

[54] **POWER SUPPLY EQUIPMENT FOR
ELECTRIC SMELTING FURNACE OF
LARGE CAPACITY**

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[58] Field of Search 13/9, 12, 13, 14

[56] **References Cited**

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[57] **ABSTRACT**

An improved power supply equipment for an electric smelting furnace of large capacity, which is characterized in that a plurality of conductors conveying electric power to the lower part of an electrode, each of which is connected to each segment of an electrode holder, are arranged in a manner that said conductor is not located on the side of the electrode facing the furnace center, and said conductors are connected to a fixed input terminal block in a manner that densities of electric currents in all the conductors are as equal as possible.

4 Claims, 3 Drawing Figures

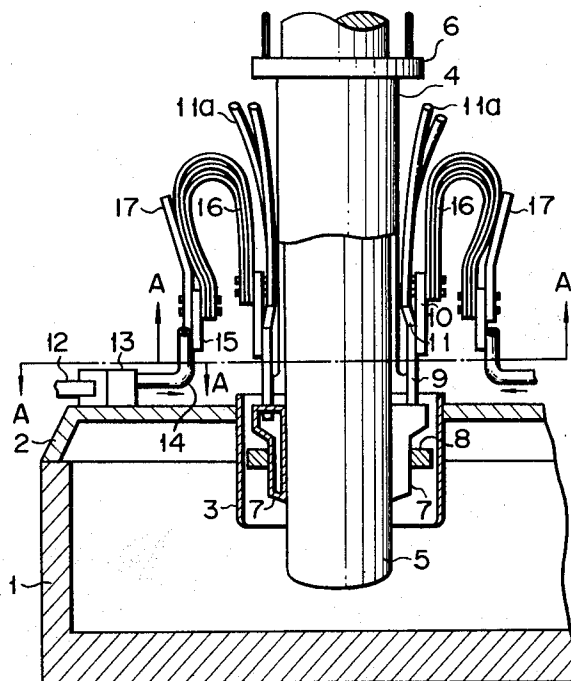


FIG. 1

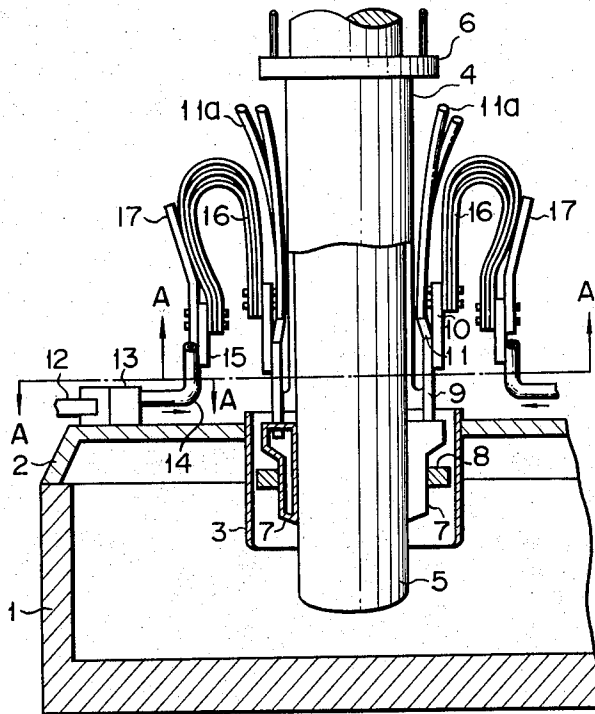


FIG. 3

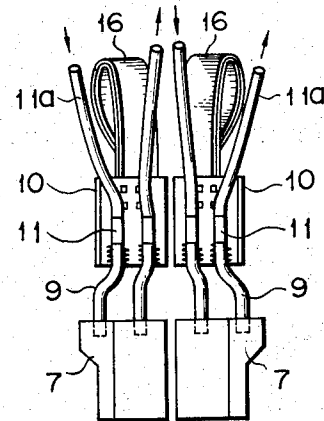
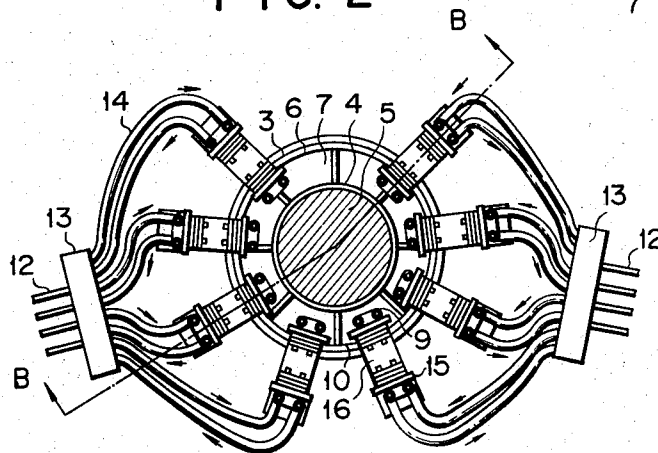


FIG. 2



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POWER SUPPLY EQUIPMENT FOR ELECTRIC SMELTING FURNACE OF LARGE CAPACITY

BACKGROUND OF THE INVENTION

This invention relates to an electric smelting furnace, and more particularly to a power supply equipment for an electric smelting furnace of large capacity.

Nowadays electric smelting furnaces of extremely large capacity are widely used. It is known, however, that when the capacity of furnace is increased, the operation efficiency thereof is improved but the power factor thereof decreases. For instance, an electric furnace of 10,000 KVA or so has a power factor of 85 to 90 percent, while the power factor of an electric furnace of 40,000 to 50,000 KVA drops to about 70 percent. In order to improve the power factor, plenty of research activities have been accumulated pertaining to combination and structure of power supply elements which are to be placed between a power source transformer and furnace electrodes, being connected therewith. However, no remarkable success is known until today.

In an electric smelting furnace, it is necessary to arrange three electrodes so that each of them can be raised and lowered separately to be positioned at desired levels. Therefore, each segment of electrode holder, which comprises a plurality of equal segments and holds the lower part of an electrode by press-contact surrounding it, and an input terminal block must be connected with the aid of a conductor comprising a series of electroconductive elements, one of which is of flexible material. As the flexible element of the conductor, a copper strand cable or a flexible laminate of thin copper plates is customarily used. These elements are damaged by heat in a high temperature atmosphere since these are not water-cooled. In a large capacity electric furnace, the conducting elements have very large cross sections so that high density current can pass therein, whereby electric current flows through the skin layer of the conducting elements in preference to the core or inner portion thereof by so-called skin effect, the greater current the more remarkable effect. This causes local super-heating in the conductor elements which accelerates the heat damage of the elements and increases trouble in the maintenance of the electric furnace.

Reduction in power factor in a large capacity electric furnace is not only due to heat damage of the electroconductive elements and skin effect but also due to unbalance in electric current distribution in the parallel conductors.

SUMMARY OF THE INVENTION

An object of this invention is to prevent heat damage and skin effect in electroconductive elements in a large capacity electric smelting furnace to improve the power factor thereof. This object may be attained in accordance with the present invention by using a power supply equipment comprising a plurality of power supply conductors, each of which consists of (a) a U-shaped electroconductive copper pipe, the ends of which are secured to an input terminal block fixed to the furnace, (b) a terminal copper plate secured to the pipe described in (a) at the turning point thereof, (c) a laminated bridge of substantially non-elastic thin copper plates, which is bent upwardly, secured to the terminal copper plate described in (b) at its one end, (d) another terminal copper plate to which the other end of the laminated bridge described in (c) is fixed, and (e) a pair of electroconductive copper pipes which are secured to the terminal copper plate described in (d) on each one end, and are connected to a hollow segment of electrode holder, whereby said power supply conductors are arranged around each electrode in a manner that none of said conductors is located on the side of the electrode which faces the furnace center; and said conductors are connected respectively to corresponding segments of the electrode holder and input terminal blocks in a manner that every conductor has substantially equal impedance so as to pass a substantially equal electric current therethrough.

This and further objects will be evident from a study of the following disclosure and the accompanying drawing which illustrates one embodiment of the present invention. This embodiment is merely exemplary and is not intended to detract from the full scope of the invention as set out in the annexed claims.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWING

In the Drawing:

FIG. 1 is a schematic partly sectional vertical view of an electrode with the surroundings thereof of an enclosed type three-phase alternate current electric furnace along the plane B—B in FIG. 2;

FIG. 2 is a cross-sectional view along the plane A—A in FIG. 1; and

FIG. 3 is a side view of electroconductive elements of two conductors located on the side of the electrode opposite to the furnace center.

DETAILED DESCRIPTION OF THE INVENTION

The power supply equipment of this invention is now explained in respect of an embodiment thereof, the attached drawing being referred to.

A furnace body 1 has a lid 2 which is equipped with protective cylinders 3, and an electrode 5 is inserted in the furnace through each of the protective cylinder. Usually this protective cylinder 3 is jacketed and water-cooled, but the jacket is not shown in the figures. The electrode 5 covered by a steel plate cylinder 4 is suspended by a suspending mechanism 6, which effectuates raising and lowering of the electrode. The detail of the suspending mechanism 6 is omitted from FIG. 1. At the lower part of the electrode 5, an electrode holder comprising a plurality of equal hollow segments 7 is attached thereto by press-contact with a binding means 8 made of an insulating material which surrounds the segments. The binding means 8 slides on the inside surface of the protective cylinder 3, and has functions to prevent leakage of gases generated in the furnace and also to stabilize the hanging center of the electrode 5. The electrode holder usually comprises 12 or more segments, but in the present figures only 8 segments are shown for the convenience of illustration. The above-mentioned is the common practice for the enclosed type electric furnaces in general.

The present invention relates to an improvement of the power supply equipment connecting the above-mentioned electrode holder comprising a plurality of equal segments 7 with two input terminal blocks 13 secured on the furnace lid 2. Now the construction of the equipment is explained below in detail.

As shown in FIGS. 1 and 3, to each of the hollow segments 7 of the electrode holder a pair of electroconductive copper pipes are connected, which function as electric conductor as well as an inlet and outlet of water to be circulated through the hollow segment for the purpose of cooling the segment. The other ends of the pipes are secured to the lower end of a copper terminal plate 10 by welding or any other suitable means. Therefore, the copper terminal plates 10 are raised or lowered together with the electrode per se. The copper pipes are not straight but respectively curved differently according to the position at which each of them is located so that they accommodate themselves to a unique spatial relation between the segment and flexible conductor elements made of flexible laminate of thin copper plates. The unique spatial relation characterizes this invention as explained hereinafter. However, the lengths of these copper pipes should be as equal as possible in order to make the impedance of the power supply conductors, which mainly consists of reactance, substantially equal. The upper end 11 of each copper pipe 9 is raised from the surface of the copper terminal plate 10 so that a rubber tube 11a is connected thereto for circulation of water.

The furnace has bus bars 12, which are connected to a power source transformer (not shown in the figures). The other ends of the bus bars 12 are connected to input terminal blocks 13 secured to a suitable position on the furnace lid 2. To each of the input terminal blocks 13, a plurality of U-curved electroconductive copper pipes 14 are secured at their open ends, and the U-end parts of the pipes are raised upward to be secured to a copper terminal plate 15 by means of welding or some other suitable means. Cold water is circulated in these pipes from the input terminal blocks 13 and back thereto by way of the terminal plate 15.

The copper terminal plates 10 aside the electrode holder and the copper terminal plates 15 on the side of the input terminal block 13 are positioned facing each other, and are respectively connected with a substantially non-elastic electroconductive element such as a flexible laminate bridge of thin copper plates 16, which is curved upwardly.

Thus the electrode can be vertically moved with little resistance because of the substantial non-elasticity of the laminated bridge of thin copper plates 16. It is desirable to provide the electrode cover 4 with an insulator on the surface thereof so as to prevent the electrode cover 4 from contacting the laminated elements when the latter are bent or tilted toward the former. (In the drawing, insulator is not shown.) On the other hand, the terminal plate 15 on the input terminal block side is provided with a holding plate 17, which supports the laminated element when the latter is bent toward that side.

In the prior art, customarily, a full set of the laminated elements are arranged so that they surround the electrode with equal space therebetween, and each laminated element is connected to a corresponding segment of the electrode holder, which are equally arranged around the electrode. In this invention, however, the power supply conductor is not located on the side of the electrode which faces the furnace center as shown in FIG. 2, in which the furnace center is present in the upward direction. All the power supply conductors are located on the side of the electrode not facing the furnace center rather closely with each other, not necessarily equally spaced, but each of the conductors being connected to the corresponding segment of the electrode holder.

In this case, it is necessary to select the length and curvature of the electroconductive copper pipes of the power supply conductors so that densities of the electric currents in all the conductors are as equal as possible. In broader aspect, selection and combination of all the elements 14, 15, 16, 10 and 9 of a power supply conductor must be done so that all the conductors have impedances as equal as possible. Practically, said impedance consists mainly of reactance.

When the conductors are arranged in a manner as mentioned above, the laminated copper plates are not placed in the position near to the furnace center where the temperature is the highest. This means that the laminated elements are not disposed to higher temperature, and therefore the heat damage thereof is diminished or eliminated and furthermore the tendency that electric current flows in the conductors on the furnace center side in preference to the other conductors, as taught by theories of electricity and is practically established, is avoided. Thus electric currents in all the conductors are more equalized.

Moreover, each conductor comprises substantially a plurality of conducting passages assembled in parallel, that is to say, a pair of copper pipes and a plurality of thin copper plates. Therefore, the sectional area of each passage is divided into small portions, and so the aforementioned skin effect may be avoided on each conductor too. In the design of an electric smelting furnace of extremely large capacity, it will be efficacious to attach two or more power supply conductors to one segment of the electrode holder in parallel for the same reason.

When the power supply conductors are arranged in accordance with the novel idea of this invention, densities of electric currents in the conductors are remarkably equalized and local heat damage in the conductors may be eliminated.

Furthermore, the reactance of the conductors is reduced, and thus the power factor is increased by 5 to 10 percent over the prior art level in electric smelting furnaces of 40,000 to 80,000 KVA.

A further marked effect of this invention is that access to the furnace center is made easy. In the prior art electric smelting furnace, the furnace center space is jumbled with power supply conductors, chutes for feeding raw materials, etc., and the space is so limited that works for repair and maintenance of the furnace are extremely troublesome. According to this invention, there exists no power supply conductor in the furnace center, and thus the space allowable for working is remarkably enlarged.

Some of the prior art furnaces are of the type in which elastic copper plates are employed for the laminated plates and the resultant elastic force of the set of equally spaced copper plates surrounding the electrode stabilizes the hanging center of the electrode. In this invention substantially non-elastic copper plates are used, and they have no effect upon the hanging of the electrode. However, in an enclosed type furnace as shown in the figures, the lower part of the electrode is supported horizontally by the protective cylinder 3 and the binder 8, which stabilize the hanging center thereof, and thus there is no inconvenience in this respect. In an open type furnace without a lid, which is of a large capacity as much as from 40,000 to 80,000 KVA, size and weight of electrodes are considerably great, and so the hanging centers thereof are stabilized by the weight of themselves. Where elastic copper plates are used for the laminated elements, raising and lowering of the electrode is not easy.

In this invention, as substantially non-elastic copper plates are used, the vertical movement of the electrode is easily effected.

It will be understood that the power supply equipment for a large capacity electric smelting furnace of this invention is not only applied to a furnace of enclosed type but also to that of open type.

What I claim is:

1. A power supply equipment for an electric smelting furnace of large capacity comprising a plurality of power supply conductors, each of which consists of

- a. a U-shaped electroconductive copper pipe, the ends of which are secured to an input terminal block fixed to the furnace,
- b. a terminal copper plate secured to the pipe described in (a) at the bight portion thereof,
- c. a laminated bridge of substantially non-elastic thin copper plates, which is bent upwardly, secured to the terminal copper plate described in (b) at its one end,
- d. another terminal copper plate to which the other end of the laminated bridge described in (c) is fixed, and
- e. a pair of electroconductive copper pipes which are secured to the terminal copper plate described in (d) on each one end, and are connected to a hollow segment of electrode holder,

whereby said power supply conductors are arranged around each electrode in a manner that none of said conductors is located on the side of the electrode which faces the furnace center; and said conductors are connected respectively to corresponding segments of the electrode holder and input terminal blocks in a manner that every conductor has substantially equal impedance so as to pass a substantially equal electric current therethrough.

2. The power supply equipment for an electric smelting furnace of large capacity according to claim 1, wherein said capacity is from 40,000 to 80,000 KVA.

3. The power supply equipment for an electric smelting furnace of large capacity according to claim 1, wherein said impedance mainly consists of reactance.

4. The power supply equipment for an electric smelting furnace of large capacity according to claim 1, wherein two of said conductors are connected to one segment of electrode holder in parallel.

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