Europäisches Patentamt
Beschwerdekammern

European Patent Office
Boards of Appeal

Office européen des brevets
Chambres de recours

Veröffentlichung im Amtsblatt	Ja/Nein
Publication in the Official Journal	Yes/No
Publication au Journal Officiel	Oui/Non

Aktenzeichen / Case Number / N° du recours : T 398/88 - 3.4.1

Anmeldenummer / Filing No / N° de la demande : 81 302 533.5

Veröffentlichungs-Nr. / Publication No / N° de la publication : 0 042 689

Bezeichnung der Erfindung: Method and apparatus for controlling electrode drive speed in a consumable electrode furnace
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement : H05B 7/152, H05B 3/60

ENTSCHEIDUNG / DECISION

vom / of / du 6 December 1990

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent / Titulaire du brevet : Consarc Corporation

Einsprechender / Opponent / Opposant : Leybold AG

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56

Schlagwort / Keyword / Mot clé : "Inventive step (yes)"

Leitsatz / Headnote / Sommaire

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 398/88 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 6 December 1990

Appellant : (Proprietor of the patent)
Consarc Corporation
100 Indel Avenue
Rancocas
New Jersey 08073 (US)

Representative :
R.B. Thomson
Pollak Mercer & Tench
High Holborn House
52-54 High Holborn
London WC1V 6RY

Respondent : (Opponent)
Leybold AG
Wilhelm-Rohn-Strasse 25
D-6450 Hanau am Main

Representative :
Dipl.-Ing. H. Zapfe
Am Eichwald 7
D-6056 Heusenstamm - 2

Decision under appeal :
Decision of the Opposition Division of the European Patent Office dated 24 June 1988 revoking European patent No. 0 042 689 pursuant to Article 102(1) EPC.

Composition of the Board :

Chairman : G.D. Paterson

Members : Y.J.F. van Henden

R. Shukla

Summary of Facts and Submissions

I. Notice of Opposition was filed against European patent No. 0 042 689 on the ground that the claimed subject-matter was not patentable within the meaning of Articles 52 to 57 EPC, having regard to the state of the art disclosed in the following documents:-

D1: DE-A-1 934 218
D2: DE-B-1 220 057
D3: DE-A-2 456 512
D4: Proceedings of the international vacuum metallurgy conference on special melting, San Diego, California, 1979, pages 831-847, J.H. Chen et al. "Computer control of the electro slag remelting process",

In response, the Patentee filed an amended Claim 1.

II. The Opposition Division revoked the patent on the ground that the subject-matter of new Claim 1 lacked an inventive step in view of document D4.

III. In the appeal, oral proceedings were held on 6 December 1990. During the hearing, the Appellant's representative filed a set of claims numbered 1-10 to replace those previously filed, together with a new page 3 of the description taking into account the amendments to the claims. Independent Claims 1 and 9 thereof read as follows:

"1. A consumable electrode melting furnace (10) comprising an electrode (18), a fluid cooled mould (12), an electrical supply system (32) for melting the electrode (18) to form an ingot (34) in the mould (12), electrode drive means (26, 30) for re-positioning the electrode (18) as the melt proceeds, and a control system (44) for

regulating the output speed (S) of said electrode drive means (26, 30) during the melt to control the length of the gap between the bottom of the electrode (18) and the top surface of the ingot (34) being formed in the mould, characterized in that
the control system (24, 40, 42, 44, 46, 50) is arranged to regulate the output speed (S) of said electrode drive means (26, 30) as a function of a base speed (S_B) computed at frequent intervals from measured changes in the melt rate constituting changes in the weight per unit of time of the electrode (18) or ingot (34) during the melt, the geometry of the electrode (18), the geometry of the mould (12), and the speed of movement of the bottom of the ingot (34) if other than zero and in that the base speed (S_B) is increased or decreased by a function of a relatively less responsive trim speed (S_T) provided by a relatively slow-acting feedback control variable which is determined from measurement of voltage or current or other electrical phenomenon which has a value related to the distance between the bottom of the electrode and the top surface of the ingot having an average value determined over a period of time that is relatively longer than the period of time over which changes in output speed (S) are computed based upon base speed (S_B) which is determined from measured changes in the weight of the electrode (18) or ingot (34) during the melt.

9. A method for consistently maintaining the spacing between the bottom of an electrode (18) and the top of an ingot (34) in a consumable electrode melting furnace (10) of the type having an electrode (18), a fluid cooled mould (12), an electrical supply system (32) for melting the electrode (18) to form an ingot (34) in the mould (12), electrode drive means (26, 30) for re-positioning the electrode (18) during the melt and means for regulating

the output speed (S) of the electrode drive means (26, 30)
characterised in that
the output speed (S) of the electrode drive means (26, 30) is regulated as a function of a base speed (S_B) computed at frequent intervals from measured changes in the weight per unit of time of the electrode (18) or ingot (34) during the melt, the geometry of the electrode (18), the geometry of the mould (12) and the speed of movement of the bottom of the ingot (34) if other than zero, and in that the base speed (S_B) is increased or decreased by a function of a relatively less responsive trim speed (S_T) provided by a relatively slow-acting feedback control variable which is determined from the measurement of voltage of current or other electrical phenomenon having a value related to the distance between the bottom of the surface of the electrode (18) and the top surface of the ingot (34) having an average value determined over a period of time which is relatively longer than the period of time over which changes in the output speed (S) are computed based upon base speed (S_B) which is determined from changes in the weight of the electrode (18) or the ingot (34) during the melt."

Claims 2-8 are dependent upon Claim 1 and Claim 10 is dependent on Claim 9.

IV. The Appellant requested that the Decision of the Opposition Division be set aside and that the patent in suit be maintained in amended form on the basis of the following documents:

Description, pages 2 and 4 to 6 of the European patent specification No. 42 689, and page 3 filed during the oral proceedings;

Claims 1-10 filed during the oral proceedings;

Drawings, sheet 1 of the European patent specification No. 42 689.

In support of his request, the Appellant argued substantially as follows.

According to the invention, the base speed signal (S_B) is produced by dead reckoning instead of a closed loop, whereas the trim speed signal (S_T) is produced by a feedback loop which is a P-I regulator. It is agreed that it is known to control the drive speed of an electrode in relation to its geometry and that of the crucible in which it is melted. It is also agreed that it is known to control the drive speed in relation to the appearance of drip-shorts, caused when molten droplets on the electrode contact the metal pool in the crucible. Until the invention was made, however, no feasible process using both control procedures had been developed, which is strong evidence that combining them in the correct manner is not obvious.

Drip-shorts are produced randomly, so that a statistically significant number must be monitored and averaged to obtain a meaningful drive speed parameter. This means that the overall control procedure must use a rapidly-responding (S_B) as major control factor and a slowly-responding (S_T) as minor control factor. This concept is properly expressed in the amended version of Claim 1.

Such teachings are not rendered obvious by document (D4), where no expressis verbis disclosure can be found in respect of response times. Besides, the control system disclosed in (D4) comprises two P-I feedback loops, of which the one based upon melt rate measurements operates

in the opposite way to the invention as travel is actually measured to derive melt rate. Finally, as the whole control process is computerised, it is not possible to say that one factor is used there in a major mode and the other in a minor mode. It follows therefrom that (D4) cannot be relevant to the invention and that the conclusion underlying the impugned decision is based upon a misunderstanding of the invention.

V. The Respondent requested that the appeal be dismissed and put forward the following main arguments in support of his request.

A significant feature of the invention consists in superposing two velocities. It is thus clear that the patent in suit pertains to a device comprising two regulators, of which at least one is a proportional-integral regulator, whereas the other may be a proportional-integral-differential regulator. This principle, which is known in speed regulation, is here applied to the special problem of electrode driving in a furnace, with the difference that what is regulated is not a speed but a quantity which, in turn, determines a speed. Considering that it is also known to perform speed regulation on the basis of the criteria mentioned in the claims, no inventive step can be perceived in the subject-matter of said claims.

It is furthermore noted that the terminology of the claims is inappropriate and results in lack of clarity. In particular, the notion of "trim speed" should be understood as meaning "correction speed". Moreover, the patent does not reveal what the geometry of the electrode and that of the mould exactly represent. Such features of the claims are unclear and may not, therefore, be considered as contributing to the invention. As a matter

of fact, the only difference between the claimed subject-matter and the disclosure in (D1) is that, in Claim 1, one of the time periods is relatively longer than the period over which changes in output speed are computed. This feature, however, is implicitly disclosed in (D1).

With regard thereto, the reasoning in the Statement of Grounds of Appeal does not overcome the Decision of the Opposition Division.

VI. At the conclusion of the oral proceedings the decision was announced that the Decision under appeal was set aside and the patent was maintained with text as requested by the Appellant.

Reasons for the Decision

1. The appeal is admissible.

2. **Interpretation of the claims and the allowability of their amendment**

2.1 The Board considers that Claim 1 as a whole makes clear that electrode weight changes are determined at time intervals that are shorter than the periods over which the value of a voltage, a current or an electrical phenomenon is averaged.

The Board furthermore accepts that the statement in Claim 1 that the "base speed ... is increased or decreased by a function of ... a trim speed provided by a ... control variable" is understandable by a skilled person. How the trim speed is provided is indeed not stated, so that its value might be different from that of the speed correction to be performed. Hence, the reference to a

function of the trim speed. Furthermore, since said speed correction is either positive or negative, the alternative "increased or decreased" is clear. Finally, the Board also accepts that with reference to the "geometry" of the electrode or mould, a complete definition of the geometrical form and dimensions of said electrode or mould should be understood. It is indeed the Board's view that this interpretation is sufficiently supported by the description - see page 9 of the published patent application, lines 8 to 14.

The Board, therefore, is satisfied that the amended claims submitted during the oral proceedings meet the requirement of clarity - Article 84 EPC.

2.2 The Board is also satisfied that the claims were not amended in such a way as to contain subject-matter extending beyond the content of the application as filed, nor in such a way as to extend the protection conferred - Article 123(2) and (3) EPC.

The present Claim 1 substantially corresponds to Claim 2 as originally filed and the few amendments it exhibits with respect to the latter are supported by the application as filed. In particular, it is stated on page 1 of the published patent application, lines 5 to 9, that the invention relates to a method and apparatus for controlling the gap between the electrode bottom and the top surface of the ingot. In lines 19 to 22 of the same page, it is stated that the drive speed is adjusted during the melt. The feature that a base speed is computed at frequent intervals is mentioned on page 9, lines 26 to 34. The definition of the melt rate as change in weight of the electrode per unit of time is given on page 9, lines 31 and 32. An averaged value of an electrical phenomenon is disclosed in relation with drip shorts frequency on

page 10, lines 19 to 24, and, in relation to the arc voltage, on page 12, lines 29 to 34. From the statement on page 5, lines 23 to 26, however, it is readily understood that averaging of the value is performed whatever the electrical phenomenon may be and, furthermore, over periods which are relatively longer than the time interval between consecutive computations of the base speed. Finally, a reference to a trim speed determined by a relatively slow acting control loop using electrical parameters as a feedback signal appears on page 5, lines 5 to 8, where the word "parameter" is obviously taken as meaning "variable".

3. The novelty of the amended claims was challenged only having regard to the disclosure of (D1) - see paragraph V above.

The Board nevertheless takes the view that none of the documents (D1) to (D4) discloses the claimed subject-matter.

None of these documents does indeed pertain to a system in which the base speed of an electrode is controlled in relation to measured changes in the melt rate nor in relation to the geometry of the electrode and that of the crucible in which it is melted. Likewise, none of them discloses the use of a slow acting loop for increasing or decreasing a base speed by a function of a trim speed. Now, only (D2) and (D3) disclose the precharacterising parts of Claims 1 and 9. However, they do not reveal that the electrode speed is regulated in dependence on a phenomenon having a value related to the distance between electrode and ingot in the manner defined in Claims 1 and 9, whereas (D3) pertains to a proportional-differential regulation of the electrode penetration into the slag based on a measure of the gap resistance.

4. **Inventive step**

4.1 Document (D4) relates to a system comprising two control loops, one for current and the other for voltage, which are used to maintain the melt rate at a predetermined value. Process variables such as voltage, current, electrode weight, are fed back to a computer which calculates the required set point changes for both the current and voltage loops. Then, the new voltage set point is sent to an analog controller which actuates a hydraulic servo or motor drive of the furnace to adjust the position of the electrode. The duration of the time intervals elapsing between consecutive executions of the process is not disclosed. Nevertheless, from the statement, "traditionally, the melting rate was controlled by maintaining a constant feed rate of the electrode" - see the first paragraph on page 843 - one readily infers that, in contrast to the traditional method, in (D4) the electrode movement is discontinuous and may not be compared to that of an electrode whose speed is computed from measured changes in the melt rate, the geometry of the electrode, the geometry of the mould and speed of the bottom of the ingot, as required by the claimed invention. In the Board's judgement, the teaching in document D4 consequently does not suggest or lead to the present claimed invention in an obvious manner.

4.2 The system known from (D1) may comprise a closed loop in which a signal derived from electrical parameters of the discharge is used to keep the distance between electrode and melt constant. Nevertheless, the main result to be achieved there is to make the electrode weight vary during the melt procedure in accordance with a predetermined function of time - cf. "Soll-Gewicht". To this purpose, the power supplied to the furnace is regulated in

dependence upon the deviation from the desired weight. No speed computation is carried out. Furthermore, it cannot be inferred from (D1) that any of the loops might be a slow acting one. Therefore, in the Board's judgement, the skilled person attempting to combine the teachings of (D1) with those disclosed in (D4) would not arrive at the invention in an obvious manner.

4.3 The control circuit of the arc furnace known from (D2) comprises two potentiometers having their extremities connected to a current supply, the voltage between the cursors being used to control the electrode drive motor. The movement of one of the cursors is proportional to the electrode displacement, whereas the other one is moved in dependence upon a phenomenon representative of the distance between electrode and ingot. It is true that said phenomenon may be the occurrence of voltage discontinuities over the arc gap, as contemplated in the patent in suit. Nevertheless, it cannot be inferred from (D2) that any physical value related to these voltage discontinuities is averaged, nor that the circuit processing them is a slow acting one. Therefore, although it mentions an electrical phenomenon of relevance in the present case, in the Board's judgement document (D2) does not render obvious the teaching of Claims 1 and 9 as regards electrode speed regulation.

4.3 Document (D3) relates to a device for regulating the penetration depth of an electrode into the slag of a furnace. The thickness of the slag being not known accurately, it may thus not be contended that a regulation of the distance between electrode and top of the ingot is performed in said device. Moreover, the parameters which are used for the regulation are the resistance between electrode and mould, and the derivative of said resistance with respect to an axial displacement of the electrode.

Such parameters are, however, not liable to exhibit rapid variations, so that no advantage would be provided by averaging them. Document (D3) consequently appears to be irrelevant to the present case.

4.5 For the above reasons, the Board holds that the independent Claims 1 and 9 submitted during the oral proceedings involve an inventive step.

4.6 Claims 1 and 9 are, therefore, allowable having regard to Article 52(1) EPC in relation with Article 56. The remaining Claims 2-8 and 10 are, therefore, also allowable.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to maintain the patent with text as identified in paragraph IV above.

The Registrar: The Chairman:

P. Martorana G.D. Paterson

00591