P. GIROD.

METHOD OF SUPPLYING ELECTRIC FURNACES WITH POLYPHASE CURRENTS.

APPLICATION FILED AUG. 24, 1910.

983,043. Patented Jan. 31, 1911.

Fig. 1,

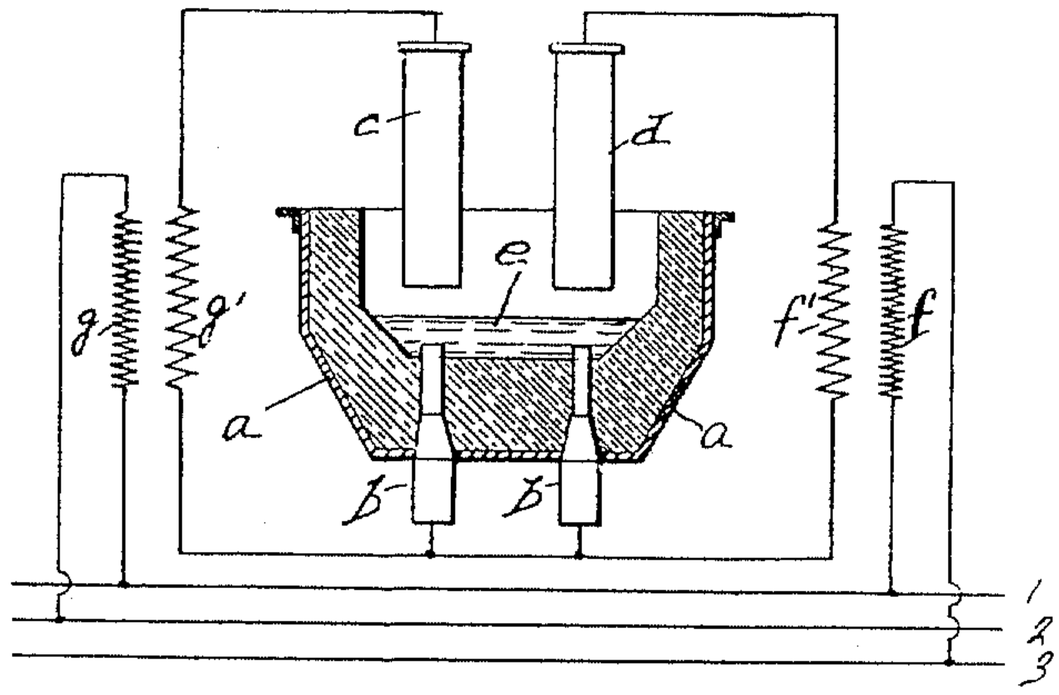


Fig. 2,

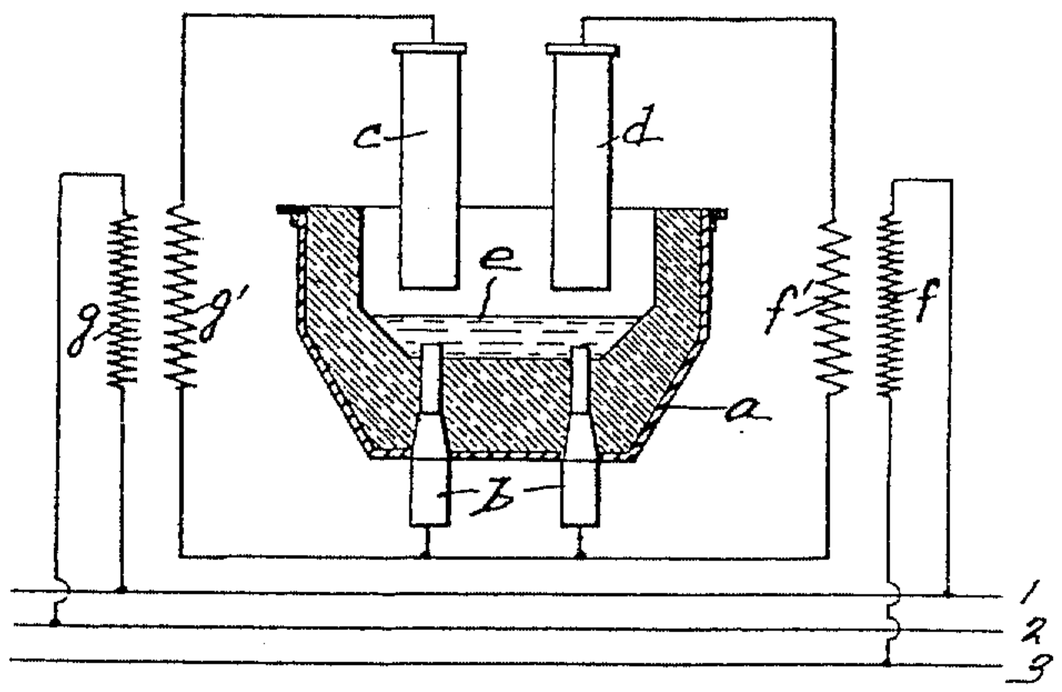
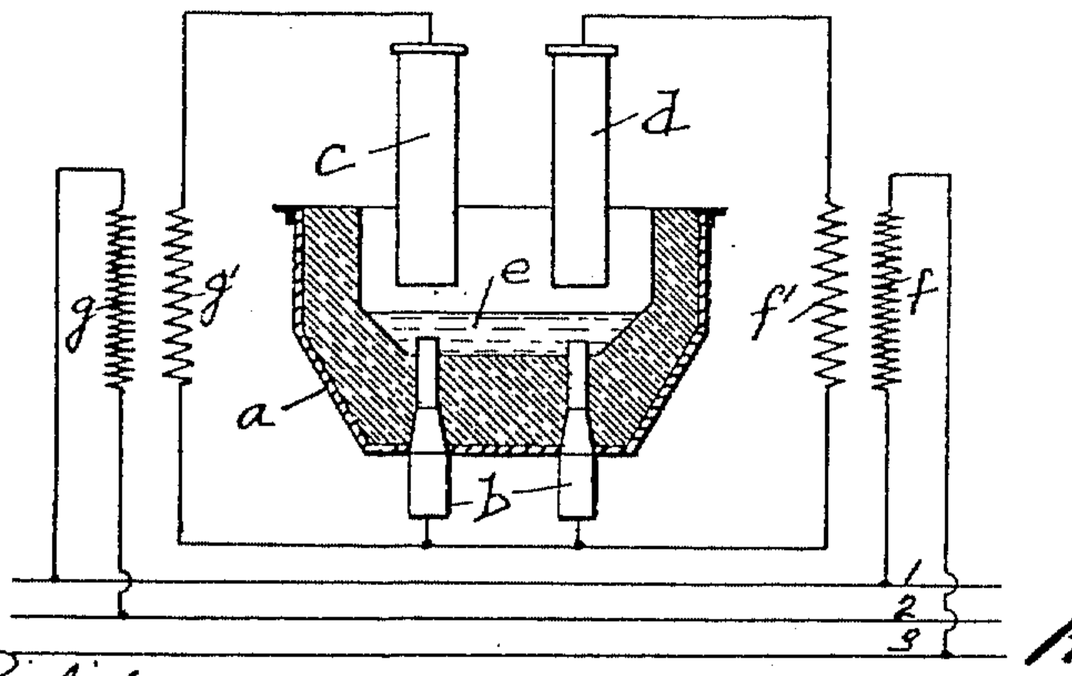


Fig. 3,



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METHOD OF SUPPLYING ELECTRIC FURNACES WITH POLYPHASE CURRENTS.

983,043. Specification of Letters Patent. Patented Jan. 31, 1911.

Application filed August 24, 1910. Serial No. 578,703.

To all whom it may concern:

Be it known that I, PAUL GIROD, a citizen of the Republic of Switzerland, residing at Ugine, Savoie, France, have invented certain new and useful Improvements in the Method of Supplying Electric Furnaces with Polyphase Currents; 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.

It has heretofore been proposed to supply electric furnaces with polyphase currents, each phase being connected directly with an electrode or group of electrodes. For example, the three distributing wires, 1, 2, 3, of a three-phase system have been respectively connected to three electrodes, or groups of electrodes *b*, *c*, *d*. In such case the potential differences existing between the several electrodes are the same. That is, the potential difference between *b* and *c*, is the same as that between *c* and *d*, and between *d* and *b*. This system, which may be feasible when each of the electrodes, or each of the groups of electrodes, is similarly situated relatively to the bath, so that the resistances existing between the several electrodes are the same, is inadequate in the case of furnaces wherein the electrodes, or group of electrodes, are not so situated, as is the case, for example, in furnaces having one or more upper electrodes and the other electrode or electrodes in the hearth, or having a conducting hearth.

It is possible, by the interposition of transformers, to reproduce the above described conditions of equal voltages between the several electrodes, with or without a change in voltage due to the transformation. Such a result is effected by providing two transformers of which the two primary terminals which at any instant are positive are connected to one of the three phases and the two terminals which at that instant are negative are connected respectively to the other two phases, or vice versa; and connecting the two like secondary terminals to one of the electrodes, or groups of electrodes, and the other two like secondary terminals to the other two electrodes, or groups of electrodes, respectively. Such an arrangement, however, is, like the direct connection described above, inadequate for furnaces wherein the electrodes, or groups of electrodes, are not similarly situated with respect to the bath.

The present invention provides an arrangement for overcoming this defect, and allows the current to be equally distributed among the several electrodes of an electric furnace when some of the electrodes are separated by a much higher resistance than other of the electrodes; and it consists essentially in inverting the terminals of one of the transformers supplying the furnace so as to increase the potential difference between those electrodes which are separated by the greater resistance.

In the drawings Figure 1 is a diagrammatic illustration of an electric furnace fed from a three phase system, with transformers interposed in such manner that the voltages between the several electrodes are the same. Fig. 2 is a similar illustration of present invention, and Fig. 3 is a similar illustration of another arrangement embodying the invention.

In Fig. 1, *a* is an electric furnace of any suitable type, for example of the type described in my French Patent No. 350,524 dated January 4, 1905, and in certificates of addition to said patent, No. 4,829 dated May 22, 1905, and No. 7,008 dated December 7, 1906. The lower electrodes of the furnace are represented at *b* and the upper electrodes at *c* and *d* respectively, while the reference letter *e* indicates the bath of molten metal. The distribution wires of a three phase system are indicated in the figure and are numbered 1, 2, and 3 respectively. It will be seen that one transformer has its primary *f* connected across the wires 1—3, the lower terminal of the primary being connected to the wire 1 and the upper terminal to the wire 3. The other transformer has its primary *g* connected across the wires 1—2, its lower terminal being connected to the wire 1, as is the lower terminal of primary *f*, and its upper terminal being connected to the wire 2. The secondaries *f'* and *g'* of these two transformers have their lower terminals connected together and to the electrodes *b*, whereas their upper terminals are connected respectively to the electrodes *c* and *d*. With such a connection the voltage between the two electrodes *c* and *d* is the same as the voltage between the electrodes *c* and *b*, and between the electrodes *d* and *b*. The resistance between the elec-

trodes *b* and *d* is the same as the resistance between the electrodes *b* and *c*, but is much less than the resistance between the electrodes *c* and *d* since currents passing between these two electrodes would have to traverse two arcs in series. The result is that only a very small current, in comparison, would pass between the electrodes *c* and *d*.

In accordance with the present invention the voltage between electrodes *c* and *d* is increased by inverting the terminals of one of the transformers (either the primary or secondary terminals). The connections are illustrated in Figs. 2 and 3. In Fig. 2 the primary terminals of the transformer *f* are inverted, the upper terminal being connected to 1 and the lower terminal to 3, while the upper terminals of primary *g* are connected as before, the upper to 2 and the lower to 1. In Fig. 3 the primary terminals of *g* are inverted, the upper one being connected to 1 and the lower to 2, while the terminals of primary *f* are connected as in Fig. 1, the upper to 3 and the lower to 1. In either case the voltage between *b* and *c* will be equal to the voltage between *b* and *d* and the voltage between *c* and *d* is greater, being equal to the voltage between *b* and *c* or *b* and *d* multiplied by $\sqrt{3}$ or 1.73. Thus, assuming that the secondaries of the transformers supply current at 55 volts, there will exist between the electrodes *b* and *c*, and between the electrodes *b* and *d*, a difference of potential of 55 volts, and between *c* and *d* a difference of potential 1.73 times greater, or approximately 95 volts. The intensity of the current circulating between the electrodes *c* and *d* is consequently increased and in practice can be brought to approximately the same value as the current which circulates between *b* and *c*, and between *b* and *d*. The same result may obviously be attained by inverting the terminals of one of the secondaries, either *f'* or *g'*. The ratio of transformation may be one to one or whatever other ratio may be required by the particular conditions of the installation. The same idea may be applied to six-phase, twelve-phase and other polyphase systems by connecting the transformers in accordance with this invention. Of course, the number of electrodes would be increased or the number of furnaces connected to the system would be increased to utilize the greater number of phases, but the principle involved is an obvious modification of the system herein disclosed.

What I claim is:—

1. In a system for supplying current to an electric furnace having a plurality of electrodes and wherein the resistance between some of the electrodes is considerably greater than the resistance between others of the electrodes, supply conductors carrying polyphase currents, transformers having their primaries connected to the supply conductors to receive currents of different phases, and connections from the secondary terminals of the transformers to the furnace electrodes, the transformer terminals being relatively inverted and connected to the electrodes in such order that the greater potential difference resulting from the inversion of the terminals exists between those electrodes which are separated by the greater resistance.

2. An electric furnace having a lower electrode and a pair of upper electrodes held out of contact with the fused metal, a three-phase system of electrical supply, a pair of single-phase transformers having their primaries connected to different phases of the system and their secondaries connected to the said electrodes, the terminals of said transformers being relatively inverted and the secondary terminals being connected to the electrodes in such order that the greater potential difference resulting from such inversion exists between the two upper electrodes.

3. An electric furnace having a lower electrode and a pair of upper electrodes held out of contact with the fused metal, a three-phase system of electrical supply and two transformers having their primaries connected to different phases of said system, the secondary of one transformer having one of its terminals connected to the lower electrode and the other terminal connected to one of the upper electrodes and the secondary of the other transformer having one of its terminals connected to the lower electrode and the other terminal connected to the other electrode, and the transformer terminals being relatively inverted, whereby a greater potential difference exists between the upper electrodes than between either upper electrode and the lower electrode.

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

PAUL GIROD.

Witnesses:
LÉON CAILLAT,
BLACKERE CASTON.

Correction in Letters Patent No. 983,043.

It is hereby certified that in Letters Patent No. 983,043, granted January 31, 1911, upon the application of Paul Girod, of Ugine, France, for an improvement in "Methods of Supplying Electric Furnaces with Polyphase Currents," an error appears in the printed specification requiring correction as follows: Page 1, line 76, before the word "present" the words *an arrangement in accordance with the* should be inserted; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of February, A. D., 1911.

[SEAL.]

C. C. BILLINGS,
Acting Commissioner of Patents.