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

Case Number: T 1094/97 - 3.4.2
Application Number: 92301309.8
Publication Number: 0500313
IPC: H01M 4/42, C22C 1/04

Language of the proceedings: EN

Title of invention:

Zinc alloy powder for alkaline cell and method to produce the same

Patentee:

mitsui mining & smelting co., ltd., et al

Opponent:

- (01) Grillo-Werke AG
(02) n.v. Union Minière s.a.

Headword:

-

Relevant legal provisions:

EPC Art. 54. 56

Keyword:

"Novelty (yes); Fe content specified as amounting to 1 ppm or less"

"Inventive step (yes); determination of closest prior art"

Decisions cited:

T 0656/90, T 0990/96

Catchword:

-



Case Number: T 1094/3.4.2

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

Appellant:
(Opponent 01)

Grillo-Werke AG
Weseler Strasse 1
D-47169 Duisburg (DE)

Representative:

Godemeyer, Thomas, Dr.
Sternagel, Fleischer, Godemeyer & Partner
Patentanwälte
An den Gärten 7
D-51491 Overath (DE)

Respondent:
(Proprietor of the patent)

MITSUI MINING & SMELTING CO., LTD.
1-1, 2chome
Nihombashi-Muromachi
Chuo-ku
Tokyo (JP)

Representative:

Silverman, Warren
Haseltine Lake & Co.
Imperial House
15-19 Kingsway
London WC2B 6UD (GB)

**Party to the appeal
proceedings as of right:**
(Opponent 02)

n.v. Union Minière s.a.
Gulledelle 92
B-1200 Brussels (BE)

Representative:

Saelemaekers, Juul
Patent Department
Union Minière
Leemanslaan 36
B-2250 Olen (BE)

Decision under appeal:

Interlocutory decision of the Opposition Division
of the European Patent Office posted 12 September
1997 concerning maintenance of European patent
No. 0 500 313 in amended form.

Composition of the Board:

Chairman: E. Turrini
Members: A. G. Klein
B. J. Schachenmann

Summary of Facts and Submissions

- I. The appellant (opponent I) lodged an appeal against the decision of the opposition division maintaining the European patent No.0 500 313 (application No. 92301309.8) in amended form.
- II. Two oppositions against the patent as a whole and based, among others, on the grounds of lack of novelty and lack of inventive step (Article 100(a) EPC) had been filed by the appellant and by opponent II.

In the proceedings before the opposition division, reference was made, *inter alia*, to the following documents:

- D1A: English language translation of JP-A-62123656
- D4A: English language translation of JP-A-61116755
- D6A: Battery Material Symp., Vol. 1, pages 47-48, Brussels, 1983; M. Meeus et al., "Zinc powder for alkaline dry batteries"
- D7A: EP-A-0377106
- D1B: English language translation of JP-A-61153950
- D5B: US-A-4735876
- D8B: English language translation of JP-A-61077267
- D16B: Journal of Applied Electrochemistry, Vol. 6, 1976, GB, pages 163-169; R. V. Moshtev et al., "Corrosion in alkali hydroxide solutions of electrolytic zinc powder containing codeposited lead"

D17B: Translated from Zhurnal Prikladnoi Khimii, Vol. 39, No. 10, 1966, pages 2236-2243; L. Ya. Gordeva et al., "Decrease of spontaneous dissolution of zinc electrodes in cells of the air-zinc system with an alkaline electrolyte"

D20B: English language translation of JP-A-60017088

D31B: English language translation of JP-A-3-22356

In the decision under appeal, the opposition division held that the subject matter of the claims as amended in accordance with the patent proprietor's request was novel with respect to the available prior art and non-obvious when starting from the closest prior art considered to be represented by the disclosure of document D4A and, alternatively, by the disclosure of document D16B or that of D17B.

III. Oral proceedings before the board took place on 5 July 2001 in the presence of the appellant, of the respondent (patent proprietor) and of opponent II, the latter being a party as of right to the appeal proceedings pursuant to Article 107 EPC. At the end of the oral proceedings the decision of the board was given.

IV. The appellant requested that the decision under appeal be set aside and that the European patent be revoked.

The respondent requested that the European patent be maintained in amended form on the basis of a set of claims filed during the oral proceedings held before the board and of the description and drawings in the form specified in the decision under appeal.

The wording of the claim 1 of the respondent's request reads as follows:

"1. A non-amalgamated zinc alloy powder for use in an alkaline cell, which alloy powder consists of 0.01 to 0.5 % by weight bismuth, 0,01 to 0,5 % by weight indium and 0,01 to 0,5 % by weight lead, with zinc forming the balance of the alloy, the alloy containing 1 ppm or less of iron."

Each of independent Claims 2 to 6 is directed to a non-amalgamated zinc alloy powder as defined in Claim 1, wherein the alloying content "0.01 to 0.5 % by weight bismuth, 0,01 to 0,5 % by weight indium and 0,01 to 0,5 % by weight lead" is respectively replaced by the following alloying contents:

- Claim 2: "0,01 to 0,5 % by weight of lead and 0 to 1,0 % by weight in total of at least one metal selected from the group consisting of bismuth, aluminium and calcium";

- Claim 3: "by weight, 0,01 to 0,5 % bismuth, 0,01 to 0,5 % indium and 0,005 to 0,5 % calcium";

- Claim 4: "by weight, 0,005 to 0,5 % calcium, 0,01 to 0,5 % bismuth and 0 to 0,5 % aluminium";

- Claim 5: "by weight, 0,01 to 0,5 % lead, 0,01 to 0,5 % indium, 0,01 to 0,5 % calcium and 0 to 0,5 % aluminium"; and

- Claim 6: "by weight, 0,01 to 0,5 % lead, 0,01 to 0,5 % indium, less than 0,01 % calcium and 0,01 to 0,5 % aluminium".

Independent Claim 7 is directed to a method of producing the non-amalgamated zinc alloy powder defined in any of Claims 1 to 6, and Claim 10 is directed to an alkaline cell containing as an anode active material a non-amalgamated zinc alloy powder as defined in any of Claims 1 to 6. Claims 8 and 9 are appendant to Claim 7.

V. The appellant's arguments in support of its request are essentially the following:

The closest prior art is neither represented by the disclosure of document D4A nor by that of document D16B or D17B. Since each of Claims 1 to 6 is directed to a specific non-amalgamated zinc alloy, the closest prior art for each of the claims should be selected taking into account the specific alloying content of the respective zinc alloy. Following this approach, the closest prior art for each of Claims 1 to 6 is represented by the following prior art disclosures:

- Claim 1: example 1 of document D7A, which discloses a non-amalgamated zinc alloy powder for alkaline batteries comprising 0,08 % In, 0,08 % Bi and 0,002 % Pb by weight; alternatively, example 2 of document D31B, which discloses a non-amalgamated zinc alloy containing 0,05 % Pb, 0,05 % In and 0,05 % Bi by weight;
- Claim 2: the alloying components Bi, Al and Ca being only optional: comparative example of document D7A, which discloses a non-amalgamated zinc alloy powder comprising 0,05 % Pb by weight;
- Claim 3: example 1 of Table 1 of document D1B, which discloses an alkaline battery with a zinc alloy comprising 0,05 % In, 0,05 % Ca and 0,05 % Bi and an amalgamation rate of 1 % by weight;

- Claim 4: the alloying component Al being only optional: comparative example 5 of document D1B, which discloses a zinc alloy comprising 0,05 % Ca and 0,05 % Bi and an amalgamation rate of 1 % by weight;
- Claim 5: the alloying component Al being only optional: example 11 of document D8B, which discloses a zinc alloy for alkaline batteries comprising 0,05 % Pb, 0,05 % In and 0,05 % Ca by weight and an amalgamation rate of 1 % by weight; and
- Claim 6: the alloying component Ca being only optional: example 17 of document D5B, which discloses a zinc alloy powder for alkaline batteries comprising 0,05 % In, 0,05 % Al and 0,05 % Pb and an amalgamation rate between 0,2 % and 1,5 % by weight.

In addition, each of documents D1B, D5B and D8B further specify that the respective zinc alloys can also be used with a lower amalgamation rate and even be used without amalgamation.

Documents D7A, D1B, D5B, D8B and D31B are silent as to the level of iron impurity content present in the respective alloy powders, and the single distinguishing feature of the subject matter of each of Claims 1 to 6 is thus the level of iron impurity content of equal to or less than 1 ppm.

However, this feature as well as the result it achieves, i.e. the reduction in the gas evolution rate and the subsequent improvement in the corrosion resistance of the zinc alloy, are rendered obvious by the prior art and in particular by the following disclosures:

- document D4A teaches that the electrochemical stability of non-amalgamated zinc powders for use in alkaline batteries is improved when the total amount of Fe, Cd, Cu, Ni, Co and Ag present as impurities in the zinc powder is reduced to a low level, and in particular to a level of 1,4 ppm, this value of the total impurity content implying a level of iron content below 1 ppm since iron constitutes the main component of the impurities;
- document D16B discloses the dependency of the corrosion and gassing rates of non-amalgamated zinc alloys containing lead on the iron content of the alloys, the gassing rate decreasing substantially when the iron content is lowered from 120 to 70 and then to 10 ppm; in addition, this dependency is substantially linear as can be inferred from the graphs submitted by the respondent with the letter dated 27 June 2001; a value of the gassing rate as that specified in the patent in suit and corresponding to iron content levels equal to or below 1 ppm involves nothing more than a straightforward extrapolation of this teaching;
- document D6A discloses the reduction of the gas evolution rate of pure zinc when the level of iron impurity is below 5 ppm;
- document D1A teaches reducing the gas evolution and improving the corrosion resistance of zinc alloys for alkaline batteries containing Pb, In and Al and other metals and having a low amalgamation rate or no amalgamation at all by reducing the iron content to a level in the range of 0 to 20 ppm;

- document D17B teaches the dependency of the corrosion rate of non-amalgamated zinc on the iron content; and
- document D20B discloses the production of pure zinc for alkaline batteries with an iron content of 0,3 ppm.

The skilled person, being aware of the teaching of these documents, would therefore expect that a reduction of the iron content in the zinc alloys disclosed in documents D7A, D1B, D5B, D8B and D31B would lead to a reduction in the gas evolution rate of the zinc alloys and to an improvement of the corrosion resistance. It follows that the zinc alloy powders of the invention result from a mere routine optimisation of the iron content of the zinc alloys known from the disclosure of documents D7A, D1B, D5B, D8B and D31B, and, following the established case law, they do not therefore involve an inventive step.

In addition, no support for an inventive step can be seen either in the result claimed in the patent in suit, having regard to the result which a skilled person would have expected from this routine optimisation because:

- no special effect is associated with the particular value 1 ppm specified in the claims, this value constituting a rather arbitrary value selected according to the precision in the determination of the iron content allowed by current analytical methods;
- a comparison of the examples of the alloys of the invention and the comparative examples given in Table 3 of the patent in suit reveals that there

is no synergetic effect between the iron content and the alloying components, but only an additive effect; and

- the claims are silent as to the content level of other impurities such as copper and cobalt that have a clear adverse effect in the corrosion resistance of the zinc alloys.

VI. The submissions of the party as of right to the appeal proceedings (opponent 02) can be summarised as follows:

Zinc alloy powders having the alloying content specified in Claims 1 to 6 are, as submitted by the appellant, known in the prior art. In the corresponding zinc alloy powders of the prior art iron is present in an unspecified amount as an unavoidable impurity. In addition, methods for the purification of zinc raw material are well known in the art. Therefore, following the case law established by the Boards of Appeal in the case T 990/96 (OJ EPO 1998, 489), the prior art anticipates the corresponding zinc alloy powders for all degrees of iron impurity, and in particular for the impurity degree specified in the claims of the patent. Although the principle set out in this decision refers to low molecular organic products, it should also be applied by analogy to alloys. As a consequence, Claims 1 to 6 merely define the pure form of zinc alloys already known in the art and the corresponding subject matter is therefore not new.

As to inventive step, the skilled person is aware that impurities jeopardize the gas evolution and corrosion characteristics of zinc alloy powders used in alkaline batteries and would then start from the zinc alloy powders for batteries disclosed in document D20B and having a content of iron impurity of 0,3 ppm as the closest prior art; in addition, since mercury is to be

avoided for environmental reasons, he would then select among the alloying components disclosed in the prior art the alloying components known to be effective in the absence of mercury.

In addition, document D16B clearly suggests the extrapolation of the results presented in the document to very low levels of iron impurity. The graph submitted during the oral proceedings and plotting on a logarithmic scale the values of the corrosion rate disclosed in document D16B and the corresponding value 300 $\mu\text{l/day-cell}$ achieved with the powders of the patent in suit as a function of the respective iron impurity levels shows that the value achieved in the patent falls within the value range to be expected from a mere extrapolation of the values disclosed in document D16B.

Finally, the table submitted during the opposition proceedings on 5 May 1997 and showing the ratio of the gassing values of the examples of the invention to those of the corresponding comparative examples given in Table 3 of the patent reveals that no special effect is associated with the alloying components considered in the patent in suit when the level of iron impurity is lowered from 3 to 1 ppm.

VII. The respondent's arguments in support of its request can be summarised as follows:

The selection of the closest prior art carried out by the appellant does not reflect a skilled person's realistic way of tackling the problem considered in the patent in suit.

Gassing behaviour is generally unpredictable and there is no teaching derivable from any of the available prior art documents which would suggest the skilled person that an acceptably low gassing in alkaline cells

containing non-amalgamated zinc can be achieved by the combination of features defined in each of Claims 1 to 6. The invention does not lie in a synergetic effect *per se*, but in realizing that, as shown in Table 3 of the patent, it is possible to select specific alloying components which ensure a gassing below 300 $\mu\text{l/day-cell}$ when non-amalgamated zinc alloy powder having an iron content below the specific value 1 ppm is used. In addition, it is important to distinguish between the determination of gas evolution of the alloy powder in an actual cell environment as measured in the patent and that of gas evolution in a corrosive solution following standard tests, as is generally the case in the prior art.

Document D4A teaches reducing self-discharge by reducing the total impurity content of zinc; the document, however, fails to identify the specific relevance of the removal of iron, and the removal of cadmium recommended in the document even works against the reduction of the gassing rate to a very low level as achieved by the invention.

As to document D16B, the zinc powder disclosed there is a zinc sponge co-deposited in an electrodeposition process with lead and therefore having a different physical form as that of the zinc powder of the present invention. In addition, the gassing rates considered in the document are extremely high and cannot be compared to those of the zinc alloy powders of the invention. Furthermore, as shown by the graphs plotting the gassing performance of the powders disclosed in document D16B and submitted with the letters dated 27 June 2001 and 29 June 2001 and as confirmed by the graphs submitted by the party as of right during the oral proceedings, a linear extrapolation of the data presented in document D16B to zero iron level would result in extrapolated gassing rates that are too high

and in any case far above the target value considered in the patent in suit. Therefore, the ultra-low gassing rate achieved with the alloys of the invention cannot be foreseen from a mere extrapolation of the teaching of document D16B.

Document D17B reports that gassing in zinc powder is accelerated in the presence of iron; the document, however, teaches to compensate for this effect, not by removing the iron, but by effecting amalgamation to a level proportional to the amount of iron. In addition, the lowest iron content considered in the document is 20 ppm, and the value of the gassing rate that would be expected from a mere extrapolation of the corrosion rates disclosed in this document at zero iron content is also much higher than that of the amalgamated zinc as shown in the corresponding graph filed with the letter dated 27 June 2001.

Reasons for the Decision

1. *Admissibility of the appeal*

The appeal complies with the provisions of Articles 106 to 108 and Rule 64 EPC and is therefore admissible.

2. *Compliance of the amendments with the requirements of Articles 123(2) and (3) EPC*

The wording of Claims 1 and 3 to 6 as amended during the opposition proceedings was further amended during the oral proceedings before the board to specify that zinc forms the balance of the alloy and that the alloy contains, rather than just consisting of, 1 ppm or less of iron. These two amendments are mere clarifications

of the subject matter of Claims 1 and 3 to 6, which amendments bring the formulation of Claims 1 and 3 to 6 into line with that of Claim 2.

The board is satisfied that the amended claims comply with Article 123(2) and (3) EPC. Since the allowability of the claims in this respect was not disputed by the parties, it is not considered necessary to give further detailed reasons for this finding.

3. *Late submissions*

The appellant objected to the graphs plotting extrapolation data submitted by the respondent with the letter dated 27 June 2001 and corrected by letter dated 29 June 2001 as being filed after the final date for making written submissions fixed by the board in the summons to the oral proceedings, and it requested that the graphs not be admitted into the proceedings, accordingly.

In the board's view, these graphs do not introduce any new facts or evidence; the graphs constitute a straightforward representation of data disclosed in documents D16B and D17B on file and already discussed during the proceedings and they have been submitted by the respondent merely in order to simplify the presentation of oral arguments at the oral proceedings. Therefore, the board has decided, in the exercise of its discretion under Article 114 EPC, to admit the graphs into the proceedings.

For the same reasons the board also admitted into the proceedings a similar graph submitted during the oral proceedings by the party as of right.

4. *Novelty of the subject matter of the claims*

4.1 The party as of right to the proceedings has submitted that the groups of Claims 1 to 6 merely define the pure form of zinc alloy powders already known from the prior art documents D7A, D1B, D5B, D8B and D31B and that therefore, in application of the principle laid down in decision T 990/96, the claims lack novelty.

4.2 The respondent submitted that the decision T 990/96 concerned the purity level of organic compounds and that the principle laid down in the decision does not therefore apply to the purity level of alloys.

4.3 Decision T 990/96 deals with the problem of the novelty of low molecular organic compounds in the field of preparative organic chemistry. It was held in this decision (see point 7 of the reasons) that it is common practice in this field to purify a compound obtained in a particular chemical manufacturing process according to the prevailing needs and requirements and that, since conventional purification methods are within the common general knowledge in the field, a document disclosing a low molecular chemical compound and its manufacture makes normally available this compound in all desired grades of purity. The board notes, however, that this decision pertains to an **organic compound** that has been **synthetised by a chemical reaction**, and that the impurities referred to in the decision are those resulting from the synthetisation of the compound itself, i.e. the impurities are the result of **side-reactions and incomplete conversion of starting materials** (see point 6 of the reasons).

The situation in the present case is, however, different because the invention is not directed to an organic compound synthetised by a chemical reaction but

to an alloy and, in addition, the impurities referred to in the patent in suit are already present as inevitable impurities in the raw materials used in the alloying process and are not the result of the alloying process itself. It is also noted that the term impurity does not have the same technical meaning in organic chemistry as in the field of metallurgy; contrary to the impurities present in an organic compound, in the case of an alloy all the chemical elements in the alloy are constituent elements of the alloy itself, irrespectively of whether the chemical elements are considered as impurities or as actually desired alloying components. In addition, while in an organic compound an impurity is objectively distinguishable from the chemical point of view from the compound itself, in the case of an alloy whether a specific one of the chemical elements present in the alloy in a relatively low concentration constitutes an unwanted or inevitable impurity or a desired alloying constituent depends on the particular circumstances like the intended use of the alloy and cannot be objectively and unambiguously established on the basis of the alloy alone.

Therefore, the findings in decision T 990/96 cannot be applied to alloy powders according to the subject matter of the patent in suit.

- 4.4 Now, since documents D7A, D1B, D5B, D8B and D31B are silent as to the level of iron impurity content present in the respective zinc alloys and zinc alloys are generally known to have a level of iron impurity far above 1 ppm (see for instance document D16B, page 163, second column, second paragraph and document D4A, page 2, second paragraph which specify iron contents of 5 and 50 ppm, and in the ranges 5 to 20 and 100 to 300 ppm, respectively), it follows that the specific

level of iron impurity of less than 1 ppm specified in each of Claims 1 to 6 constitutes a feature imparting novelty to the claimed subject matter over the disclosure of documents D7A, D1B, D5B, D8B and D31B.

As novelty of the subject matter of Claims 1 to 6 over the remaining prior art documents on file was not disputed by the parties, it is concluded that Claims 1 to 6, as well as Claims 7 to 10 which refer back to Claims 1 to 6, define new subject matter over the prior art within the meaning of Article 54 EPC.

5. *Inventive step of the subject matter of the claims*

5.1. Closest prior art

5.1.1 In the present case, the main point which arises in connection with the question of inventive step is the appellant's submission that the closest prior art of the different zinc alloy powders defined in Claims 1 to 6 has to be selected taking into account the specific alloying components of the zinc alloy powders and is therefore represented by documents D7A, D1B, D5B, D8B and D31B, and not by document D4A nor by documents D16B or D17B as considered by the opposition division. The party as of right to the proceedings has submitted that the closest prior art is represented by document D20B.

In the board's view, however, and in accordance with the established practice of the Boards of Appeal (see for instance T 656/90, point 1.1 of the reasons, not published in the OJ EPO, and other decisions cited in "Case Law of the Boards of Appeal of the European Patent Office", EPO, 3rd edition, 1998, Chapter I, D-3.1 and D-3.2), in order to avoid any hindsight knowledge of the invention in the objective selection of the realistic closest prior art on the basis of which the invention of the patent in suit is to be

assessed, the closest prior art is constituted by the most promising prior art disclosure starting from which the claimed invention could most easily have been made by a skilled person confronted with the primary object underlying the patent in suit, and not by the prior art disclosure merely showing the most composition similarities with the alloys defined in the claims of the contested patent.

In the following, in order to evaluate the submissions of the appellant and of the party as of right, the primary object of the patent in suit is first established and then the disclosure of documents D4A, D16B and D17B, on the one hand, and that of documents D7A, D1B, D5B, D8B, D20B and D31B, on the other hand, is discussed in view of that primary object.

- 5.1.2 The patent in suit is directed to zinc powders for use as anode active material in alkaline cells. The problem of suppressing the evolution of hydrogen gas due to the corrosion of the zinc powder and preventing the subsequent loss of leaktightness of the cell was initially solved by using the zinc powder in an amalgamated state (page 3, lines 15 to 18 of the specification of the patent). Environmental and social constraints imposed restrictions in the use of mercury, and it was possible to reduce the amount of mercury in the zinc powder from 10 % to about 1 % by weight by adding alloying metals to the zinc powder so as to compensate the adverse effect of the reduction of the amalgamation rate (page 3, lines 19 to 37). According to the patent, however, no alkaline cell with an anode material of non-amalgamated zinc alloy powder had been developed in which the evolution of hydrogen gas was substantially suppressed (page 3, lines 38 to 45).

Therefore, the primary object underlying the patent in suit is the provision of non-amalgamated zinc powders for use in alkaline cells having a low hydrogen gas evolution rate, and in particular a rate below 300 μ l/day-cell which corresponds with an allowable upper limit of leaktightness for type LR6 alkaline cells (page 7, lines 1 to 3 and Table 3).

5.1.3 Documents D4A, D16B and D17B as closest prior art for all Claims 1 to 6

Document D4A discloses zinc powders for use as anode active materials in alkaline batteries (see Claims 1 and 2 on page 1). Environmental requirements prescribe the use of zinc powders in a non-amalgamated state (page 3, paragraph in the middle), and the document teaches to compensate for the adverse effects in the gassing rate and the corrosion resistance of the zinc powder resulting from the use of the powder in a non-amalgamated state (see page 2, last four lines and paragraph bridging pages 3 and 4) by using zinc powder having a total impurity content of Fe, Cd, Cu, Ni, Co and Ag of 9 ppm or less, preferably 5 ppm or less (page 4, lines 5 to 14 and the paragraph bridging pages 4 and 5), in one example the total impurity content being of 1,4 ppm (second paragraph of page 6).

Document D16B discloses the gas evolution performances of an electrolytic non-amalgamated zinc powder containing codeposited lead as a function of the content of iron impurity present in the alloy powder (abstract together with Figures 4 and 7). The document discloses in particular that in the case of zinc powder containing 0,5 % by weight of lead the corrosion rate, which constitutes a measure of the gas evolution rate

in the powder, is reduced from 0,180 to 0,060 and then to 0,020 cm³ H₂/ g h, when the iron content is decreased from 120 to 70 and then to 10 ppm (see test "d" listed in Table 1).

It follows that the teaching of each of documents D4A and D16B relates to the primary object of the patent in suit referred to in point 5.1.2 above. This provides a clear incentive for the man skilled in the art to use the corresponding teaching as a promising starting point towards the solution proposed in the patent in suit.

Document D17B teaches that an increase in the iron content in zinc powders increases the corrosion rate of the zinc powders (page 2101, last paragraph and Figure 1 together with Table 2) and that amalgamation lowers the corrosion rate of the powder and therefore suppresses the effect of iron (page 2102, first paragraph). The document concludes that the higher the iron content in zinc powder, the more mercury oxide must be added for amalgamation of the powder in order to compensate the increase in the corrosion rate (page 2102, second paragraph and Table 3).

Therefore, document D17B teaches away from the idea of suppressing amalgamation and is therefore contrary to the primary object of the patent in suit.

5.1.4 Document D31B: example 2 as the closest prior art for Claim 1

Example 2 of document D31B discloses a non-amalgamated zinc alloy comprising an alloying content as that defined in Claim 1. However, the document teaches to compensate for the adverse effects of the absence of mercury not by modifying the alloying content of the

zinc material, but by forming a stable film of a corrosion inhibiting acid ester salt on the surface of the zinc material (page 5, second paragraph and page 6, second paragraph).

Therefore, this document teaches away from the primary object of the patent in suit referred to in point 5.1.2 above and, notwithstanding the composition similarities with Claim 1, cannot be considered as an appropriate starting point towards the invention.

5.1.5 Document D7A: example 1 as the closest prior art for Claim 1 and the comparative example as the closest prior art for Claim 2

Contrarily to the submissions of the appellant, the lead content of the zinc alloy disclosed in example 1 of document D7A is below 0,002 % by weight and therefore far below the range 0,01 to 0,5 % by weight defined in Claim 1. In addition, the main object of the disclosure of document D7A is decreasing the amount of lead in a non-amalgamated zinc alloy to a level below 0,003 % by weight (see column 1, lines 15 to 20 and 37 to 52). As to the comparative example, this example is only disclosed in document D7A as a comparative test carried out in order to evaluate the gas evolution performance of the zinc alloy powders having a low content of lead relative to a zinc powder having a relatively high content of lead, the document teaching the reduction of the content in lead in non-amalgamated zinc powders due to the toxicity of lead and other environmental requirements (column 1, lines 37 to 52).

Therefore, example 1 of document D7A cannot be selected as closest prior art for the subject matter of Claim 1 on the basis of the composition similarities as submitted by the appellant, and no promising starting point for the primary object of the patent in suit can be seen in the comparative example.

5.1.6 **Document D1B:** example 1 as the closest prior art for Claim 3, and comparative example 5 as the closest prior art for Claim 4

Example 1 and the comparative example 5 of document D1B disclose zinc alloys having an alloying content corresponding to that of the zinc alloy powders defined in Claims 3 and 4 of the patent in suit, respectively. The document, however, specifies that the zinc alloys have an amalgamation rate of 1 % by weight (see Table 1 together with page 4, last paragraph and page 6, lines 7 to 10), the main object of document D1B being the reduction of the amalgamation rate (page 2, fourth paragraph). The document specifies that the zinc alloys can be used not only in a relatively low amalgamated state, but also in a non-amalgamated state (page 3, second paragraph and page 8, second paragraph); however, the use of the zinc alloys in a non-amalgamated state is only disclosed with reference to open-type air batteries or closed-type alkaline batteries provided with a hydrogen-absorption system (page 3, last sentence of the second paragraph) in which a larger amount of evolving hydrogen gas may be allowed.

Therefore, the non-amalgamated state of the zinc alloys is disclosed only as resulting in a deterioration of the gas generation performances of the alloy itself, and the document teaches away from the primary object

considered in the patent in suit, i.e. improving the gas generation performances of the alloys when no amalgamation is carried out.

5.1.7 Document D8B: example 11 as the closest prior art for Claim 5

Example 11 of document D8B discloses a zinc alloy having an alloying content as that of the zinc alloy defined in Claim 5. However, the zinc alloy disclosed with reference to example 11 has an amalgamation rate of 1 % by weight (page 6, second paragraph). The document further specifies that the zinc alloys can also be used in a non-amalgamated state in the same conditions, however, as those discussed above with respect to document D1B (see document D8B, page 10, third paragraph).

Therefore, the same conclusion set forth above with respect to document D1B also applies to document D8B.

5.1.8 Document D5B: example 17 as the closest prior art for Claim 4

Example 17 of document D5B discloses a zinc alloy having an alloying content as that of the zinc alloy defined in Claim 4, the zinc alloy being amalgamated to a mercury concentration rate of 1 % by weight (column 4, lines 38 to 41). The document teaches indeed that the amalgamation rate can be lowered to 0,2 % (column 2, lines 54 to 58) and even be used without amalgamation but only in the same conditions as those discussed above with respect to document D1B (see document D5B, column 7, lines 14 to 25).

Therefore, the same conclusion set forth above with respect to document D1B also applies to document D5B.

5.1.9 Document D20B: as closest prior art for each of Claims 1 to 6

Document D20B discloses the production of zinc of high purity for use in dry cells or semiconductor zinc oxide varistors (see the sentence bridging pages 2 and 3) and having an iron content below 0,3 ppm (see Table 1). The document, however, only refers to pure zinc and is silent as to the corrosion and the gas evolution problems in alkaline cells considered in the patent in suit.

Therefore, the mere analogy in the iron content with the iron content in the zinc alloy powders of the patent in suit does not qualify document D20B as closest prior art, the document being silent as to the primary object considered in the contested patent.

5.1.10 It follows from the above that neither document D17B considered by the opposition division as an alternative starting point nor any of documents D7A, D1B, D5B, D8B, D20B and D31B considered by the appellant and the party as of right as representing the closest prior art comes closer to the subject matter of any of Claims 1 to 6 than the disclosure of document D4A or alternatively the disclosure of document D16B and that none of them actually qualifies as realistic closest prior art for the subject matter of any of Claims 1 to 6. The selection of documents D7A, D1B, D5B, D8B, D20B and D31B as the closest prior art for Claims 1 to 6 mainly on the basis of composition similarities with the claimed alloys can in fact only result from hindsight knowledge of the subject matter of the patent in suit.

Therefore, the closest prior art is represented by document D4A or, alternatively, by document D16B and the submissions of the appellant and of the party as of

right that, among the available documents, documents D7A, D1B, D5B, D8B, D20B and D31B, and D20B represent the closest prior art cannot be followed.

5.2 Inventive step

- 5.2.1 The closest prior art represented by the non-amalgamated zinc powder for use in alkaline cells disclosed in document D4A is substantially non-alloyed and exhibits a total impurity content of Fe, Cd, Cu, Ni, Co and Ag of 1,4 ppm (see point 5.1.3 above).

Assuming for the sake of argument that, as submitted by the appellant, this total impurity content of 1,4 ppm implies a level of iron content equal to or below 1 ppm, the subject matter of independent Claims 1 to 6 would then be distinguished from the closest prior art represented by document D4A in that the zinc powder is alloyed with specific metals to form the alloyed zinc powders set out in the respective independent claims.

Document D4A, however, teaches increasing the purity level of substantially non-alloyed zinc powders in order to improve the electrochemical stability of the zinc powder and in the board's view the skilled person would not have contemplated in this context taking the step of alloying the high-purity zinc powder disclosed in document D4A with metals in an attempt to further improve the electrochemical stability of the powder. This view is supported by the fact that in document D4A cadmium, a well known suppressor of the hydrogen evolution reaction, is identified as and removed as an impurity.

In addition, none of the other documents on file would suggest to the skilled person that an improvement of the electrochemical stability of the zinc powder is attainable to the extent achieved in the contested

patent by alloying the zinc powder disclosed in document D4A with any of the specific alloying compositions defined in Claims 1 to 6.

The appellant and the party as of right to the appeal proceedings cited a number of documents disclosing the specific alloying compositions defined in Claims 1 to 6 for alloying zinc powder for use in an alkaline cell. In the board's view, however, these documents do not provide any obvious incentive for the skilled person to use the alloying compositions disclosed in the documents in the zinc alloy comprising very low iron impurity content disclosed in document D4A, in the expectation of any further improvement in the hydrogen gas evolution. The analysis of these documents in points 5.1.4 to 5.1.10 above shows in particular that

- document D31B, involved against Claim 1, requires the provision of specific corrosion inhibitors on the surface of the zinc material, which are absent from the claimed zinc alloy powders;
- document D7A, invoked against Claims 1 and 2, calls for lead contents far lower than those specified in the contested claims, and the composition cited against Claim 2 is disclosed as a comparative example only; and
- the alloying compositions disclosed in document D1B, as invoked against Claims 3 and 4, those of document D8B, as invoked against Claim 5, and those of document D5B, as invoked against Claim 4, are all recommended in a non-amalgamated zinc alloy only when the cell construction allows for a higher degree of hydrogen gassing.

For these reasons, the skilled person had no obvious reason, without the hindsight knowledge of the claimed subject matter, to envisage using the specific alloying metal compositions disclosed in the above citations in a high-purity zinc powder as that disclosed in document D4A in the expectation of a reduction in hydrogen evolution to the extent achieved in the patent in suit.

- 5.2.2 The alternative closest prior art represented by the non-amalgamated zinc powder for alkaline cells disclosed in document D16B contains 0,5 % by weight of lead, and is particularly close to the zinc alloy powder defined in independent Claim 2 in which the alloying components bismuth, aluminium and calcium are only optional.

The subject matter of independent Claim 2 is therefore distinguished from this alternative closest prior art in that, while in document D16B the iron content of the zinc powder is decreased from 120 to 70 and then to 10 ppm (see test "d" shown in Table 1), in Claim 2 the iron impurity content is 1 ppm or less.

The disclosure of document D16B alone, however, is not sufficient to foresee that an iron content equal to or less than 1 ppm would improve the gassing evolution performances of the non-amalgamated zinc powder to the extent achieved in the patent in suit. The graphs submitted by the parties and plotting both the value 300 μ l/day-cell achieved in the patent in suit and the values obtained by extrapolation of the results presented in document D16B to an iron content of 1 ppm are, in the board's view, not conclusive because the values disclosed in document D16B correspond with the gassing evolution of the powder itself and have been measured by the hydrogen evolution method in a hermetic glass vessel containing the zinc powder (document D16B, page 164, Figure 2 and section 2.2). On the contrary,

the value specified in the contested patent corresponds with the gassing evolution of the powder in a battery cell and is determined by measuring the rate of hydrogen gas evolution in an alkaline manganese cell partially discharged by 25 % (page 9, lines 35 to 40 of the patent specification), and therefore the values cannot be directly compared with each other. In any case, the board is not convinced that the skilled person would have had any obvious reason to actually consider an extrapolation of the results presented in document D16B to iron contents differing by one to two orders of magnitude from the actual iron contents disclosed in the document, in the expectation of the substantial reduction of the gassing evolution as disclosed in the contested patent.

Neither would the other documents on file have suggested that a reduction of the iron content in the zinc powder disclosed in document D16B to a level of 1 ppm or less would achieve the result of the patent in suit.

In particular, even assuming that the iron content in the zinc powder disclosed in document D4A is equal to or below 1 ppm (see point 5.2.1 above, second paragraph), no incentive can be seen for considering the application of the teaching of document D4A to the alloyed zinc powder disclosed in document D16B. It is noted in particular that the teaching of document D4A is confined to substantially non-alloyed powders and in addition refers to the total impurity content of Fe, Cd, Cu, Ni, Co and Ag without any differentiation as to the specific effects of the different impurity elements and in particular without attaching any particular significance to the iron impurity.

Other documents cited by the parties disclose zinc materials with a relatively low content of iron impurity, see in particular documents D1A, D6A, D17B and D20B. However, the zinc materials disclosed in these documents either require amalgamation for improving the corrosion resistance (documents D1A, D6A and D17B) and/or comprise an actual iron content substantially above 1 ppm (documents D1A and D17B) or are constituted by highly-pure non-alloyed zinc materials (document D20B). Therefore, none of these documents would in an obvious way suggest reducing the iron content of the zinc powder disclosed in document D16B to a level of, or below 1 ppm.

5.2.3 The board also notes that the examples of the invention and the comparative examples given in Table 3 of the specification of the patent in suit - and not questioned by the adverse parties - convincingly show that neither the reduction of the iron impurity content to an amount of 1 ppm or less nor the specific alloying compositions defined in Claims 1 to 6 can, alone, achieve the desired reduction in hydrogen evolution. Only the combination of these two specific measures provides a major improvement that ensures a gassing below 300 μ l/day-cell, this value corresponding, when measured in an actual cell, to an allowable upper limit of leaktightness for type LR6 alkaline cells. Moreover, as shown in the comparative examples, other alloying compositions are much less effective.

Incidentally, the appellant objected that the claims do not specify the content level of impurities other than iron and also having an adverse effect in the corrosion resistance of the zinc alloys. This objection, however, does not prejudice the assessment of inventive step carried out above because it is self-evident in the

board's view that the skilled person would as a matter of course avoid content levels of other impurities that could jeopardize the hydrogen gassing reduction sought for by the invention and achieved by the claimed conjunction of an iron content of 1 ppm or less and the specific alloying metal compositions set out in the respective independent claims.

- 5.3 For these reasons, the board sees no reason to depart from the conclusion drawn by the opposition division in the contested decision that the subject matter of each of independent Claims 1 to 6 involves an inventive step within the meaning of Article 56 EPC.

The same conclusion applies to the subject matter of Claims 7 to 10 by virtue of their reference to the zinc alloy powders defined in any of Claims 1 to 6.

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 in amended form as follows:
 - Claims 1 to 10 submitted at the oral proceedings held on 5 July 2001 and
 - description and drawings as maintained by the opposition division.

The Registrar:

The Chairman:

P. Martorana

E. Turrini

