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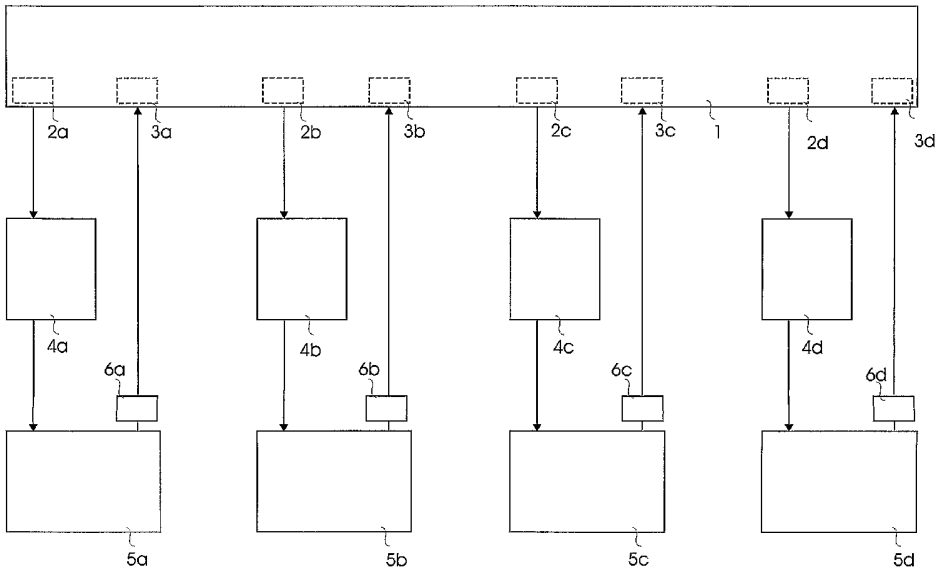
(54) Title: METHOD AND DEVICE FOR CONTROLLING A WELDING PROCESS THROUGH A CURRENT PULSE PERIODICALLY SUPERIMPOSED ON THE WELDING CURRENT



(57) Abstract: The invention relates to a method for simultaneously controlling a number of welding processes. For each individual welding process a current pulse is herein superimposed periodically on the welding current and the arc voltage for this welding process is then measured. The welding current for this welding process is regulated on the basis of a frequency spectrum of the measured arc voltage.

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METHOD AND DEVICE FOR CONTROLLING A WELDING PROCESS THROUGH A CURRENT PULSE PERIODICALLY SUPERIMPOSED ON THE WELDING CURRENT

The invention relates to a method for controlling welding processes, wherein during a welding process a welding current is periodically increased, wherein after the welding current has been increased an arc voltage is determined and the welding process is controlled by regulating a level of the welding current subject to the measured arc voltage.

Such a method is known from the application WO 95/34400, which application is added to the present application by way of reference. In accordance with the model employed in said application, the size, and more particularly the maximum extent, of a melting bath of a welding process can be derived from an alternating voltage superimposed on the arc voltage of this welding process. The welding current is then regulated such that a complete welding through is achieved without molten metal flowing away.

The method according to the invention is based on the inventive concept that the oscillations can be excited in directed manner, and has the feature that a short current pulse is periodically superimposed on the welding current and that the welding process is controlled on the basis of changes in the arc voltage resulting from this current pulse. The current pulse causes oscillations in the melting bath at a predetermined moment, whereby a measurement of the oscillations can be linked to this moment and measurement can take place in highly efficient manner.

A favourable realization of the inventive method has the feature that a current pulse has a length of 1 to10 milliseconds and an amplitude of 50 to 600 amperes. Such a current pulse is on the one hand able to excite sufficiently large oscillations in the melting bath without changing the size of the melting bath, and is on the other hand easy to realize with an existing power source.

A further advantageous realization of the inventive method has the feature that a measurement of the arc voltage is started 5 to 15 milliseconds after the current pulse has ended. The oscillations in the melting bath have then reached full development, while electromagnetic interference signals from the current pulse have practically disappeared.

A further advantageous realization of the inventive method has the feature that the change in the arc voltage is determined using a welding sensor placed close to the welding process, that this welding sensor is adapted to convert the change in the arc

voltage into digital information, and that using a computer the digital information is converted into a control signal for a welding power source. The computer can then be situated some distance from the welding process, whereby strong interference fields caused by the welding process cannot affect the computer. The connection between the welding sensor and the computer can for instance be formed by a C.A.N. network, which is known in the field and practically insensitive to interference fields, but is preferably formed by a wireless connection.

Because the change in the arc voltage can now be determined precisely and in a short period of time, it is possible to control a plurality of welding processes with one computer. A favourable realization of the inventive method therefore has the feature that the welding process can comprise more than one individually performed sub-process, that for each individual sub-process the change in the arc voltage can be determined and stored with a welding sensor placed close to the sub-process, and that using a central computer the stored changes in the arc voltage for the sub-processes are converted into control signals for welding power sources for the individual sub-processes. Each welding sensor is here preferably adapted to convert the change in the arc voltage into digital information and to store this digital information, whereby the information transfer can take place digitally in rapid manner and at a moment to be determined by the computer.

The invention also relates to a device for controlling a welding process, comprising a power source for generating a welding current, a welding sensor placed close to the welding process for measuring an arc voltage of the welding process, a computer provided with an input circuit connected to the welding sensor and an output circuit connected to a control input of the power source, wherein the computer is adapted to control a level of the welding current as a function of changes in the arc voltage.

Such a device is known from the application WO 95/34400. In the known device the welding current, and thereby the size of the melting bath, changes periodically, and measurement takes place in a predetermined part of a period of time.

Conversely, the device according to the invention can also be applied in welding processes wherein the current does not change periodically, and has the feature that the computer is adapted to superimpose short current pulses on the welding current during the welding process, that the welding sensor is adapted to always measure the arc voltage after a current pulse and that the computer is adapted

to control the welding process on the basis of changes in the measured arc voltage. The short current pulses do not change the size of the melting bath but set the melting bath into vibration. As a result of this vibration the arc voltage will begin to contain an alternating voltage component, the frequency of which is a measure of the size and maximum extent of the melting bath.

An advantageous embodiment of the inventive device has the feature that the computer is adapted to superimpose current pulses with a length of 1 to10 milliseconds and an amplitude of 50 to 600 amperes. Such a current pulse is on the one hand able to generate sufficiently large oscillations in the melting bath and is on the other hand simple to realize with an existing power source. A welding sensor is preferably adapted such that a measurement of the arc voltage is started 5 to 15 milliseconds after the current pulse has ended. The oscillations in the melting bath have then reached full development, while electromagnetic interference signals from the current pulse have practically disappeared.

An advantageous embodiment, which makes use of a more efficient method by which data relating to the condition of the melting bath are obtained, has the feature according to a further aspect of the invention that the device comprises at least two welding sensors, connected to at least two input circuits of the computer and at least two power sources connected to at least two output circuits of the computer, and that the computer is adapted to control the power sources on the basis of changes in the arc voltage of at least two individual welding processes. More particularly it is now possible to control a number of welding processes using one centrally disposed computer. This is important because the computer is expensive compared to the locally deployed components such as a power source and a welding sensor. In order to prevent the individual welding processes disturbing each other, for instance as a result of electromagnetic fields or of interference voltages created by earth loops, the connections between the computer and the welding sensors preferably take a wireless form.

The invention will now be further elucidated with reference to the following figures, wherein:

Fig. 1 shows in the form of a block diagram a possible embodiment of a fourfold welding process;

Fig. 2 shows in the form of a block diagram a possible embodiment of a welding sensor.

Fig. 1 shows in the form of a block diagram a possible embodiment of a fourfold welding process, consisting of a suitably programmed computer 1 provided with output circuits 2a,2b,2c,2d and input circuits 3a,3b,3c,3d. Connected to output circuits 2a,2b,2c,2d are four power sources 4a,4b,4c,4d, each suitable for performing a welding process, wherein using an output circuit the current from the associated power source can be adjusted in a manner self-evident to the skilled person. Power sources 4a,4b,4c,4d supply four welding processes 5a,5b,5c,5d, wherein an electrode causes metal to melt around for instance a seam such that the seam is almost fully filled with molten metal. To enable control of the power sources, there are placed close to the welding processes welding sensors 6a,6b,6c,6d which measure the arc voltage for each process and transmit this arc voltage to input circuits 3a,3b,3c,3d. Computer 1 then determines the optimal welding currents for welding processes 5a,5b,5c,5d, and controls power sources 4a,4b,4c,4d accordingly via output circuits 2a,2b,2c,2d. In the figure the connections between the output circuits and the power sources are shown as fixed connections, as are the connections between the input circuits and the welding sensors. It is however recommended to realize these connections in wireless manner or via glass fibres so as to prevent the differing welding processes disturbing or otherwise affecting each other.

Fig. 2 shows in the form of a block diagram a possible embodiment of a welding sensor 6, which is disposed close to a welding process 5. During welding an electrode 7 is placed close to a seam 8 for welding in a metal object 9 such that an arc 10 is formed which creates a melting bath 11 of molten metal around seam 8. The welding current for the welding process is supplied by a power source 4 which is controlled via a wireless connection 12 which is controlled by an output circuit 2 of computer 1, which is this embodiment is likewise provided with a wireless connection. Power source 4 must be controlled such that melting bath 11 fills practically the whole seam 8 without molten metal being able to leak away. It is known that the condition of the melting bath can be derived from an arc voltage of arc 10. The arc voltage is therefore measured using a measuring device 13 such that a signal representing the arc voltage is generated, wherein simultaneously a galvanic separation between the actual welding process and the output of measuring device 13 must be realized. Measuring device 13 can for instance be equipped with an optical coupling, via which the arc voltage is transmitted, or with a Hall element via which the arc voltage is

transmitted, this in a manner self-evident to the skilled person. The signal representing the arc voltage measured using measuring device 13, generally a direct voltage with an alternating voltage superimposed thereon, is then filtered in a filter 14 which only allows through the alternating voltage components from which the condition of melting bath 11 can be derived. Using an analog-digital converter 15 this alternating voltage component is subsequently converted into a series of digital measurement values which are stored in a memory 16. Analog-digital converter 15 receives a signal 17 from computer 1 via wireless connection 12, whereafter it performs a predetermined number of measurements. Memory 16 receives a signal 18 from computer 1, whereafter the memory sends the stored measurements via wireless connection 12 to computer 1, this in a manner self-evident to the skilled person. Once a measurement of the arc voltage has taken place, a spectrum of the alternating voltage component is determined by computer 1 in a manner known in the field, whereafter the condition of melting bath 11 is known and the amplitude of the welding current can, if desired, be adjusted and transmitted via wireless connection 12 to power source 4.

The method and the device for controlling welding processes can, if desired, also be applied in welding processes wherein the welding current is varied periodically such that periods with a low welding current and periods with a high welding current alternate with each other. It is recommended here to give a current pulse at the end of a period with a high welding current, because the melting bath is then largest. The timing of the current pulses can be provided in simple manner by computer 1 on the basis of the known timing of the periods.

CLAIMS

1. Method for controlling welding processes, wherein during a welding process a welding current is periodically increased, wherein after the welding current has been increased an arc voltage is determined and the welding process is controlled by regulating a level of the welding current subject to the measured arc voltage, characterized in that a short current pulse is periodically superimposed on the welding current and that the welding process is controlled on the basis of changes in the arc voltage resulting from this current pulse.

2. Method as claimed in claim 1, characterized in that a current pulse has a length of 1 to10 milliseconds and an amplitude of 50 to 600 amperes.

3. Method as claimed in claim 2, characterized in that a measurement of the arc voltage is started 5 to 15 milliseconds after the current pulse has ended.

4. Method as claimed in claim 3, characterized in that the change in the arc voltage is determined using a welding sensor placed close to the welding process, that this welding sensor is adapted to convert the change in the arc voltage into digital information, and that using a computer the digital information is converted into a control signal for a welding power source.

5. Method as claimed in claim 4, characterized in that the welding process can comprise more than one individually performed sub-process, that for each individual sub-process the change in the arc voltage can be determined and stored with a welding sensor placed close to the sub-process, and that the stored changes for the sub-processes are converted using a central computer into control signals for welding power sources for the individual sub-processes.

6. Method as claimed in claim 5, characterized in that each welding sensor is adapted to convert the change in the arc voltage into digital information and to store this digital information.

7. Device for controlling a welding process, comprising a power source for generating a welding current, a welding sensor placed close to the welding process for measuring an arc voltage of the welding process, a computer provided with an input circuit connected to the welding sensor and an output circuit connected to a control input of the power source, wherein the computer is adapted to control a level of the welding current as a function of changes in the arc voltage, characterized in that the computer is adapted to superimpose short current pulses on the welding current during the welding process, that the welding sensor is adapted to always measure the arc voltage after a current pulse, and that the computer is adapted to control the welding process on the basis of changes in the measured arc voltage.

8. Device as claimed in claim 7, characterized in that the computer is adapted to superimpose current pulses with a length of 1 to10 milliseconds and an amplitude of 50 to 600 amperes.

9. Device as claimed in claim 8, characterized in that a welding sensor is adapted such that a measurement of the arc voltage is started 5 to 15 milliseconds after the current pulse has ended.

10. Device as claimed in claim 7 or 8, characterized in that the device comprises at least two welding sensors, connected to at least two input circuits of the computer, and at least two power sources connected to at least two output circuits of the computer, and that the computer is adapted to control the power sources on the basis of changes in the arc voltage of at least two individual welding processes.

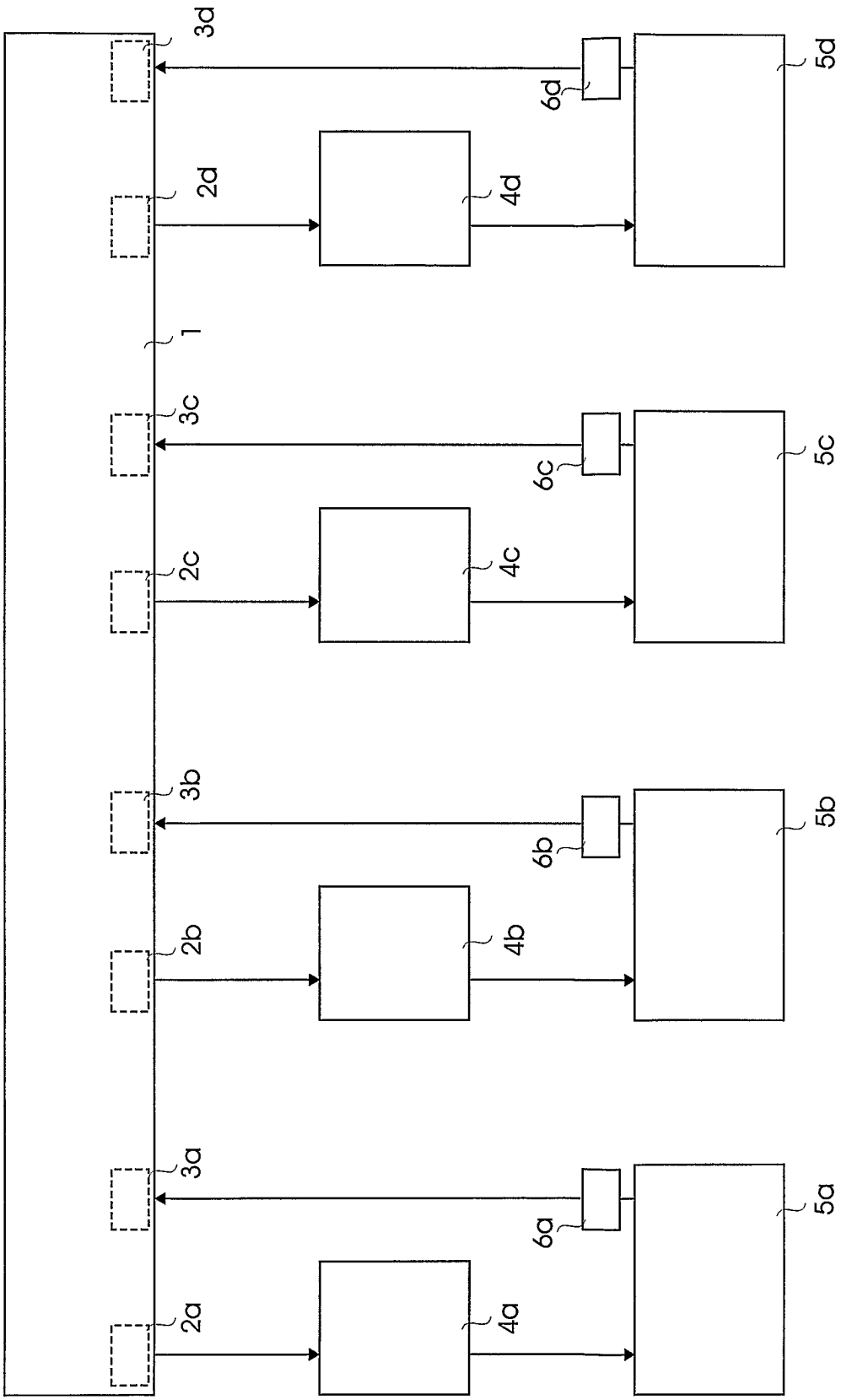

Fig. 1

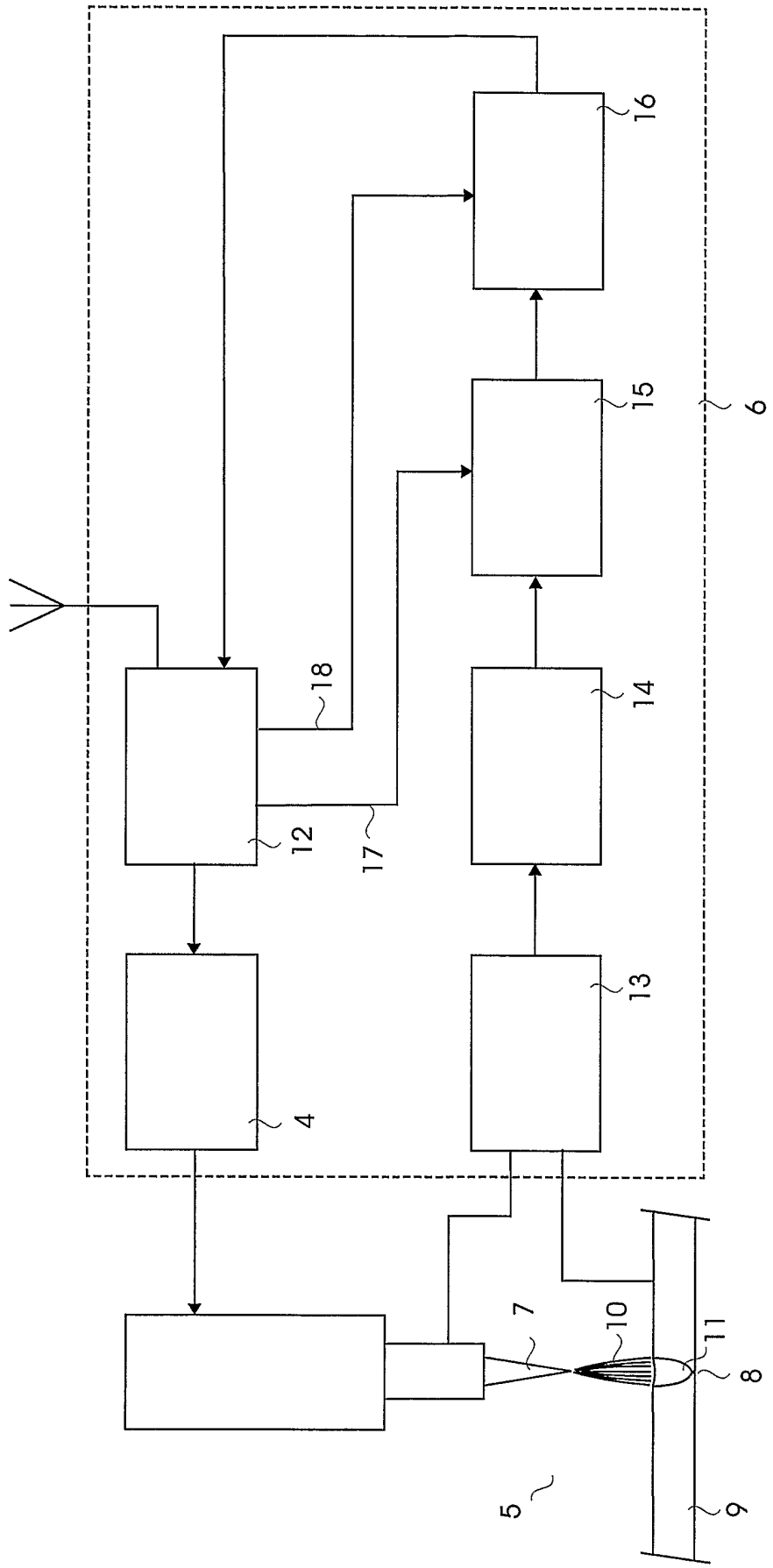

Fig. 2

INTERNATIONAL SEARCH REPORT

ıtional Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B23K9/095 B23K9/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 May 2005	28/06/2005

Name and mailing address of the ISA	Authorized officer
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tional Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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