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PATENT REQUEST: STANDARD PATENT

We, ASEA BROWN BOVERI LTD, being the person(s) identified below as the Applicant, request the grant of a standard patent to the person identified below as the Nominated Person, for an invention described in the accompanying complete specification.

Full application details follow.

Applicant: ASEA BROWN BOVERI LTD

Address: Baden SWITZERLAND

Nominated Person: ASEA BROWN BOVERI LTD

Address: Baden SWITZERLAND

Invention Title: "PROCESS FOR ELECTRODE CONTROL OF A DC ARC FURNACE, AND AN ELECTRODE CONTROL DEVICE"

Name(s) of Actual Inventor(s): Eduard Strebel

Address for service is: F.B. RICE & CO.,
28A Montague St,
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Attorney Code: RI

BASIC CONVENTION APPLICATION(S) DETAILS

Application No	Country	Country Code	Date of Application
406/91-9	Switzerland	CH	8 February 1991

We are not an eligible person described in Section 33 - 36 of the Act.

Drawing number recommended to accompany the abstract 1

Dated this 24 day of January 1992

ASEA BROWN BOVERI LTD

By: _____
Registered Patent Attorney

24/01/92

56478

Commonwealth of Australia
The Patents Act 1952

DECLARATION IN SUPPORT

In support of the (Convention) Application made by: ASEA BROWN BOVERI LTD
of Baden SWITZERLAND

for a patent for an invention entitled: PROCESS FOR ELECTRODE CONTROL OF A DC ARC FURNACE, AND AN ELECTRODE CONTROL DEVICE

~~I~~ (We) Ernest KLEIN and Giacomo BOLIS

of and care of the applicant company do solemnly and sincerely declare as follows:

~~a) I am (We are) the applicant(s) for the patent~~
or
b) ~~I am~~ (We are) authorised by the applicant~~(s)~~ for the patent to make this declaration on its behalf.

Delete the following if not a Convention Application.

The basic application~~(s)~~ as defined by section 141 ~~(142)~~ of the Act was ~~(were)~~ made

on 8 February 1991 in SWITZERLAND

~~on~~ ~~in~~

~~on~~ ~~in~~

by Asea Brown Boveri Ltd

The basic application~~(s)~~ referred to in this paragraph is ~~(are)~~ the first application~~(s)~~ made in a Convention country in respect of the invention the subject of the application.

~~a) I am (We are) the actual inventor(s) of the invention.~~

or
b) Eduard Strebel of Nueachtalstr. 10B, 5415 Nussbaumen, Switzerland

is ~~(are)~~ the actual inventor~~(s)~~ of the invention and the facts upon which ASEA BROWN BOVERI LTD

is ~~(are)~~ entitled to make the application are as follows: The applicant is a person who would if a patent were granted upon an application made by the actual inventor~~(s)~~ be entitled to have the patent assigned to it.

Declared at Baden this 16th day of January 19 92

Asea Brown Boveri Ltd.

Signed i.V. Klein i.V. Bolis

Ernest Klein Giacomo Bolis

Declarant's Name

Procurist Authorized representative

F. B. RICE & CO PATENT ATTORNEYS

This form is suitable for any type of Patent Application. No legalisation required.

AU9210490

(12) PATENT ABRIDGMENT (11) Document No. AU-B-10490/92
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 647576

(54) Title
PROCESS FOR ELECTRODE CONTROL OF A DC ARC FURNACE, AND AN ELECTRODE CONTROL DEVICE

International Patent Classification(s)
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(56) Prior Art Documents
EP 68180

(57) Claim

1. A process for electrode control of a DC arc furnace comprising the steps of controlling an actual arc current intensity of the DC arc furnace by means of a rectifier control signal (α_{act}) to a prescribable reference current intensity (i_{des}) and

controlling an electrode separation, being the distance between at least one adjustable electrode and a molten bath of the arc furnace, as a function of the difference between a prescribable electrode controller reference variable signal (α_{des}) and the rectifier control signal (α_{act}).

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ORIGINAL
COMPLETE SPECIFICATION
STANDARD PATENT

Invention Title:

PROCESS FOR ELECTRODE CONTROL OF A DC ARC FURNACE, AND AN ELECTRODE CONTROL DEVICE

The following statement is a full description of this invention including the best method of performing it known to us:-

TITLE OF THE INVENTION

Process for electrode control of a DC arc furnace, and an electrode control device

BACKGROUND OF THE INVENTION

Field of the Invention

The invention proceeds from a process for electrode control of a DC arc furnace ~~according to the preamble of claim 1~~, and from an electrode control device ~~according to the preamble of claim 5~~.

Discussion of Background

~~The preambles of the invention refer to~~ In the prior art as disclosed in EP-B1-0,068,180, ~~There~~ an arc furnace with a DC supply is controlled by means of two control circuits. A current controller ensures a constant current corresponding to a prescribed desired current value. An electrode control circuit influences the position of the electrode, and thus the arc length. In the event of lengthening of the arc, the current controller must increase the voltage or drive the rectifier so that the current remains constant. However, this works only as long as there is a voltage reserve present. The control of the electrode is performed by means of an adaptable DC controller. The arc voltage, which is fed via an attenuator to a comparator or summer, serves as the actual DC voltage value. The desired DC voltage value must be calculated in each case taking account of the transformer voltage ratio and the electrode current for each operating point. It is initially limited by a limiter, in accordance with the transformer ratio of the converter transformer, and thus with the possible voltage range of the converter, in such a way that the converter is operated in a steady state at most just below the rectifier limit. The desired value is fed smoothed to the summer, so as not to have any overshooting of the

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actual value in the case of sudden changes in the desired voltage value, which could cause interruption of the arc.

SUMMARY OF THE INVENTION

Accordingly, one object of this invention is further to develop a process for electrode control of a DC arc furnace and further to develop an electrode control device of the type mentioned at the beginning in such a way that simpler electrode control becomes possible.

Thus in a first aspect of the present invention there is provided a process for electrode control of a DC arc furnace comprising the steps of controlling an actual arc current intensity of the DC arc furnace by means of a rectifier control signal (α_{act}) to a prescribable reference current intensity (i_{des}) and

controlling an electrode separation, being the distance between at least one adjustable electrode and a molten bath of the arc furnace, as a function of the difference between a prescribable electrode controller reference variable signal (α_{des}) and the rectifier control signal (α_{act}).

One advantage of the invention consists in that it is possible to avoid calculating the desired value for the electrode control. For example, instead of the DC voltage, a signal proportional to the control angle may be taken from the current controller for the purpose of electrode control. This signal is passed via an attenuator, which in addition to signal matching also monitors the limiting values and filters out undesired frequencies. The desired value is prescribed as a value which determines the mean drive level of the rectifier.

A further advantage consists in that the arc length is adjusted independently of a voltage variation in such a way that the demanded current is achieved by means of a prescribed drive level at the rectifier. An adequate control range for stabilizing the current is thus always

available.

The compensation to a constant drive level at the rectifier also brings with it a constant mean power factor in the supplying mains. This is particularly important in the case of static compensation, by means of which compensation is carried out to a prescribed power factor.

The power of an operating point is very easily determined by means of selecting a transformer voltage ratio and prescribing the direct current.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be

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readily obtained as the same becomes better understood by reference to the following detailed description, relating to an exemplary embodiment, and considered in connection with the sole figure which shows a DC arc furnace with a current control circuit and an electrode control circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawing, the figure shows a furnace transformer (2) with a plurality of tappings, which is connected on the one hand to an a.c. mains (1) with an a.c. voltage of 22 kV, and on the other hand to the a.c. voltage input of a converter or rectifier (5). The DC voltage side of the rectifier (5) is connected via a choke (6) to a 1st electrode or cathode (7) of an arc furnace (8). A 2nd electrode or anode (12) arranged in the bottom region of the arc furnace (8) is connected to the positive terminal of the rectifier (5). An arc (10) burns between the lower end of the cathode (7) and a charge or scrap to be melted, denoted by (9), and the surface of a melt or a molten bath (11). (d) denotes an electrode separation or the distance between the cathode (7) and the molten bath (11).

An actual current value signal (i_{act}) is detected and fed to a negating input of a comparator or summer (13) by means of a current transformer (3) in the alternating current feeder to the rectifier (5). A prescribable desired current value signal (i_{des}) is fed to a non-negating input of this summer (13), for example from a potentiometer (not represented). On the output side, the summer (13) is connected to a current controller (14) with a proportional-plus-integral characteristic, which on the outside side delivers a rectifier manipulated variable signal (α_{act}), corresponding to a turn-on angle, to a turn-on pulse transformer (15), which controls the rectifier (5) on the output side.

The rectifier manipulated variable signal (α_{act}) is connected via an attenuator or a bandpass (16) for signal matching, limiting value monitoring and filtering out undesired frequencies to a negating input of a summer (17), to whose non-negating input a prescribable electrode controller reference variable signal (α_{des}) is fed, corresponding to a desired turn-on angle value in the range of 15° - 50°, preferably in the range of 25° - 35°. On the output side, the summer (17) is connected to an electrode controller (18) with a proportional characteristic, which acts on the output side via a valve amplifier (19) on a valve (20) of an electrode adjusting device (21). The electrode adjusting device (21), for example a hydraulic pump with an adjusting mechanism and an electrode speed controller, is mechanically coupled to the cathode (7) and permits its height to be adjusted; it acts as a 1st order delay element.

The electrode control operates approximately 10 times slower than the current control. The height adjustment of the cathode (7) is performed in such a way that the rectifier (5) operates on average with a drive level of, for example, 25° electrical, irrespective of the secondary voltage of the furnace transformer (2) and of the adjusted desired current value (i_{des}). For the sake of simplicity, values and signals assigned to them are denoted identically.

The frequencies to be filtered by the bandpass filter (16) comprise frequencies in the range of 0.5 Hz - 20 Hz.

Obviously, numerous modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described here.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A process for electrode control of a DC arc furnace comprising the steps of controlling an actual arc current intensity of the DC arc furnace by means of a rectifier control signal (α_{act}) to a prescribable reference current intensity (i_{des}) and

controlling an electrode separation, being the distance between at least one adjustable electrode and a molten bath of the arc furnace, as a function of the difference between a prescribable electrode controller reference variable signal (α_{des}) and the rectifier control signal (α_{act}).

2. A process as claimed in claim 1 wherein, before comparison with the electrode controller reference variable signal (α_{des}), the rectifier control signal (α_{act}) is monitored for overshooting of a limiting value.

3. A process as claimed in claim 1 or claim 2 wherein before comparison with the electrode controller reference variable signal (α_{des}) the rectifier control signal (α_{act}) is attenuated.

4. A process as claimed in claim 1 or 2 or 3 wherein, before comparison with the electrode control signal (α_{des}), undesired frequencies are filtered out from the rectifier control signal (α_{act}).

5. A process as claimed in any of claims 1, 2, 3 or 4 wherein the electrode controller reference variable signal (α_{des}) is a turn-on angle signal for the rectifier which is controlled to a desired turn-on angle value in the range of 15^{o}-50^{o}.

6. A process as claimed in claim 4 wherein the desired turn-on angle is in the range of 25^{o}-35^{o}.

7. An electrode control device for a DC arc furnace for carrying out the process of claim 1 comprising at least one adjustable electrode which is electrically connected

to a converter controlled by a current controller and having an electrode adjusting device for adjusting an electrode separation between the at least one electrode and the molten bath of the arc furnace which is controlled by an electrode controller wherein the electrode controller is connected on the input side to the output of the current controller.

8. An electrode control device as claimed in claim 7 wherein the electrode controller is connected on the input side via a bandpass filter.

9. An electrode control device as claimed in claim 7 wherein the electrode container is connected on the input side via an attenuator to the output of the current controller.

10. An electrode control device as claimed in claim 7, 8 or 9, wherein the difference signal between an electrode controller reference variable signal (α_{des}) and a rectifier control signal (α_{act}) is fed to the input side of the electrode controller.

11. The electrode control device as claimed in claim 7, wherein the rectifier control signal (α_{act}) is a turn-on angle signal for a rectifier and the electrode controller manipulated variable signal (α_{des}) corresponds to a desired turn-on angle value in the range of 15^{o}-50^{o}.

12. A device as claimed in claim 11 wherein the range is 25^{o} to 35^{o}.

13. A process substantially as hereinbefore described with reference to the drawings.

14. An electrode control device substantially as hereinbefore described with reference to and as shown in Figure 1.

DATED this 31st day of December 1993

ASEA BROWN BOVERI LTD
Patent Attorneys for the
Applicant:

F.B. RICE & CO.

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ABSTRACT OF THE DISCLOSURE

Process for electrode control of
a DC arc furnace, and an electrode control device

DC arc furnaces (8) have a current controller (14) for stabilizing the current of an arc (10), and an electrode controller (18) for influencing the position of an electrode (7) of the arc furnace (8) and thus the length of an arc (10). The control of the position of the electrode (7) is performed by means of a hydraulic electrode adjusting device (21), which is controlled as a function of a difference between a prescribable electrode controller reference variable signal (α_{des}) and a rectifier manipulated variable signal (α_{act}) at the output of the current controller (14). As a result, the arc length is regulated such that a rectifier (5) operates on average with a drive level of, for example, 25° electrical, irrespective of the secondary voltage of a furnace transformer (2) and of an adjusted desired current value signal (i_{des}). Limiting values are monitored and undesired frequencies are filtered out by means of a bandpass filter (16) between the output of the current controller (14) and a comparator or summer (17) for forming the difference signal between the electrode controller reference variable signal (α_{des}) and the rectifier manipulative variable signal (α_{act}).

(single figure)

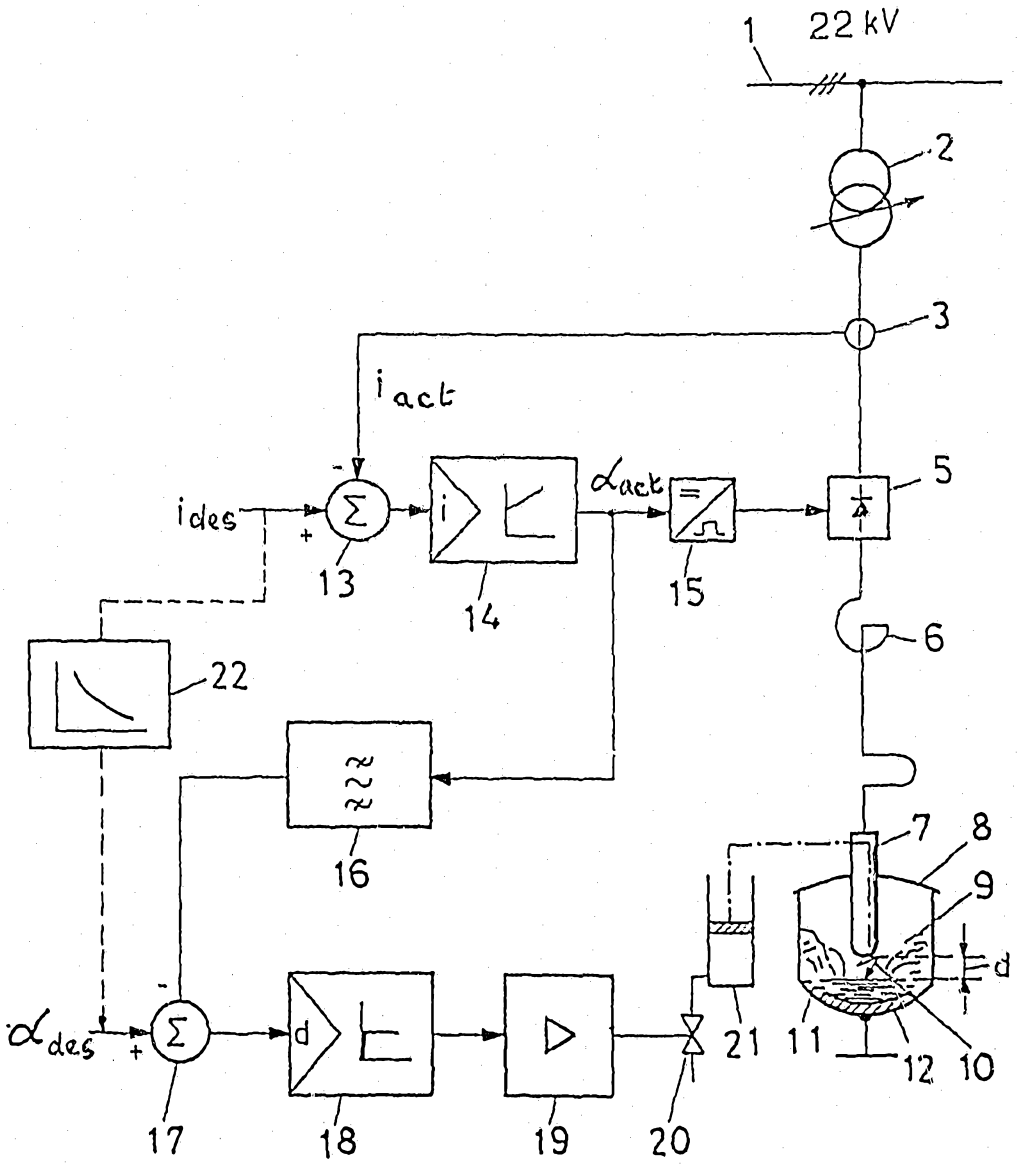

1
22 kV
2
3
i_{act}
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FIG.1

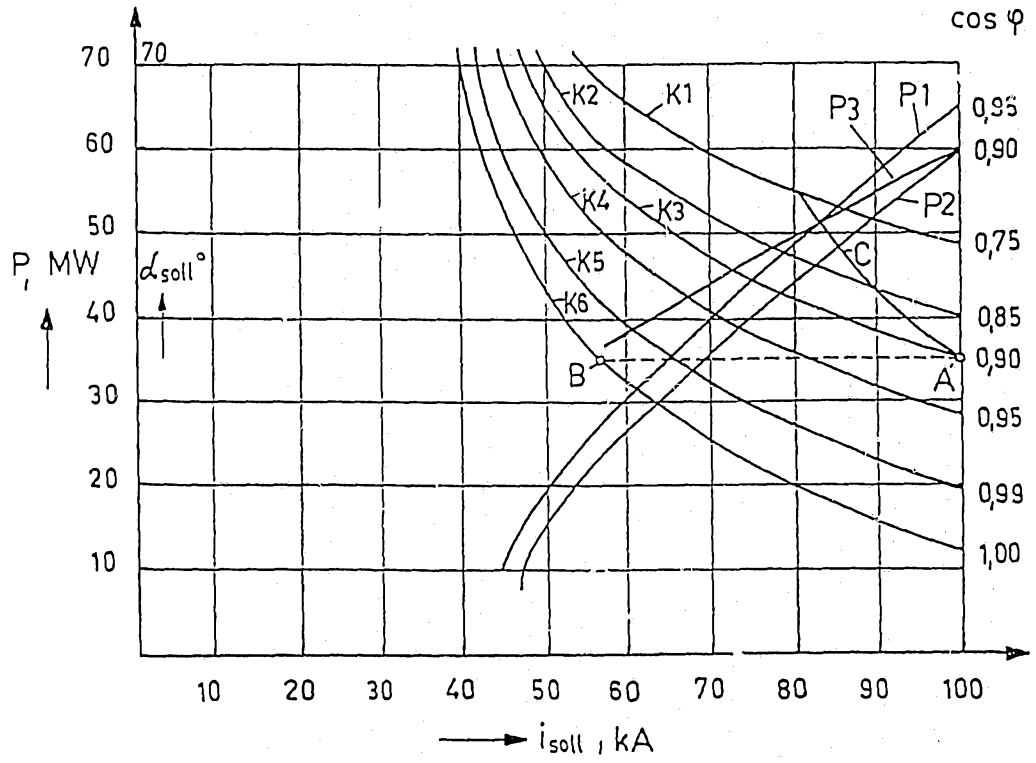

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FIG.2