PROCESS AND EQUIPMENT FOR OPERATING ELECTRIC ARC FURNACES

5 Claims, 2 Drawing Figs.

ABSTRACT: A process and apparatus are provided for operating three-phase electric arc furnaces by maintaining equal impedance in all of the three electrode circuits. This may be accomplished by adjusting the relative sag of the circuit wires.
INVENTOR
Manfred Jellinghaus

[Signature]
PROCESS AND EQUIPMENT FOR OPERATING ELECTRIC ARC FURNACES

This invention relates to methods and apparatus for operating electric arc furnaces and particularly to a process and equipment for operating electric arc furnaces on three-phase current for the production of steel.

In the case of known electric arc furnaces which can be tilted for the production of steel, the electric circuits for three electrodes which are arranged in a triangle arc at one side of the furnace. Due to this arrangement, the circuits have different impedances which cause an irregular burning of the electrodes and the masonry of the furnace. Moreover, in operation, the circuits are changed in position due to the automatic adjustment of the electrodes as a function of their burning. This also results in a change in the impedances.

In order to reduce this irregular wear which is caused by the variable impedances and which is called the sharp phase, the suggestion has already been made that the arc outputs of the individual electrodes be adjusted differently. In the case of another suggestion for reducing the irregular wear, three single-phase transformers which are placed next to each other are used. However, satisfactory results have not been obtained with either of these known devices.

Satisfactory results with respect to the uniform burning of the electrodes and the masonry of the furnaces have been obtained only with nontippable electric arc furnaces which are not used for ferrous alloys and which have single-phase transformers placed in a triangle around the furnaces. However, such an arrangement is not suitable for electric arc furnaces which are to be used to produce steel, since the single phase transformers prevent or even make impossible the tipping of the furnaces due to their triangular arrangement around the furnace.

Consequently, it is a purpose of the present invention to create a process and a device for the operation of three-phase fed electric arc furnaces with which a uniform burning of the electrodes and a uniform wearing of the masonry of the electric arc furnaces can be obtained. The electric arc furnaces are to be usable especially for the production of steel.

This problem is solved according to the present invention by keeping the circuit impedances of the electrodes equal to each other. By a uniform wear, both of the electrodes as well as the masonry of the electric arc furnace is assured. Since, for example, the transformer for the balancing of the three circuit impedances does not need to be arranged around the furnace, the electric arc furnace can be tipped without hindrance by the transformer or circuits and thus can be used for the production of steel.

One advantageous embodiment of the present invention provides that the adjustment of the circuit impedances takes place by shifting the circuit cables. This is a very simple possibility of changing the impedances. According to another embodiment of the invention it is preferred that all the circuits are not changed but that the shifting of the circuits takes place only at the slack of the circuits.

The process according to the invention is suitable for electric arc furnaces with a random arrangement of electrodes. However, the electrodes are preferably arranged in a triangle for one furnace and moreover, two of the electrodes are preferably placed at the same distance from the transformer. Then it is advantageous to undertake the shifting either at the circuits of the center electrode or at both circuits of the two outer electrodes. Undertaking the shift at the two outer circuits has proved particularly advantageous.

A device according to the invention for executing the process is characterized by the fact that each electrode is connected with a measuring apparatus for the circuit's impedance which is connected to a comparison instrument for measuring values of the circuits' impedances and by the fact that at least one adjusting organ for shifting the circuit is actuated by the output signals of the comparison instrument. Preferably, an adjusting organ is provided at both of the outer circuits. However, it is also possible to connect adjusting organs to all circuits so that the compensation of the circuit's impedances can be undertaken at all circuits.

As a preferred device, the invention suggests that the adjusting organs be borne by position support arms and have lifting and lowering devices to which the circuits are connected. Insofar as tubes which direct the circuits over the electrode support arms have a flexible piece, the contact point of the lifting and lowering devices according to the invention should be at the end of the electrode support arm seen from the electrodes. By means of the lifting and lowering devices which are arranged with the electrode carrier arms, changes in the circuit impedances, which are also influenced to a large extent by the position of the electrode support arms with respect to each other, can be equalized by lifting and lowering the sag of the circuits.

In the foregoing general description certain objects, purposes and advantages of this invention have been set out.

Other objects, purposes and advantages will be apparent from a consideration of the following description and the accompanying drawings in which:

FIG. 1 is a side elevational view, partly in section, of an apparatus according to the invention; and

FIG. 2 is a schematic view of an apparatus such as that of FIG. 1 with a second embodiment of control.

Referring to the drawings I have illustrated an electric arc furnace 10 having three electrodes 11, 12 and 13, which are arranged in an equilateral triangle. Two of these electrodes 11 and 13 are placed equally distant from a transformer 14 which is housed within a walled area 15 having an opening 16 through which the connecting leads 17, 18 and 19 pass to the electrodes. Each of the electrodes 11, 12 and 13 is mounted on an adjustable electrode support arm 20, 21 and 22 respectively. The electrodes 11, 12 and 13 are connected to the transformer leads 17, 18 and 19 by circuits 23, 24 and 25 respectively. Each of the circuits 23, 24 and 25 passes over the support arms 20, 21 and 22 respectively within pipes 26, 27 and 28 supported on said arms. Each of the outside pipes 26 and 28 have a flexible portion 29 and 30. A lift and lower mechanism 31 and 32 is mounted on each of the outside support arms 20 and 22 and carries the outside pipes 26 and 28. Each of the circuits 23, 24 and 25 in the area between the end of pipes 26, 27 and 28 and the transformer lead ins 17, 18 and 19 is suspended in the form of a U whose position is changed by lifting or lowering pipes 26 and 28 by means of lift and lower mechanisms 31 and 32.

The apparatus works in the following manner. The sag in each of the two outside circuits 23 and 25 is adjusted by lifting or lowering the pipes 26 and 28 by means of lift and lower mechanisms 31 and 32. The lift and lower mechanism is controlled as a function of inductance. The control as shown in FIG. 1 consists in measuring the position of the individual supports arms relative to one another by means of depth indicators 33, 34 and 35 and slide rheostats 36, 37 and 38 attached thereto and comparing the two outer electrodes 11 and 13 with the center electrode 12. If a deviation from the normal position is found, the current path of the electrode in question is either raised or lowered by raising or lowering the pipe 26 or 28 as the case may be to produce impedances in all circuits which are equal. If an irregular burning should occur at the electrodes 11, 12 or 13 during operation of the furnace, then the electrodes are adjusted as usual and the circuit impedances consequently assume different values which are corrected by the signal from the comparison measuring devices which signal the lift and lower mechanism 31 and 32 through polarized relays 39 and 40 which in turn shift the circuits in such a way that the impedances become equal in all circuits.

The apparatus shown in FIG. 2 is similar to that of FIG. 1 in having electrodes 11a, 12a and 13a and a transformer 14a spaced therefrom and connected to the electrodes through circuits 23a, 24a and 25a. In this case, however, the position of the electrodes is determined by the relative phase position.
of the electrode. Here the phase position of the two outer phases is compared with that of the center or inside phase. When the cos φ of an outer phase deviates from that of the inside phase, this is detected by the phase measuring instruments 41, 41a, 42, 42a, 43, 43a which signals the comparison instrument 50 made up of comparator 44, 45, 46 which signals the motor controllers 48 and 49 so that the adjusting device 31a and 32a are caused to change the sag in the corresponding circuit to restore phase coincidence.

In the foregoing specification certain preferred practices and embodiments of this invention have been set forth, however, it will be clear to men skilled in the art that the invention may be otherwise practiced.

I claim:

1. A process for operating three-phase electric arc furnaces having three electrodes, comprising the steps of connecting the three electrodes to a power source through three independent lines each with a cable having a normal sag therein, monitoring the impedance in each line and adjusting the relative sag in said cables as their impedance changes to maintain equal impedance in all of the electrode circuits.

2. A process as claimed in claim 1 wherein equal impedance is achieved by arranging three electrodes, one for each phase, in a triangle with two of said electrodes equidistant from a common power source, monitoring the impedance of all three lines and automatically changing the relative sag of the cables connecting said two electrodes and the power source with respect to cables connecting the third electrode and said power source.

3. An apparatus for operating three-phase electric arc furnaces having three electrodes and a transformer spaced therefrom comprising cable connections between said transformer and each of said electrodes having a sag therein and forming with said electrodes three separate electrode circuits, means for measuring the impedance in each said electrode circuit and impedance adjusting means acting on the cable sag in each circuit to alter said cable sag and thereby maintain equal impedance therein.

4. An apparatus for operating three-phase electric arc furnaces having three electrodes and a transformer spaced therefrom comprising connections between said transformer and each of said electrodes forming with said electrodes, three separate electrode circuits, means for measuring the impedance in each said electrode circuit, said electrodes being carried on electrode arms overhanging the furnace and the electrode circuit including an elongated pipe carried on lift means responsive to impedance change mounted on the support arms and carrying a current wire connected to the transformer, said circuit wire having a sag therein adjusted by raising and lowering said elongated pipes relative to one another.

5. An apparatus for operating three-phase electric arc furnaces having three electrodes and a transformer spaced therefrom comprising connections between said transformer and each of said electrodes forming with said electrodes, three separate electrode circuits, means for measuring the impedance in each said electrode circuit and impedance-adjusting means acting on each circuit to alter said circuits to maintain equal impedance therein, said impedance measuring means including means for measuring the effective length of each electrode and means for controlling the impedance adjusting means relative to the effective electrode length.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,594,486 Dated July 20, 1971

Inventor(s) Manfred Jellinghaus

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 74, "the" should read -- the --. Column 2, line 3, "circuits's" should read -- circuit's --; line 6, "position" should read -- electrode --. Column 3, line 8, before "31a" insert -- motors --.

Signed and sealed this 10th day of October 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCHALK
Attesting Officer Commissioner of Patents