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D E C I S I O N
of 22 July 1994

Case Number: T 0402/92 - 3.4.2

Application Number: 84301188.3

Publication Number: 0119770

IPC: G01N 15/00, G01N 33/20

Language of the proceedings: EN

Title of invention:
Method and apparatus for the detection and measurement of particulates in molten metal

Patentee:
LIMCA RESEARCH INCORPORATED

Opponent:
Stiftelsen for industriell og teknisk forskning ved Norges tekniske hoegskole (SINTEF)

Headword:

Relevant legal norms:
EPC Art. 56, 82

Keyword:
"Inventive step (yes) - after amendment"
"Unity of invention - no requirement in opposition stage"

Decisions cited:
G 0001/91

Catchword:
-

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Case Number: T 0402/92 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 22 July 1994

Appellant: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office dated 6 December 1991, posted on 26 February 1992 revoking European patent No. 0 119 770 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: E. Turrini
Members: W. W. G. Hofmann
M. Lewenton
M. Chomentowski
B. Schachenmann

Summary of Facts and Submissions

I. The Appellant (Proprietor of the patent) lodged an appeal against the decision of the Opposition Division on the revocation of the patent No. 0 119 770.

The Respondent (Opponent) had filed opposition against the patent as a whole, based on Article 100(a) and (b) EPC, and had cited as prior art

(E1) "Senter for Industriforskning (SI)", Rapport 78 01 56 - 1, dated 12 February 1980 (submitted together with an English translation),

(E2) "Senter for Industriforskning (SI)", Rapport 78 01 56 - 2, dated 1 July 1982 (submitted together with an English translation), and

(E9) US-A-2 656 508.

The Opposition Division had held that the grounds for opposition mentioned in Article 100(a) EPC prejudiced the maintainance of the patent.

II. Oral proceedings were held, at the end of which the Appellant requested that the decision under appeal be set aside and the patent maintained

on the basis of the Claims 1 to 21 (bearing the wrong date "22.6.94" instead of the correct "22.07.94") filed at the oral proceedings, with description to be adapted and drawings as granted - main request

or

on the basis of the Claims 1 to 20 filed with the letter of 12 June 1992 - auxiliary request.

The Respondent requested that the appeal be dismissed.

III. The independent Claims 1, 7, 8 and 13 according to the **main request** of the Appellant read as follows:

"1. A method for the detection and measurement in a molten metal sample of suspended particulates of greater than a predetermined size whose electrical conductivities differ from that of the suspending molten metal including the steps of:
establishing a current path which will include molten metal of the sample between two electrodes and through a passage of predetermined cross-sectional area, said passage being defined by an aperture through an electrically insulating wall,
passing the molten metal sample in the said current path and through the said passage while an electric current is maintained through the current path, and
measuring the voltage difference between the said electrodes and detecting changes therein caused by the passage through the passage of said particulates,
characterised by conditioning the passage by passing through it a current from 2 to 10 times the chosen operating current."

"7. Apparatus for the detection and measurement in a molten Aluminium (better read "aluminium") metal sample of suspended particulates of greater than a predetermined size whose electrical conductivities differ from that of the suspending molten metal in the molten metal sample comprising:
electrically insulating wall means (14) having an aperture providing a passage (26) of predetermined size therethrough, a pair of electrodes (24, 29) disposed on opposite sides of the wall means to establish a current path between them through the molten metal of the sample and passing through the said passage,

means for passing the sample of molten metal through the passage,
means for passing an electric current between the two electrodes through the molten metal in the said current path at least while the molten metal sample is passing through the passage, and means connected to the two electrodes for detecting a change of voltage in the path resulting from the passage through the passage of the said particulates, characterised in that the electrodes are of metal resistant to attack by molten aluminium."

"8. Apparatus for the detection and measurement in a molten Aluminium (better read "aluminium") metal sample of suspended particulates of greater than a predetermined size whose electrical conductivities differ from that of the suspending molten metal in the molten metal sample comprising:
electrically insulating wall means (14) having an aperture providing a passage (26) of predetermined size therethrough, a pair of electrodes (24, 29) disposed on opposite sides of the wall means to establish a current path between them through the molten metal of the sample and passing through the said passage,
means for passing the sample of molten metal through the passage,
means for passing an electric current between the two electrodes through the molten metal in the said current path at least while the molten metal sample is passing through the passage, and means connected to the two electrodes for detecting a change of voltage in the path resulting from the passage through the passage of the said particulates, characterised in that the electrically insulating wall means are of borosilicate glass."

"13. A method of treating molten metal for removal of non-metallic inclusions therefrom comprising the steps of:
(a) providing a test container having an electrically insulating wall and a passage therethrough of predetermined cross-sectional area, said passage being defined by an aperture through an electrically insulating wall,
(b) establishing a current path which will include molten metal of the sample between two electrodes and through the passage,
(c) withdrawing a sample of the molten metal from a stream or bath thereof through the passage into the test container, while an electric current is maintained through the current path,
(d) measuring the voltage difference between the said electrodes and detecting changes therein caused by the passage through the passage of said inclusions,
(e) counting the number of said changes in voltage difference as a representation of the number of the said inclusions in the sample, and measuring the size of the changes as representative of the sizes of the inclusions causing the changes, and
(f) when the inclusion content is above a given value treating the stream or batch of the metal to reduce the inclusion content thereof, characterised by conditioning the passage by passing through it a current from 2 to 10 times the chosen operating current."

Claims 2 to 6, 9 to 12 and 14 to 21 are respectively dependent on the independent Claims 1, 7, 8 and 13.

The independent Claims 1, 7, 8 and 13 according to the **auxiliary request** of the Appellant read as follows:

"1. A method for the detection and measurement in a molten aluminium metal sample of suspended particulates

of greater than a predetermined size whose electrical conductivities differ from that of the suspending molten metal including the steps of:
establishing a current path which will include molten metal of the sample between two electrodes and through a passage of predetermined cross-sectional area,
passing the molten metal sample in the said current path and through the said passage while an electric current is maintained through the current path,
and measuring the voltage difference between the said electrodes and detecting changes therein caused by the passage through the passage of said particulates,
characterised by conditioning the passage by passing through it a current from 2 to 10 times the normal operating current."

"7. Apparatus for the detection and measurement in a molten aluminium metal sample of suspended particulates of greater than a predetermined size whose electrical conductivities differ from that of the suspending molten metal in a molten metal sample comprising:
electrically insulating wall means (14) providing a passage (26) of predetermined size therethrough,
a pair of electrodes (24, 29) disposed on opposite sides of the wall means to establish a current path between them through the molten metal of the sample and passing through the said passage,
means for passing a sample of molten metal through the passage,
means for passing an electric current between the two electrodes through the molten metal in the said current path at least while the molten metal sample is passing through the passage, and means connected to the two electrodes for detecting a change of voltage in the path resulting from the passage through the passage of the said particulates, characterised in that electrodes are of metal resistant to attack by molten aluminium."

"8. Apparatus for the detection and measurement in a molten aluminium metal sample of suspended particulates of greater than a predetermined size whose electrical conductivities differ from that of the suspending molten metal in a molten metal sample comprising:
electrically insulating wall means (14) providing a passage (26) of predetermined size therethrough,
a pair of electrodes (24, 29) disposed on opposite sides of the wall means to establish a current path between them through the molten metal of the sample and passing through the said passage,
means for passing a sample of molten metal through the passage,
means for passing an electric current between the two electrodes through the molten metal in the said current path at least while the molten metal sample is passing through the passage, and means connected to the two electrodes for detecting a change of voltage in the path resulting from the passage through the passage of the said particulates,
characterised in that the electrically insulating wall means are of borosilicate glass."

"13. A method of treating molten aluminium metal for removal of non-metallic inclusions therefrom comprising the steps of:
(a) providing a test container having an electrically insulating wall and a passage therethrough of predetermined cross-sectional area,
(b) establishing a current path which will include molten metal of the sample between two electrodes and through the passage,
(c) withdrawing a sample of the molten metal from a stream or bath thereof through the passage into the test container, while an electric current is maintained through the current path,

(d) measuring the voltage difference between the said electrodes and detecting changes therein caused by the passage through the passage of said inclusions,
(e) counting the number of said changes in voltage difference as a representation of the number of the said inclusions in the sample, and measuring the size of the changes as representative of the sizes of the inclusions causing the changes, and
(f) when the inclusion content is above a given value treating the stream or batch of the metal to reduce the inclusion content thereof, characterised by conditioning the passage by passing through it a current from 2 to 10 times the normal operating current."

Claims 2 to 6, 9 to 12, and 14 to 20 are respectively dependent on the independent Claims 1, 7, 8 and 13.

IV. The Appellant essentially argued as follows:

While E1 is not considered as a prior publication, the prior publication of E2 is not contested. However, E2 is vague and general. The device described had evidently not been built and operated at that time. The use of boron nitride for the aperture and of graphite for the electrodes is wholly inappropriate. Conditioning the passage helps to obtain reliable measurements for an extended period of time. As indicated in the statement of Professor Guthrie, dated 22 June 1994, conditioning is beneficial for measurements in a great number of metal melts. There is nothing in the whole prior art that would suggest such a conditioning step. Using metal electrodes in an aluminium melt (instead of graphite electrodes) is completely unusual. Metal electrodes have, however, proved to ensure low electrical noise since they are wettable by aluminium. Moreover, they have a lower electrical resistance than graphite. While E2 teaches the use of boron nitride for the insulating

wall means, Claim 8 proposes borosilicate glass. Contrary to boron nitride, borosilicate glass is wetted by molten aluminium and thus its use contributes to stability and low noise. Surprisingly, borosilicate tubes do not suffer from rapid attack by molten aluminium.

V. The Respondent's arguments may be summarised as follows:

E1 as well as E2 are prior publications; they disclose the main features of the patent in suit. It is not clear what is meant by "conditioning". It is self-evident that in any apparatus containing molten metal care has to be taken to avoid solidification of the metal, and to apply heat if necessary. Therefore, applying a "conditioning" current is not inventive. Metal is a usual material for electrodes and an obvious equivalent to the graphite electrodes mentioned in E1 and E2, and in fact, in the basic patent of Coulter (document E9) metal electrodes were used. Likewise, Coulter already used a glass vessel, and it is obvious to specially use a particularly heat resistent glass, i.e. borosilicate glass. Whether Claims 7 and 8 refer to aluminium or not makes no difference since anyway the apparatus has only to be "suitable for" use with aluminium. Claims 7, 8 and 16 are moreover not allowable for formal reasons since Claims 7 and 8 relate to different inventions and Claim 16 has no counterpart in the granted patent.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 The Board has no reason to investigate the objection, raised by the Respondent, that Claims 7 and 8 relate to different inventions since decision G 01/91 (OJ EPO 1992, 253; see in particular "order") of the Enlarged Board of Appeal clearly indicates that unity of invention (Article 82 EPC) does not come under the requirements which a European patent and the invention to which it relates must meet when the patent is maintained in amended form.

2.2 Amendments to the claims

It is true that the patent as granted did not contain a claim corresponding to the present dependent Claims 16 and 20. However, it is not a requirement under the EPC that after grant amendments to the claims must have a basis in the granted claims themselves, as long as the original description provides the necessary disclosure (Article 123(2) EPC) and the scope of protection conferred by the patent is not extended (Article 123(3) EPC). Both of these conditions are fulfilled in the patent in suit since applying the claimed method to the measurement of boride inclusions is mentioned in the original description on page 1, line 17; page 21, line 33; page 22, lines 17 to 23 and page 23, line 24; steel electrodes on page 11, lines 26, 27, and the scope of protection is not determined by the dependent claims 16 and 20, but only by the independent claims.

The disclosure of Claims 1 and 13 is based on the original Claims 1 and 12 with the additional features "aperture" and "conditioning by a current from 2 to 10 times the chosen operating current" disclosed on original pages 12, line 33, and 18, lines 5 and 6, respectively Claims 7 and 8 are based on the original Claim 7 with the additional features "aluminium", "aperture", "electrodes of metal resistant to attack by molten aluminium" and "borosilicate glass" being respectively disclosed on page 1, lines 2 to 7 and examples 1 to 3; page 12, line 33; page 7, line 31 to page 8, line 5 and page 11, lines 32 to 34; and page 11, lines 20, 21.
By adding the above-mentioned features to the independent Claims 1, 7 and 12 as granted, the protection conferred was not extended, but rather restricted.

The dependent Claims 2 to 6 correspond to the original Claims 2 to 6 and the dependent Claims 9 to 12 to original Claims 8 to 11. The features of dependent Claims 14, 15, 17 to 19, and 21 are originally disclosed on page 18, lines 20 to 23; page 18, lines 27 to 31; page 16, line 6; page 16, lines 8 to 10; page 17, lines 26 to 29 + Figure 4; and page 1, lines 2 to 7, respectively.

The amendments to the claims therefore meet the requirements of Articles 123(2) and (3) EPC.

2.3 Clarity

The Respondent's objections to the definition of the value of the current in Claim 1 have been met by the amended wording "chosen operating current".

However, the Respondent still considers the meaning of the term "conditioning" unclear as a whole since it leaves undefined what, in addition to merely remelting solidified melt, could be effected by such conditioning.

In the Board's view, the said feature in Claim 1 is sufficiently clear since it expresses the fact that before or in between measurements the current is raised to a value of 2 to 10 times the current chosen for the measurements, in order to reduce electrical noise during measurement. An explanation of what actually happens within the aperture during the application of the increased current, is not required for a clear definition of the method step to be taken.

2.4 Novelty

2.4.1 E1 and E2 are reports of a research institute. The Respondent claims that both of these reports were available to the public before the priority date of the patent in suit. The Appellant declared (cf. letter of 12 June 1992, page 1) that he did not contest the finding of the Opposition Division that E2 was a prior publication, while he maintained that prior publication of E1 had not been proved.

Since in the view of the Board the teachings of E1 and E2 are substantially equivalent as regards their relevance to the present subject-matter, the latter question (regarding prepublication of E1) may be left open while in the following considerations E2 is taken into account as prior art.

2.4.2 E2 (see in particular summary on page 2 and Figure 1) discloses a method for the detection and measurement in a molten metal sample of suspended particulates which comprises all the features according to the preamble

portion of Claim 1. The known method comprises, in particular, establishing a current path, which will include molten metal of the sample, between two electrodes and through a passage of predetermined cross-sectional area, said passage being defined by an aperture through an electrically insulating wall, passing the molten metal sample through the said passage while an electric current is maintained through the current path, and measuring the voltage difference between the said electrodes and detecting changes therein caused by the passage of said particulates through the passage (cf. pages 2 and 3; note the reference to Coulter's measuring principle).

Conditioning the passage or applying a current from 2 to 10 times the chosen operating current, is not mentioned in E2.

E9 is the basic patent describing "Coulter's principle". This document discloses the principle of detecting suspended particles in a fluid by passing the fluid through an aperture in an electrically insulating wall and measuring the voltage difference (and changes thereof) between two electrodes which maintain an electric current through the said aperture.

E9 does not mention molten metals, but as far as examples are concerned relates to body fluids and blood cells, i.e. aqueous or organic fluids (cf. column 1, lines 20 to 22). Moreover, conditioning by an elevated current is also not mentioned.

The further documents cited in the European search report, Patent Abstracts of Japan, vol.5, no.36, page 117 P 51, and US-A-4 140 966, do not come closer to the subject-matter (method or apparatus) of the patent in suit.

The method according to Claim 1 is therefore novel in the sense of Article 54 EPC.

2.4.3 The same considerations apply to to the independent method Claim 13 which contains the same features as Claim 1 and differs from Claim 1 only insofar as the claimed method additionally aims at removal of the non-metallic inclusions and comprises the step of reducing the inclusion content.

The method according to Claim 13 is therefore also novel.

2.4.4 In its preamble portion, apparatus Claim 7 contains essentially the same features as the preamble portion of Claim 1 (known from E2), i.e. in particular electrically insulating wall means having an aperture therethrough, a pair of electrodes disposed on opposite sides of the wall means, means for passing the sample of molten metal through the aperture, means for passing an electric current between the two electrodes in the molten metal and through the aperture, and means for detecting a change of voltage between the electrodes. Additionally, it specifies the molten metal to be aluminium (also in correspondence with E2).

The Board does not share the Respondent's view that in the definition "for the detection and measurement in a molten aluminium metal sample" the mention of aluminium is irrelevant since it is only to be interpreted in the sense of "suitable for aluminium". Although certainly the said definition has to be interpreted as "suitable for aluminium", it must nevertheless be borne in mind that an apparatus suitable for measurements in molten aluminium has necessarily constructional features which are different from those of an apparatus intended for

use with molten metals whose properties regarding melting point, chemical reactivity etc. may be far away from those of aluminium.

From the teaching of E2 the apparatus according to Claim 7 is distinguished by the use of metal electrodes (E2 describes graphite electrodes).

E9 does not mention the possibility of measurements in molten aluminium (or even molten metals), and thus the apparatus according to E9 cannot be considered as suitable to operate at the required temperatures and currents. Moreover, although the electrodes shown in the schematic drawings of Figures 1, 6 and 7 could possibly be metal electrodes, this interpretation is not unambiguous and is not corroborated by any mention in the text of E9. Thus, a disclosure of metal electrodes cannot be assumed.

The subject-matter of Claim 7 is therefore novel in the sense of Article 54 EPC.

The same is true for Claim 8 which corresponds to Claim 7, with the exception that, instead of metal electrodes, it specifies the insulating wall means to be of borosilicate glass. Borosilicate glass is neither mentioned in E2 nor in E9.

2.5 Inventive step

2.5.1 Of the two documents E2 and E9, both relating to the "Coulter principle" of determining and measuring suspended particles in fluids, E2 is closer to the subject-matter of the patent in suit since it is concerned with measurements in molten metal, in particular aluminium.

2.5.2 Claims 1 and 13

A teaching regarding conditioning of the passage by applying a current of 2 to 10 times the chosen operating current is not only lacking in E2, it is not mentioned either in any of the other cited documents.

The Appellant has convincingly argued (see in particular the statement of Professor Guthrie filed with the letter of 20 June 1994) that such conditioning is effective in reducing noise and instabilities in the electrical signal to be detected, and that this advantageous effect is not only achieved in aluminium melts, but in most, if not all, metal melts which are suitable for being checked for suspended particulates in accordance with the "Coulter principle". It is apparent from the patent specification that noise and instabilities are a great problem for the measurement in molten metals (cf. page 6, lines 42, 43; page 6, line 65 to page 7, line 1; page 7, lines 31 to 38 and 55) and that any reduction of noise and instabilities is therefore important.

Contrary to the objections raised by the Respondent, it is not required that further details be specified in Claim 1 as to what happens within the aperture during the conditioning steps. It is not necessary that the reasons for the stabilising effect of conditioning are understood in all detail and these details are not required for distinguishing conditioning from other actions which might be self-evident: it is clear that the instruction to apply a current of 2 to 10 times the chosen operating current goes beyond the mere care to keep all parts coming into contact with the melt at a temperature above the melting point.

Since conditioning as specified in Claim 1 helps to reduce noise and instabilities by means neither mentioned in nor derivable from the prior art, the method according to Claim 1 involves an inventive step in the sense of Article 56 EPC.

The same is true for Claim 13 since all the above-mentioned method steps of Claim 1 are equally contained therein.

2.5.3 Claim 7

Whereas in E2 the electrodes are described to be of graphite, apparatus Claim 7 specifies that they are of metal resistant to attack by molten aluminium.

It should be mentioned beforehand that the Board attributes no inventive merit to the fact that the metal should be resistant to attack by molten aluminium. It is considered to be self-evident that any material provided for contact with the molten aluminium should be resistant to attack by this melt (that there exist metals resistant to attack by molten aluminium is shown in the patent specification, page 5, lines 10 to 14).

However, apart from the fact that there is no prior art document on file mentioning a metal electrode material in connection with metal melts, such electrode material (contrary to graphite) is considered to be quite generally an unusual choice for applying electric current to aluminium melts. The practice, generally known with aqueous or organic electrolytes, of using metal electrodes (and the drawings of E9 might also give a hint in this direction) could not form a model for the treatment of aluminium melts since the conditions (temperature, electrical and chemical requirements) are too different.

Moreover, it represents an unexpected effect that metal electrodes in aluminium help in reducing noise (due to their better wettability by molten aluminium and lower resistance) (cf. Affidavit of Dr. Don Doutre, filed with the letter of 7 May 1991, paragraph 6, and the Appellant's letter of 12 June 1992, pages 6 and 7).

For these reasons, the subject-matter of Claim 7 involves an inventive step in the sense of Article 56 EPC.

2.5.4 Claim 8

Apparatus Claim 8 is distinguished from the teaching of E2 by the fact that the electrically insulating wall means which include the aperture are of borosilicate glass, instead of boron nitride.

As the Appellant has submitted (cf. letter of 12 June 1992, pages 7 and 8), the wall material of borosilicate glass, like electrodes of metal, also improves the electrical noise and signal stability (due to its better wettability by molten aluminium which is particularly critical in the aperture region), an effect which could not have been expected beforehand.

None of the prior art documents on file mentions this wall material (E9 only mentions glass in general). Although, in principle, borosilicate glass may be a type of glass quite well known for its relatively high thermal resistance, its particular suitability for forming a vessel and an aperture for molten aluminium is not apparent at first sight. It has a softening temperature of about 720°C (cf. Affidavit of Dr. Don Doutre, sentence bridging pages 7 and 8) which is thus very close to the necessary temperature of the aluminium melt used (about 700°C, cf. page 5, lines 4 and 5 and

Table 1 on page 6 of the patent specification), and at these high temperatures the possibility of chemical reactions with the aluminium could not be excluded. Therefore, there was no obvious reason for choosing borosilicate glass as the insulating wall means in an apparatus according to E2.

Consequently, the subject-matter of Claim 8 involves an inventive step in the sense of Article 56 EPC.

2.5.5 Summarising, neither one of the four independent Claims 1, 7, 8 and 13 of the main request contains all the above-mentioned advantageous features (i.e. conditioning, metal electrodes, borosilicate glass) together, but each independent claim contains only one of them.

In fact, the Board would not consider it justified to demand the Appellant to combine all of these features in one claim. Each of these features makes its own contribution to the reduction of noise and instability of the measuring system, independent of the other features. It could not be argued either that the claimed methods or apparatuses were unable to function without these three features together. The Board sees each of these features as a cause for an **improvement**, not as a necessary prerequisite for functioning. The Board does not even deny that the apparatus according to E2, which has none of the above-mentioned features, may function to some extent.

2.6 For the above reasons, it is concluded that the independent Claims 1, 7, 8 and 13 are allowable (Article 52(1) EPC). Claims 2 to 6, 9 to 12 and 14 to 21 are allowable due to their dependence on the independent claims.

3. Since the amended claims according to the main request of the Appellant are found to be allowable, there is no need to discuss the claims according to the Appellant's auxiliary request.

4. The patent as amended does not yet meet the requirements of the Convention since, in particular, the description is not adapted to the claims and lacks an acknowledgment of the prior art according to E2 (Rule 27 EPC).

Having regard to the numerous amendments required and to their dependence on the wording of the claims, for which wording various options had to be considered by the Appellant during the oral proceedings, the Board did not insist upon the Appellant filing a complete set of documents, but deemed it appropriate to make use of the power conferred upon it under Article 111(1) EPC to remit the case to the Opposition Division for further prosecution regarding the necessary amendments to the description.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the Opposition Division with the order to maintain the patent in amended form on the basis of

   Claims 1 to 21 filed at the oral proceedings (main request),

   with the description to be adapted and drawings as granted.

The Registrar: The Chairman:

P. Martorana E. Turrini