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D E C I S I O N
of 5 April 2001

Case Number: T 1170/97 - 3.4.2

Application Number: 91906310.7

Publication Number: 0474883

IPC: H05B 7/06

Language of the proceedings: EN

Title of invention:

DC electric furnace for melting metal

Patentee:

KAWASAKI STEEL CORPORATION

Opponent:

Siemens AG
Mannesmann Aktiengesellschaft

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

"Novelty - claim 1 (yes)"
"Inventive step - claim 1 (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 1170/97 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 5 April 2001

Appellant: KAWASAKI STEEL CORPORATION
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 2 October 1997
revoking European patent No. 0 474 883 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: E. Turrini
Members: M. A. Rayner
B. J. Schachenmann

Summary of Facts and Submissions

I. The appellant (=patent proprietor) has appealed against the decision of the opposition division revoking European patent number 474 883 (application number 91 906 310.7). In the proceedings before the opposition division, reference was made, amongst others, to the following documents:

D1: AT-E-51 337

D2: DE-C-3 543 278

D4: DE-A-2 510 326

The opposition division considered the subject matter of claim 1 in dispute to be novel over the disclosure of document D1 which it considered to represent the closest prior art. The division identified the following features of the claimed direct current electric furnace as novel:

- (a) the furnace includes a single top electrode,
- (b) an ammeter is provided in each of the thyristor circuits, and
- (c) each of said thyristor circuits controls one of the electric currents flowing through the furnace bottom electrodes on the basis of the electric current values measured by said ammeters thereby controlling the direction of direct current arc generated in the electric furnace.

As far as inventive step was concerned, the division considered feature (a) to be a matter of normal design procedure. Feature (b) amounted to merely one of

several possibilities, selectable by the skilled person without inventive skill. An ammeter can be interchanged with a "receptor" of document D1. The first part of feature (c) is known from document D1 and for example document D4 shows that the direction of direct arc current generated can be controlled by controlling the current. A thyristor is merely a special kind of switching device. Reference was also made to lines 56 to 60 of document D2 in relation to individual control of the bottom electrodes.

II. According to the appellant, the decision under appeal failed to discuss whether the combination of features (a), (b) and (c) is anticipated and involves an inventive step. The statement that a receptor can be interchanged with an ammeter is wrong as no standard textbook could be found explaining a receptor as having the meaning of an ammeter. Furthermore the statement that a thyristor is a special kind of switch appears partly wrong as in the invention the thyristor circuits are not used for switching on and off but to adjust the current to a desired level. The appellant elaborated the difference, in its view, between thyristor current control as opposed to switch based current control. Surprisingly, the subject matter of claim 1 in issue enabled deflection of the arc in the radial direction of the furnace, i.e. to swing the direction of arcs.

III. According to respondent I, there are far fewer differences between the main claim and the state of the art than submitted in the statement setting out the grounds of appeal. Thyristors control current flow through the ratio of open to closed time, thyristors being semiconductor switches. Reference to any textbook shows that the arguments of the appellant are incorrect

in this respect. Document D4 discloses the main features of the claim (for example "controlling the direction of direct current arc" in the second paragraph on page 5). The sole difference between the subject matter of claim 1 in issue and the disclosure of document D4 is current measurement through the arc furnace and use of the measured value for control. According to the patent in suit, a closed loop control is formed by an arc furnace and a controller, the latter comprising a sensor, control algorithm and control means. Only the sensor is missing from document D4 and this is provided by the disclosure of document D1. The appellant is incorrect in submitting that an ammeter is not disclosed in document D1 because a sensor for measuring current is an ammeter and thus is disclosed in the middle paragraph on page 5 of document D1. Moreover the subject matter of claim 1 is also obvious over document D1 in the light of document D4, since the former discloses all its features except the single electrode, which is obvious in view of the last paragraph on page 6 of document D4.

- IV. According to respondent II, the use of a single upper electrode is obvious for the skilled person and a thyristor such a usual component that no special consideration is requiring by an engineer for its use. It is essential in a closed loop control circuit that a value be measured by a measuring device, typically an ammeter. Therefore no inventive step is required in using ammeters for controlling an arc furnace according to document D1. So far as the advantage of a swinging arc is relied on by the appellant, respondent II referred to column 4, from line 6 onwards of document D2 (referred to as D7 by respondent II) in order to show this too was known long before the patent.

V. The appellant requested setting aside of the decision of the opposition division and maintenance of the patent as amended before the opposition division. Both respondent I (=opponent I) and respondent II (=opponent II) requested the board to dismiss the appeal of the appellant. Oral proceedings were requested on an auxiliary basis by the appellant and respondent II.

VI. Oral proceedings were appointed, consequent to the auxiliary requests of the parties. During the oral proceedings, reference was made to

D8: EP-A-58 817

which is mentioned as the starting point for the teaching of document D2 (see column 2, line 39).

The appellant explained that in the patent in dispute there was one upper electrode and a plurality of lower electrodes. Although use of a single electrode can be considered per se known, as a rule the configuration is one-one or plurality-plurality. The significance of the construction of the invention is that the electric arc can be steered in the furnace between the single upper electrode and lower electrodes as appropriate. This is not the case in the three-three configuration of document D1, nor can this document give any hint towards the invention because it teaches that the arcs should be balanced (see page 2, second paragraph). Document D2 offers the possibility of moving the arc, this however occurs by switching. So far as document D8 is concerned, it was never in dispute that use of a single electrode is as such known. Document D4 is concerned with the directional characteristics, yet

relies on switches for the electrodes. In the invention, there is by virtue of use of thyristors one hundred percent power and no down time, whereas in the prior art current is off during the switched off time, the switches also having a response lag. The structural features necessary for defining the invention are present in the claim. It is not necessary that the arguments in support of inventive step thereof as advanced by the representative of the appellant also be recited in the claim.

VII. The respondents argued during the oral proceedings as follows.

Respondent I

The last paragraph on page 6 of document D4 relating to only one or two of the upper electrodes taking current following arc blow-out or some other malfunction renders a one to many electrode configuration obvious and thyristors are well known to be switches as is their current handling behaviour. The claim does not contain features bearing on the direction control functionality stressed by the appellant. Accordingly, the subject matter as claimed lacks any inventive step.

Respondent II

According to page 6, line 40 et seq. of the patent, the real reason why there is only one upper electrode is to permit use of a single cable. Document D1 discloses use of thyristors, meeting the claim wording which does not specify arc steering. One upper electrode allows steering, this is however known from document D2. The arguments of the appellant are not reflected in the

subject matter claimed. Thus, the subject matter of the independent claim cannot be considered to involve an inventive step.

VIII. Claim 1 according to the request of the appellant is worded as follows:

A direct current electric furnace (110;16) for melting metal using direct current arcs, including: a single top electrode (118;18) a plurality of furnace bottom electrodes (130;30), characterized by further including a plurality of electric current controlling thyristor circuits each of which respectively controls one of the electric currents flowing through said furnace bottom electrodes (130;30), wherein in each of said thyristor circuits an ammeter (126;35) is provided for measuring the value of each of the electric currents flowing through said furnace bottom electrodes (130; 30), and wherein each of said electric current controlling thyristor circuits controls one of the electric currents flowing through said furnace bottom electrodes (130;30) on the basis of the electric current values measured by said ammeters (126;35) thereby controlling the direction of direct current arc generated in the electric furnace (110;16).

IX. At the end of the oral proceedings, the board gave its decision.

Reasons for the Decision

1. The appeal complies with the provisions mentioned in Rule 65(1) EPC and is therefore admissible.

2. *Article 123 EPC*

2.1 Claim 1 derives from a combination of claims 1 and 2 as granted, which in turn derive from claims 1 and 2 as originally filed with certain linguistic clarifications and adaptation in the light of Rule 29.

Therefore, claim 1 satisfies the requirements of Article 123 EPC.

3. *Novelty*

3.1 According to document D1, the power supply system is designed to supply direct current to an electric arc furnace comprising three movable upper electrodes, the furnace also comprising three base electrodes of the same polarity coupled to one another and behaving as if there were only a single base electrode. Power is supplied from a three phase alternating current transformer. Each of the upper electrodes of the furnace is powered by a converter formed by a set of controlled rectifiers constituted by thyristors arranged in three bridges. There is thus a half bridge of three thyristors connecting the alternating current supply to each movable electrode and a half bridge of three thyristors connecting the alternating current supply to each base electrode. The dephasing and control of the thyristors of the two sets of half bridges are dissociated. The half bridges to the upper electrodes have independent dephasing angles and are each controlled individually so providing independent function in blocking or conducting state with the arc voltage. A regulator supplies a control voltage to a control assembly for each of the half bridges. The current signal is measured by a receptor associated

with a probe at each of the load supply buses and is compared to a reference current for the corresponding electrode. The difference controls dephasing. It is thus possible to balance the currents in the three bridges.

The subject matter of claim 1 of the patent in dispute also uses thyristor circuits with a DC furnace but differs from the disclosure of document D1 by having a single top electrode, bottom electrode currents measured by ammeters and thyristor function for current and arc direction control.

Accordingly the board concurs with the opposition division as to the features by which the subject matter of claim 1 is novel with respect to the disclosure of document D1.

- 3.2 According to document D2, bottom electrodes are provided with current feedlines which include switching elements. These switching elements can be controlled individually. Through controlled interruptions of the current flow through individual feed lines it is possible to set the arc into motion. The controlled selection and interruption of current flow for individual electrodes provides the arc with a contour such as an oblique orientation, which is instrumental in lowering the load on certain areas inside the furnace otherwise experiencing excessive load. Circuit breakers controlled by a controller are used for this purpose.

The board also reviewed document D8, disclosing what in document D2 is stated to be a furnace of the type to which the invention of document D2 pertains

(gattungsbildend). While no upper electrode structure is shown in document D2, a single upper electrode is disclosed in Figure 1 of document D8.

Accordingly the subject matter of claim 1 is novel with respect to the disclosure of document D2 because the current value is not measured therein so that no basis is provided for current and arc direction control as required by the claim.

- 3.3 In accordance with the teaching of document D4, with selective connection of electrodes, the directions of the lobes of power dissipation within the furnace during arcing can be manipulated so as to control and improve melting within the furnace for example to melt down banks of scrap. The arc furnace comprises a vessel and three dependent graphite electrodes extending through a roof. The power supply for the furnace is derived from a transformer, the secondary windings of which separately apply an appropriate phase to full-wave rectifier banks comprising silicon rectifiers. The positive outputs from these banks are individually coupled through a switching mechanism to one or more electrodes in the vessel which contact the melt, whilst the negative connections are separately coupled to the dependent electrodes. In the example, there are six electrodes contacting the melt which are interleaved in groups of three. The switching mechanism comprises three switches to one group ganged together with a conductive link and three individually operative switches to the other group. Therefore, if the ganged switches are closed, the arc is blown in. If, instead, one of the other switches is closed, the arc is propelled away from the electrode concerned. The power supply can also use a delta primary since this ensures

load balancing where only one or two of the dependent electrodes are taking current following arc blow-out or some other malfunction.

Accordingly the subject matter of claim 1 is, similarly to the case of document D2, novel with respect to the disclosure of document D4 because in this teaching the current value is not measured therein so no basis is provided for current and arc direction control. As the other upper electrodes, though inoperative, remain physically present even if there is a blowout, the board also considers a fair reading of the claim to involve the recitation of a single top electrode being novel.

3.4 Therefore, the subject matter of claim 1 is novel over the subject matter of any one of documents D1, D2 or D4.

4. *Inventive step*

4.1 If document D1 is taken as representing the closest prior art, the problem solved by the novel features can be seen as that of redesigning the electrode and control configuration to permit efficient steering of the arc within the furnace.

4.2 While the teaching of document D2 permits the arc to be steered, this achieved only by use of switches, resulting simply in a disconnected electrode rather than controlling the direction of direct current arc on the basis of current value measured. A similar situation exist with respect to document D4, where switches are also used. The problem with this approach is that since an electrode is "off", its performance is

lost entailing both reduced efficiency and disproportionate wear of the other "on" electrodes. Accordingly the teaching of document D2 or D4 does not provide a solution to the problem solved by the subject matter of claim 1 of the patent. Thus, even if the inefficient option of document D2 or D4 were to be applied to the teaching of document D1, the most that could be achieved would be disconnecting one or other of the upper electrodes shown in document D1, which not only fails to satisfy the wording of claim 1 but is itself an improbable route for the skilled person in view of the objective in document D1 of keeping the three upper electrodes balanced.

- 4.3 If, on the other hand, document D2 or D4 is taken as closest prior art, then the problem to be solved is that of improving the control configuration to enhance steering of the arc within the furnace. In the case of document D4, there is the further problem of the upper electrode configuration also needing to be redesigned. As is apparent from document D2 or D4, steering operation relies on the electrodes being out of balance in their on or off conditions, this lack of balance being the reason for arc deflection. The board therefore considers the disclosure of document D1 towards balancing of the currents in the three upper electrodes to provide exactly what the skilled person would **not** want in this connection. Moreover, any attempt to use the teaching of document D1 would reinforce the need for three top electrodes. In this context, the board therefore observes that a possible fit of document D1 with document D4 in the sense of a "closed loop control" would seem to be in connection with the ganged up switches and blown in arc, which would then be well balanced. However, if the skilled

person would, as postulated by the respondents, have started from document D2 or D4 and wished to improve arc control, no fit between the documents exists at all because the skilled person would have dismissed the "balancing" teaching of document D1 as irrelevant to replacement of the switches in either document for use in the contrary function of arc steering. Accordingly, the board is of the view that in view of their incompatibility, a combination of the teaching of document D1 with that of document D2 or D4 can only be based on impermissible hindsight considerations.

The submissions of respondent I that switches have on/off periods like thyristors do not change this situation because they do not address the issue of the differing balancing and steering functions of document D1 and D4, respectively. The board furthermore notes that, for example the claim in dispute contains a feature "thereby controlling the direction of direct current arc generated in the electric furnace". Therefore, submissions of the respondents that this claim does not contain features relevant to arc steering can in the view of the board neither be considered correct nor as a convincing line of argument as to lack of inventive step. The view of respondent II that the real reason for the single upper electrode is to have a single cable results from picking out just one factor discussed in line 40 onwards on page 6 of the patent and, in the light of the foregoing analysis of the board, does not constitute a convincing attack on the subject matter of claim 1.

4.4 Therefore, independent of which of documents D1, D2 or D4 is taken as closest prior art, it was not possible for the skilled person to have reached the subject

matter of claim 1 in an obvious way. Therefore, the board has reached the conclusion that having regard to these documents, the subject matter of claim 1 can be considered to involve an inventive step within the meaning of Article 56 EPC.

- 4.5 The remaining prior art in the file relates either to thyristor as such or direct current electric furnaces coming less close to the subject matter of claim 1 than that already dealt with. Consequently, this prior art does not affect the conclusion of the board that the subject matter of claim 1 can be considered to involve an inventive step within the meaning of Article 56 EPC.

5. *Adaptation of the description and dependent claims*

- 5.1 The amendment made to claim 1 necessitates consequential amendments to the description and dependent claims. In adapting the description, document D1 and D4 should be evaluated and care should be taken to amend passages no longer fully consistent with the claim (for example page 4, line 18 onwards) and to cancel any passages inconsistent with claim 1 (an example is lines 13 to 15 on page 5). Similarly, the dependent claims contain inappropriate repetition of wording consequent to incorporation of the granted claim 2 into claim 1 in the post grant proceedings (see for example claims 4, 6 and 8 of the granted patent). Consequential amendments to the statement of claim as well as renumbering of dependent claims are therefore appropriate.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to maintain the patent as amended with claim 1 submitted on 19 February 1997 and with the dependent claims and the description to be adapted and the drawings as in the patent specification.

The Registrar:

The Chairman:

P. Martorana

E. Turrini