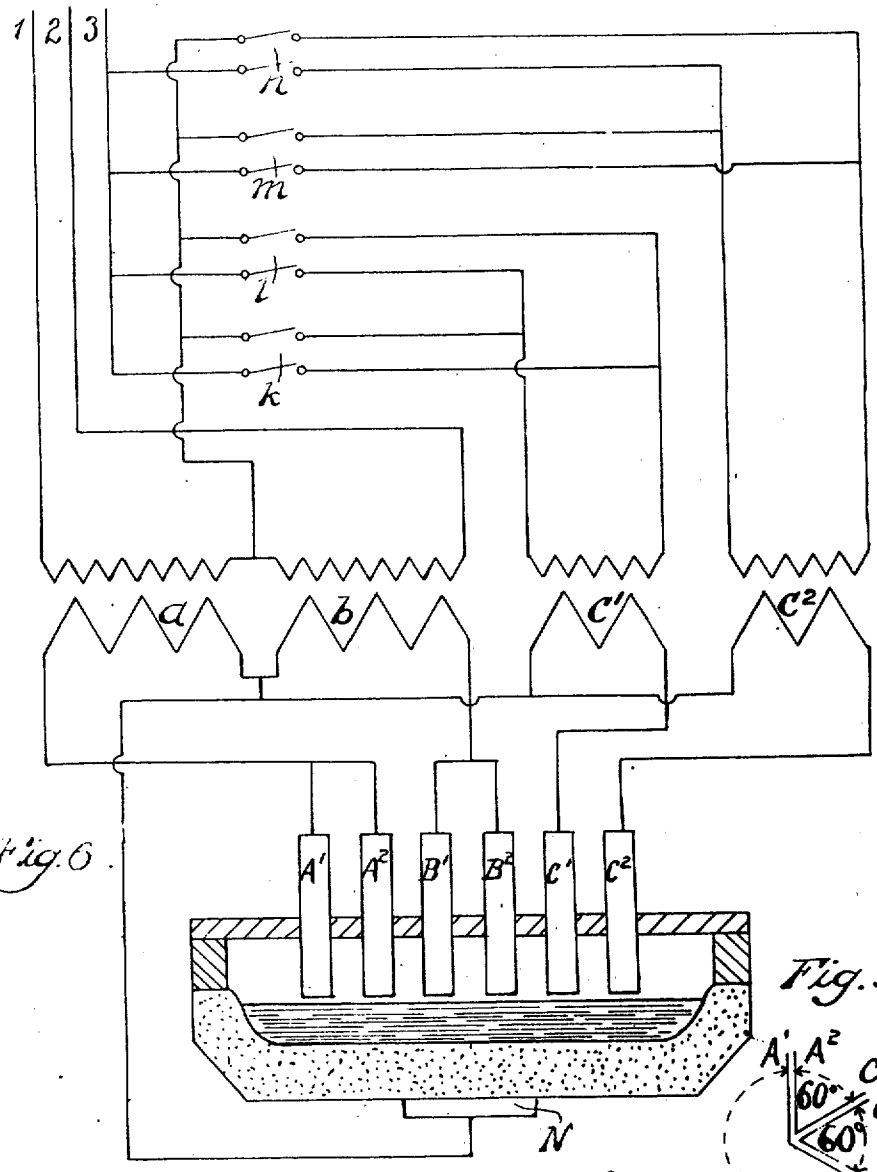


Fig. 6.

Fig. 9

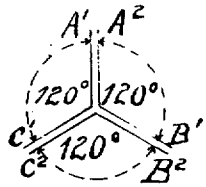


Fig. 7

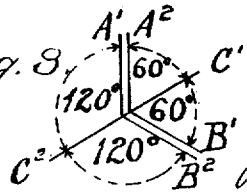


Fig. 8.

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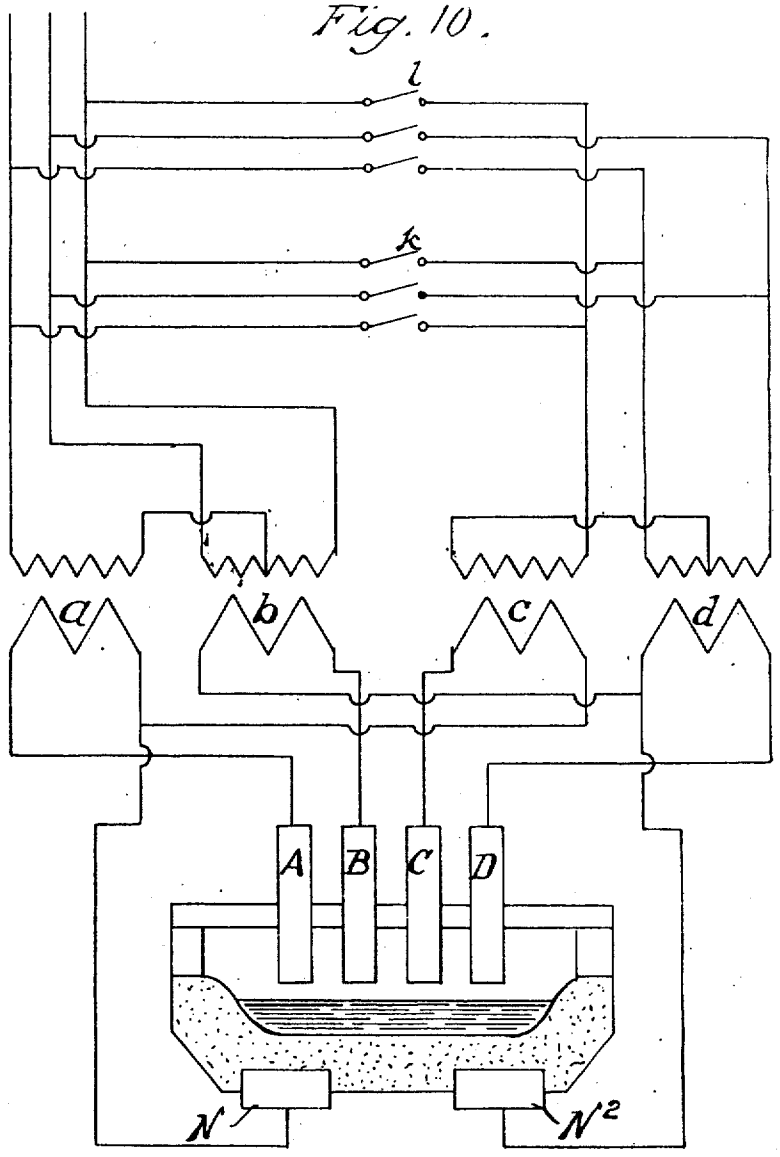
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4 SHEETS—SHEET 4.

Fig. 10.



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UNITED STATES PATENT OFFICE.

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ELECTRIC FURNACE.

1,241,351 Specification of Letters Patent. Patented Sept. 25, 1917.

Application filed February 23, 1915. Serial No. 9,782.

To all whom it may concern:

Be it known that I, JOSEPH L. DIXON, a subject of the King of Great Britain, residing at 6 Ashgate road, in the county of York and city of Sheffield, England, have invented certain new and useful Improvements in Electric Furnaces; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

Electric arc smelting furnaces as known heretofore can be classified under two heads. First those wherein the current passes from one electrode to the other, and second those in which substantially the entire current passes through the bath of metal, through the lining and back to the generator.

Certain distinct advantages and accompanying disadvantages accompany the use of either mode of using the current alone, and, where different conditions are to be foreseen and provided for, a distinct improvement will follow the devising of a suitable system wherein the two modes of using the current are made optionally available in combination or separately. Such an improvement follows from the use of my present invention.

The object of my invention is the construction of furnaces in which the proportion of current passing through the bath and lining is separately controllable, so that if desired there can be caused to flow through the bath and lining much smaller proportions of current than are possible with furnaces of the second type above mentioned.

I carry out my invention by several methods, the method selected in any particular case being dependent partly on the size of the furnaces, and partly on the nature of the metallurgical operation to be conducted in the furnace. All the methods are such that the power may be taken from a standard polyphase supply system, a most important feature being that the carrying out of the invention does not necessitate any unequal loading of the supply system.

In the accompanying drawings, Figure 1 is a diagram illustrative of the general principle of my invention, Fig. 2 is a diagram illustrative of the general case wherein three phase currents are applied to furnaces having an even number of upper electrodes, Fig. 3 is a diagram showing one form of furnace embodying my invention, Figs. 4 and 5 are vector diagrams illustrative of the different conditions available in the system shown in Fig. 3, Fig. 6 is a diagram illustrating a modified form of my invention, Figs. 7, 8 and 9 are vector diagrams illustrating the modes of use of said modification, and Fig. 10 is a diagram illustrating still another modification.

In Fig. 1, I have shown a furnace wherein three upper electrodes A, B and C are connected to a suitable source of three phase current from points *a*, *b* and *c* whose phases are 120 degrees apart, while the lower terminal N is connected to the neutral point *n*. This arrangement is within my invention and admits of obtaining the advantages hereinafter pointed out.

One method of carrying out my invention is shown in Fig. 2, in which F, is the furnace, A^1, A^2, B^1, B^2, are four electrodes (hereinafter termed upper electrodes) which are on to the bath of metal or alloy or other material. N, is an electrode embedded in the furnace lining (hereinafter termed a lower electrode).

The furnace is fed with two-phase secondary current taken from two single phase transformers, represented in the drawings as *a*, and *b*, whose primaries are fed from three-phase mains, 1, 2 and 3.

The two secondary terminals of the transformer, *a*, are connected, one to the electrode A^1, and the other to the electrode A^2.

The middle point of the secondary winding of the transformer, *a*, is connected to the lower electrode N.

Similarly, the secondary terminals of the transformer, *b*, are connected to the electrodes B^1 and B^2 and the middle point connected to the lower electrode N, as shown in the diagram.

It is apparent that when the two electrodes A^1 and A^2, are supplying to the furnace currents of equal magnitude, these currents will exactly neutralize each other and the transformer, *a*, will supply no current to the lower electrode N. The electrodes, A^1 and A^2 may be adjusted so that the currents in them are not equal, and therefore there is a current flowing along the wire connected to the middle point of the transformer, *a*, and through the lower electrode N. To take an extreme case for the sake of illustration, the electrode A^2, may be raised so that it supplies no current to the furnace, and the

whole of the current in the electrode A^1, passes through the bath and returns to the middle point of the transformer, *a*. The same adjustment may be made with the electrodes B^1, and B^2, fed by the transformer, *b*.

Whatever adjustment is made with the four upper electrodes and whatever the amount of current flowing through the lower electrode, the electrical system will not be unequally loaded if the transformers *a*, and *b*, are supplying equal amounts of power to the furnace.

It is apparent that the invention may be carried out with the middle point of only one of the transformers connected to the lower electrode, N.

My invention contemplates means for easily altering the connections between the transformer primaries and the mains 1, 2 and 3 whereby the phase relations in the secondaries may be so altered as to control at will the amount of current passing through the bath to the lower electrode.

In Fig. 3 is shown an arrangement for this purpose wherein is used a number of transformers less than the number of upper electrodes in the furnace. In this case six upper electrodes are supplied from four transformers. For this purpose two electrodes A, B are connected with the terminals of one secondary *a*. Two others, C, D, are connected in common to one secondary terminal of *b*, while E and F are connected with the outer terminals of the secondaries of *c* and *d*. The interior or contiguous secondary terminals of *c* and *d* are connected in common with the secondary of *b*. The four primaries of the four transformers are Scott-connected with the mains 1, 2 and 3, and these connections are made by means of multiple switches *k* and *l*.

When the switch *k* is closed and switch *l* is open, the phase relations are indicated by the diagram in Fig. 4. When *l* is closed and *k* is open the phase relations are those indicated in Fig. 5.

In Fig. 6 is shown another mode of supplying six electrodes from four transformers fed from the three-phase mains 1, 2 and 3. Here the multiple switches *k*, *l*, *m* and *n* cause various changes in phase relations, thus altering the proportion of current going through the bath.

With switches *k* and *m* closed and switches *l* and *n* open, the currents occupy the positions shown in the diagram Fig. 7, and the only current flowing through the lower electrode is that due to the difference in the secondary voltages.

When larger currents through the lower electrodes are required, the switches *k* and *n*, are open and the switches, *l* and *m* closed, and the transformer c^1, supplies current in a reversed manner, the positions of the six currents being shown in Fig. 8. Similarly by opening the switches, *l* and *m*, and closing the switches *k* and *n*, the transformer, c^2 will supply current in a reversed manner. When still larger currents through the lower electrode are required, the switches, *k* and *m*, are opened and the switches *l* and *n*, closed, and then both the transformers c^1 and c^2, are reversed, the secondary currents occupying the positions shown in Fig. 7.

Whatever the magnitudes and positions of the secondary currents, the electrical system will not be unequally loaded provided each of the transformers, *a*, and *b*, is supplying power equal to the total power supplied by the two transformers, c^1 and c^2.

In Fig. 6, I have shown the primary side of the transformers connected to the supply mains in star fashion. It is apparent that without interfering with the carrying out of the invention they can be connected in delta fashion.

In all the methods I have described of carrying out my invention, there is only one lower electrode embedded in the lining or sole of the furnace. At the same time, I wish it to be understood that my invention, in most of the methods I have described, can be carried out with more than one lower electrode.

This is shown in Fig. 10, wherein are also shown multiple switches *k* and *l* for governing the phase relations in the secondaries of the transformers *a*, *b*, *c* and *d*. The two lower electrodes are shown at N and N^2 and are connected respectively to common secondary terminals of *a* and *c*, and of *b* and *d*.

What I claim is—

1. An electric furnace having suitable upper electrodes and a lower electrode, main leads for supplying three-phase alternating current, transformers having their primaries so connected with said main leads as to deliver two-phase current from their secondaries, two or more switches in circuit between said main leads and said primaries and adapted to alter the phase relations in said transformers, a common connection between the terminals of two of said secondaries and the lower electrode, and suitable connections between the secondaries of said transformers and said upper electrodes.

2. An electric furnace having suitable upper electrodes and a lower electrode, main leads for supplying three-phase alternating current, transformers less in number than said upper electrodes and so connected with said main leads as to deliver two phase current from their secondaries, switches suitably connected with the primary circuits for producing alterations in phase relations in said transformers, and suitable connections between said electrodes and the secondaries of said transformers.

3. An electric furnace having six upper

electrodes and a lower electrode, two pairs of transformers, means for supplying alternating current to the primaries thereof, conductors connecting the outer terminals of one pair of transformer secondaries each to two of the upper electrodes, conductors connecting one secondary terminal of each of the other transformers with one of the remaining upper electrodes, and a common connection between the remaining secondary terminals and said lower electrode.

In testimony whereof, I affix my signature, in presence of two witnesses.

JOSEPH L. DIXON.

Witnesses:
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