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DECISION
of 5 February 2004

Case Number: T 0678/02 - 3.4.2

Application Number: 91107009.2

Publication Number: 0482287

IPC: H01M 10/40, H01M 4/40,
H01M 4/58

Language of the proceedings: EN

Title of invention:
A non-aqueous secondary electrochemical battery

Patentee:
MATSUSHITA ELECTRIC INDUSTRIAL Co., Ltd.

Opponent:
Alcatel
Merck Patent GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56, 87(1), 88, 123(2)

Keyword:
"Inventive step (yes)"
"Problem/solution approach"
"Optimisation of performance within a range"

Decisions cited:
G 0002/98, T 0057/84, T 0615/95, T 0939/92

Catchword:
-



Case Number: T 0678/02 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 5 February 2004

Appellant I:
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Appellant II:
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Respondent:
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Representative: -

Decision under appeal: Interlocutory decision of the Opposition
Division of the European Patent Office posted
29 April 2002 concerning maintenance of
European patent No. 0482287 in amended form.

Composition of the Board:

Chairman: A. G. Klein
Members: A. G. M. Maaswinkel
 G. E. Weiss

Summary of Facts and Submissions

I. The appellant I (proprietor of the patent) lodged an appeal, received on 20 June 2002, against the interlocutory decision of the opposition division, dispatched on 29 April 2002, on the amended form in which the European patent No. 0 482 287 (application No. 91 107 009.2) could be maintained. The fee for the appeal was paid on 20 June 2002. The statement setting out the grounds of appeal was received on 28 August 2002.

The appellant II (opponent I, Alcatel) likewise lodged an appeal, received on 28 June 2002, against the interlocutory decision of the opposition division. The appeal fee was paid the same day. The statement setting out the grounds of appeal was received on 28 August 2002.

The opponent II (Merck Patent GmbH), party as of right pursuant to Article 107 EPC, did not file any requests or observations during the appeal proceedings.

II. Two oppositions had been filed against the patent as a whole, on the basis of Articles 100(a), (b) and (c) EPC. During the opposition proceedings the grounds for opposition against the patent as granted under Articles 100(b) and (c) were withdrawn. The objection under Article 100(a) EPC was substantiated by the grounds that the subject-matter of the patent was not patentable within the terms of Articles 52(1), 54 and 56 EPC.

The Opposition Division held that the patent in amended form according to the proprietor's auxiliary request met the requirements of the EPC, having regard *inter alia* to the following documents:

- (D1) JP-A-63 121 260 with French translation
- (D4) US-A-4 957 833
- (D5) JP 289150/90 with English translation
- (D6) JP 300765/90 with English translation
- (D8) EP-A-0 398 689
- (D10b) EP-B2-0 201 038
- (D13) EP-A-0 548 449.

III. At the auxiliary requests of both appellants oral proceedings were held on 5 February 2004.

IV. Appellant I requested that the decision under appeal be set aside and that the patent be maintained on the basis of Claims 1 to 4 and pages 2 to 8 of the description filed at the oral proceedings and the figures of the patent specification.

Appellant II requested that the decision under appeal be set aside and that the patent be revoked.

V. The wording of Claim 1 reads as follows:

"A non-aqueous secondary electrochemical battery comprising a complex oxide containing lithium of the formula $\text{Li}_{1-x}\text{MO}_2$ ($0 \leq x < 1$) for a cathode, where M is a transition metal selected from the group consisting of Co, Ni, Fe and Mn, or a plurality of transition metals including one selected from the group consisting of Co, Ni, Fe and Mn; a carbon material capable of

intercalating and deintercalating lithium ions for an anode; and a non-aqueous electrolyte, wherein said non-aqueous electrolyte is obtained by dissolving an inorganic salt in a mixed solvent containing a cyclic ester and a second solvent, wherein said cyclic ester is at least one selected from the group consisting of ethylene carbonate, propylene carbonate, butylene carbonate, and γ -butyrolactone and said second solvent is at least one selected from the group consisting of diethyl carbonate, dimethyl carbonate, methyl carbonate, and wherein the mixing ratio of said second solvent to cyclic ester (second solvent/cyclic ester) is in the range of 1 to 4 by volume."

The wording of Claim 3 reads as follows:

"A non-aqueous secondary electrochemical battery comprising $\text{Li}_{1-x}\text{MO}_2$ ($0 \leq x < 1$) for a cathode, a carbon material capable of intercalating and deintercalating lithium ions for an anode, and a non-aqueous electrolyte, wherein M is Co or part of Co is replaced by another transition metal, and wherein said non-aqueous electrolyte is obtained by dissolving at least one inorganic salt selected from the group consisting of lithium tetrafluoroborate, lithium hexafluorophosphate, lithium hexafluoroarsenate, lithium trifluoromethanesulfonate, and lithium perchlorate in a mixed solvent containing ethylene carbonate and diethyl carbonate and wherein the mixing ratio of said diethyl carbonate to ethylene carbonate (diethyl carbonate/ethylene carbonate) is in the range of 1 to 4 by volume."

Claims 2 and 4 are dependent claims.

VI. The arguments of appellant II (opponent) may be summarised as follows.

The amendments in Claim 1 are not admissible under Article 123(2) EPC because the second solvent defined in this claim represents a particular selection of the group of chain esters disclosed in Claim 3 as originally filed. According to the case law of the boards of appeal, see Decision T 615/95, to arbitrarily select and delete only certain elements from a list is not admissible if the originally filed group loses its general character. In the present case, out of a group of originally seven chain esters five have been deleted, which creates a new invention, in contrast to the amendment found to be admissible by the board in Case T 615/95, where only one element from each of three independent lists of sizeable length was shrunked out.

The claimed priority dates of the patent in suit are not valid, because the requirement for claiming priority of "the same invention" as stipulated in Article 87(1) EPC is not fulfilled. As ruled by the Enlarged Board in Case G 2/98, this requirement means that priority of a previous application in respect of a claim in a European patent application in accordance with Article 88 EPC is to be acknowledged only if the skilled person can derive the subject-matter of the claim directly and unambiguously, using common general knowledge, from the previous application as a whole. In the present case already the three objectives stated on page 3, lines 39 to 44 of the patent specification do not have a corresponding support in the priority

documents D5 and D6, since in D5 only the objective of improving the low temperature characteristics is addressed (see page 3, penultimate paragraph and page 4, first full paragraph of the translation). Furthermore in Claim 1 the transition metals Ni and Fe as well as the "plurality of transition metals including one of the group consisting of Co, Ni, Fe and Mn" do not find any support in priority documents D5 and D6, because in D5, see pages 6 and 7 of the translation, and similarly D6, only lithium cobalt complex oxide and lithium manganese complex oxide are disclosed. For the same reason the expression in present Claim 3 that "part of Co is replaced by another transition metal" is not supported by the priority documents. As to the solutes, Claim 1 defines "an inorganic salt" and Claim 2 defines five explicit lithium salts, whereas the only solute in the priority document D5 is lithium perchlorate. With respect to document D6, its teaching is confined to electrolytes comprising the cyclic esters ethylene carbonate or propylene carbonate and chain esters dimethyl carbonate or diethylcarbonate, and wherein the mixing ratio of the chain ester to the cyclic ester is precisely 1. Therefore a valid priority claim cannot be based on this document, because both independent Claims 1 and 3 define a mixing ratio in the range of 1 to 4 by volume.

With respect to the issue of inventive step, document D1 is considered as the closest prior art. This document discloses a rechargeable electrochemical battery comprising a LiCoO_2 -cathode, an anode made of carbon and a non-aqueous electrolyte. The electrolyte preferably consists of a carbonate ester solvent (page 6, line 5 of the French translation), for

instance propylene carbonate (PC) or ethylene carbonate (EC) in which an inorganic salt is solved, for instance lithium hexafluorophosphate. The subject-matter of independent Claims 1 and 3 differs from this known battery in that the electrolyte comprises a second solvent consisting of a chain ester. In Claim 1 this ester is selected from the group of diethyl carbonate (DEC), dimethyl carbonate or methyl carbonate; in Claim 3 the chain ester is DEC. The mixing ratio of the second solvent to the cyclic ester is in the range of 1 to 4 by volume. According to the patent specification, see page 3, lines 39 to 44, three objectives are addressed by the invention. However, the first and second of the stated problems are already solved in D1, see page 6, last line and page 7, first line of the translation, disclosing that the battery has excellent cycle life capability and autodischarge properties, and Table 1, in which for the embodiment of Example 1 a charge efficiency of 98% is disclosed. Therefore the only new technical problem actually addressed by the patent is the third problem, namely to improve the low temperature performance of the known non-aqueous battery. In accordance with established case law, see Decision T 939/92, point 2.4.2 of the Reasons (OJ EPO 1996, 309), everything falling within a valid claim must be inventive and (*ibidem*, point 2.5.3) a selection, in order to be patentable, must not be arbitrary but must be justified by a hitherto unknown technical effect. Therefore, concerning the subject-matter of Claims 1 and 3, the technical problem must be solved throughout the claimed volume range of 1 to 4. However, as is shown by the patent document D13 which belongs to the same patent proprietor but was published after the application date of the present patent, the

low temperature behaviour of a very similar battery with solvents DEC and EC in a volume ratio of 70:30 is not satisfactory. This is shown in Figures 2 and 3 of D13 for the curves labelled C and C'. In fact, already at a temperature of -10°C (Figure 3) the discharge capacity of battery C' is poor, from which it must be concluded that at -20°C (the temperature at which, according to the patent specification, the claimed batteries should still have an "improved discharge performance") the behaviour should even be worse. Since the battery C (respectively C') from D13 corresponds in its composition to the battery "D" from the patent specification it follows that the technical problem addressed in the patent is not solved throughout the claimed range. Furthermore, since the low temperature behaviour is poor already at a mixing value 70:30 (battery "D"), it will be poorer for a battery with solvent mixture at the lower limit of the claimed range (battery "E", mixing value 50:50). In this context it is noted that, except for some observations on solidification of the solvents at -20°C in Tables 1 and 2, the patent discloses nothing on the discharge behaviour at this temperature, presumably no electrical measurements having been made on the batteries. Therefore, since the technical problem over the prior art (D1) is not solved throughout the claimed range, already for this reason the subject-matter of Claims 1 and 3 does not involve an inventive step.

Furthermore, the skilled person knows from document D4, see column 1, lines 51 to 54, that the degradation of the battery performance at low temperatures is related to the composition of the solvent in particular for cyclic carbonates such as EC or PC, because these are

viscous and show a reduced ionic conduction at low temperatures. Document D4 pertains to the same technical field of non-aqueous secondary batteries as document D1 and the skilled person will therefore be familiar with its contents. In this respect, the objection of the patent proprietor that the electrodes of the battery disclosed in D4 are of a different composition than those disclosed in D1, is irrelevant because the battery performance at low temperature is related to the composition of the solvent. In column 2, lines 26 to 29, D4 summarises to provide a battery with "... sufficient discharge capacity at low temperatures" and in the same column, lines 31 to 42, it is disclosed that by combining non-cyclic carbonates such as DEC with the cyclic carbonates EC or PC a non-aqueous solvent mixture as liquid electrolyte for high-performance cells is obtained which is stable at an increased voltage and is sufficiently less viscous to provide a relatively high ionic conduction at low temperatures. In column 4, line 38, D4 discloses that DEC is especially preferred, and in the same column, lines 49 and 50, the cyclic carbonates EC and PC are disclosed. Concerning the mixture range, in column 5, line 45, the preferable range is 1/3 to 3/1 in weight ratio; and in Example 1 (column 7, line 3) a mixture of PC and DEC in a ratio of 50/50% by weight is used, which corresponds approximately to a volume ratio of 1.24. Finally reference is made to document D8, which represents prepublished prior art within the meaning of Article 54(2) EPC, since the priority of the patent in suit is not valid. This document casts doubts on the assertion of the patent proprietor that the teaching of document D4 could not be combined with that of document D1 because of different electrode structures. Document

D8 addresses the same technical problem as the patent and D4, namely to improve secondary battery operation characteristics at low temperatures, see column 3, lines 2 to 9. In column 5, lines 52 to 57 a number of materials for a positive electrode is mentioned, for instance lithium-manganese composite oxide, which is an intercalating material. In column 6, lines 1 to 6, materials for a negative electrode are disclosed, for instance lithium or lithium-containing material (lithium-aluminium alloy), and in particular "carbon-containing lithium ions". This illustrates that the skilled person was aware that the problem of low temperature behaviour of such batteries is related to the composition of the solvent and that this problem may be solved by selecting the proper solvent mixture regardless of the particular type of electrodes, since in D8 both the electrodes employed in D1 and in the patent in suit (intercalating material including carbon anode) and the electrodes used in the battery of D4 (lithium-aluminium alloy anode) are referred to. According to D8, see column 6, lines 11 to 50, the electrolyte solvent may be a mixture of EC, a second ester (dimethyl carbonate, DMC, see line 18), and a further constituent (2-methyltetrahydrofuran). The mixing ratio of these solvents is preferably 20 to 60 vol% of EC, 10 to 50 vol% of 2-methyltetrahydrofuran, and 10 to 50 vol% of the ester (DMC). Therefore the relative mixing ratio of DMC and EC also covers the range 1 to 4 by volume as in Claims 1 and 3, because the claims do not exclude that the electrolyte may comprise a third solvent (e.g. 2-methyltetrahydrofuran). In conclusion, both in document D8 and in D4 the problem of improving the performance of non-aqueous secondary batteries is addressed, and

both documents offer the solution of mixing a cyclic ester (EC) with a chain ester (DEC resp. DMC) in a relative ratio within the range 1 to 4 by volume. From document D8 the skilled person furthermore learns that this solvent may be used in batteries with different types of electrodes. Therefore for improving the low temperature performance of the battery of document D1 the skilled person would routinely apply the teaching of document D4 and/or D8 thereby arriving at the subject-matter of Claims 1 and 3 without an inventive step being involved.

VII. The arguments of appellant I (patent proprietor) may be summarised as follows.

The objections of appellant II (opponent) in respect to the admissibility of the amendments are unfounded. Contrary to the argumentation of appellant II, the amendments are fully consistent with the reasoning in Decision T 615/95 (not published in OJ EPO), according to which a deletion in a list is allowable under Article 123(2) EPC if it does not result in singling out any hitherto not specifically mentioned individual compound or group of compounds. In the present case the patent application as originally filed contained two lists, one for the cyclic esters (Claim 2) and one for the chain esters (Claim 3) wherein each list explicitly recited the individual compounds. From the list of chain esters a number of entries were deleted, the carbonate esters remaining, because these corresponded to the Examples in the patent application. Therefore the amendments in the claims do not involve any arbitrary selection but are fully consistent with the original disclosure.

As to the objections that the priority dates of the patent are not valid the patent proprietor does not comment, since it is of the opinion that the prior art on file, including document D8, cannot question the patentability of the claims with respect to Article 52(1) EPC, irrespective of the effective filing date of the patent.

With reference to Decision T 939/92 (OJ EPO 1996, 309) the appellant II has objected that the subject-matter of the claims does not involves an inventive step because not each and every element within the scope of the claims excels in every aspect over the prior art. This, however, is an erroneous interpretation of the case law. Rather, as is set out in Section I.D.6.14 of the Case law of the Boards of Appeal, 4th edition, and analogous to Decision T 57/84 (OJ EPO 1987, 53), the relevant criterion is whether the invention outperforms the prior art device as a whole, even if the prior art device proves better in any particular aspect. It is the object of the patent to provide a non-aqueous secondary electrochemical battery having a better overall performance and a net advantage over the prior art batteries having regard to the objectives (1) improved cycle life capabilities, (2) improved discharge performance, and (3) improved low temperature performance (see page 3, lines 39 to 44 of the patent specification). Making reference to document D13 the opponent has argued that since, according to D13, a mixed solvent DEC/EC with volume ratio 70:30 (curve C' in Figure 3) has the poorest characteristics at a low temperature of -10°C out of three mixtures, the above recited technical problem (3) is not solved for the

batteries "E" and "F" in the patent specification and within the claimed range 1 to 4 by volume. However, as is readily visible by comparing the batteries in Figure 2 of D13, battery C has the best cycle life, and, furthermore, has the best shelf life (Figure 4 of D13). Hence, even if battery C does not excel in low temperature behaviour, it is the best choice for storage capacity and cyclability, which are equally objectives addressed in the patent. Furthermore, concerning the low temperature properties of a solvent mixture of PC and DEC in ratio 50:50, the experimental data filed with the letter dated 28 August 2003 convincingly show that the low temperature behaviour of a battery containing this solvent mixture is much better than that of a battery only containing PC (as the battery disclosed in document D1). Therefore the argument of the opposition division that the patent specification only discloses experimental data of solvent mixtures comprising EC and DEC whence the solution of the technical problem by further combinations of solvents and cathode materials in Claim 1 was not demonstrated and an inventive step could not be acknowledged is refuted.

Document D1 discloses a battery system comprising a carbon material anode and a lithium oxide cathode. The solvents used in this system are cyclic carbonates such as γ -butyrolactone, propylene carbonate and ethylene carbonate or mixtures of these. The opponent has argued that the subject-matter of Claims 1 and 3 would result from a combination of the teaching of D1 with those in documents D4 and/or D8. However, such a combination can only be made with the benefit of hindsight, because the battery system disclosed in D1 and the one known from

D4 and D8 are completely different. Document D4 is an example of a secondary battery using a lithium metal anode and a conductive polymer cathode. These systems have undesirable factory cycle life, float life and self-discharge life, when used at high discharge capacity, and they operate at an EMF of between 2.0 and 3.5 V. In contrast, the battery of D1 operates at a high EMF of approximately 4 V. The use of a lithium metal oxide cathode is intrinsically associated with a problem of growth of metallic lithium dendrites at the electrodes which impedes the charge and discharge transfer. According to D4, column 2, lines 55 to 60, the disclosed solvent mixtures can control dendrite growth and can inhibit for lithium alloys as the negative electrode material electrode disintegration and coulombic efficiency loss. The performance of this type of batteries depends critically on the concentration of the electrolyte, wherein the lithium ions are responsible for the charging and discharging, therefore a high salt concentration of the electrolyte is important. In contrast, in the battery disclosed in D1 the lithium ions move from the cathode to the carbon anode where they are intercalated, therefore the lithium ions in the electrolyte are *replaced* whence this type of battery has a much smaller dependence on the concentration of the electrolyte than the one in D4. Therefore these aspects addressed in column 2 of D4 are non-relevant for the electrode system of D1 and the skilled person would not have been motivated to use the solvent mixtures of D4 in the electrode system of D1. The problem related to the use of an intercalating carbon electrode as in D1 is the decomposition of the solvent at the carbon electrode, this was a known problem as can be seen from document D10b, page 3,

line 31 to 34. However, this problem is not addressed in D4 and this document does not offer any solution to this problem which is another reason why the skilled person did not have any incentive to consult this document or combine its teaching with the one in D1.

As to document D8, this relates to a battery of the same type as the battery in D4, having an anode in which metallic lithium is used, in contrast to D1 where the anode electrode comprises intercalating carbon. The reference by appellant II to the passage from column 5, line 52 to column 6, line 6 of D8, from which it would follow that the solvent mixture disclosed in this document is usable for batteries having various types of electrodes, including those employing intercalating materials, is not convincing, because in the examples the anodes are made of metallic lithium. Furthermore, according to D8, the solvent is always a mixture of ethylene carbonate and 2-methyltetrahydrofuran, therefore the skilled person concludes that the presence of 2-methyltetrahydrofuran in the solvent is mandatory and he would not consider combining the teachings of D8 and D1.

Reasons for the Decision

1. The appeal is admissible.
2. *Amendments*
 - 2.1 The appellant II (opponent) has objected that the amendments in Claim 1 are not admissible under Article 123(2) EPC, because by the deletion of five

esters from the group of chain esters defining the second solvent in Claim 3 as originally filed this group loses its general character, which, according to Decision T 615/95, is not admissible since it creates a new invention.

The appellant I (patent proprietor) has argued that the original list of chain esters, defined in Claim 3 as originally filed, consisted of seven compounds explicitly recited in this claim and of which those esters were deleted which did not correspond to the Examples in the patent application.

2.2 The Decision T 615/95 considers amendment of a claim including a *generic* chemical formula with three independent lists of sizeable length specifying distinct meanings for three residues and in which the amendment of reducing the original group of compounds by deleting some of the originally disclosed compounds from the residues was found to be admissible, because the amendment did not result in singling out any hitherto not specifically mentioned individual compound or group of compounds, but maintained the remaining subject-matter as a generic group of compounds differing from the original group only by its smaller size (*point 6 of the Reasons*).

2.3 The present appeal case concerns a factually different situation, because the group of chain esters defined in Claim 3 as originally filed did not comprise a *generic group*, which by its very nature may include a large plurality of compounds by all possible substituents in the residues, but was limited to seven compounds explicitly defined in the claim. The limitation to the

carbonate chain esters in the second solvent is therefore not objectionable under Article 123(2) and (3) EPC. According to appellant I, this limitation had been introduced during the opposition proceedings in order to overcome an objection under Article 100(b) EPC by appellant II; therefore the amendment is also allowable under Rule 57a EPC.

3. *Priority*

The Board concurs with appellant II that the present independent claims include features which do not have an unambiguous support in the priority documents D5 and/or D6 (*see the feature enumerated in point VI supra*). Therefore the claim to priority in accordance with Article 88 EPC cannot be acknowledged, as ruled by the Enlarged Board of Appeal in Opinion G 2/98, as a consequence of which the decisive date to be considered for Article 54 and 56 EPC is the filing date of the European patent application (*i.e. 30 April 1991*).

4. *Patentability*

4.1 Novelty

During the appeal proceedings, novelty of the subject-matter of the claims was not in dispute among the parties.

4.2 Inventive step

4.2.1 Closest prior art

The Board concurs with the parties' agreed view that document D1 discloses the closest prior art. This document shows in Figure 1 a non-aqueous secondary electrochemical battery of the same type as in the patent in suit comprising a cathode (*positive electrode 1*) of lithium metal oxide wherein the metal is Co or Ni; an anode (*negative electrode 2*) made of carbon material capable of intercalating and deintercalating lithium ions ("*activated carbon*"); and a non-aqueous electrolyte, obtained by dissolving an inorganic salt (*for instance, lithium perchlorate, see page 7, last paragraph of the French translation*) in a solvent containing a cyclic ester (*for instance, ethylene carbonate or propylene carbonate, see page 6, lines 11 and 12 of the translation*).

- 4.2.2 The subject-matter of Claim 1 differs from the battery known from document D1 in that the solvent is a mixed solvent wherein the second solvent is at least one selected from the group consisting of diethyl carbonate, dimethyl carbonate, methyl carbonate, and wherein the mixing ratio of said second solvent to cyclic ester (second solvent/cyclic ester) is in the range of 1 to 4 by volume.

The subject-matter of Claim 3 differs from the known prior art battery in that the mixed solvent contains ethylene carbonate and diethyl carbonate and wherein the mixing ratio of these (diethyl carbonate/ethylene carbonate) is in the range of 1 to 4 by volume.

4.2.3 According to the appellant II, since two out of the three objectives addressed in the patent (*on page 3, lines 39 to 44 of the specification*) are already solved in document D1, (*page 6, last line and page 7, first line of the translation*), the only new problem in the patent in suit is to improve the low temperature performance of battery of D1. Since independent Claims 1 and 3 define that this problem is solved by mixing two solvents in a volume range of 1 to 4, it follows by reference to Decision T 939/92 that it is essential for an inventive step to be acknowledged that this solution must be achieved *throughout* the claimed range. In the opinion of appellant II this condition is not met, for which reference was made to document D13.

Appellant I has argued that the reasoning in Decision T 939/92 relied on by appellant II does not apply and that the relevant criterion is whether the invention outperforms the prior art device as a whole, as ruled in Decision T 57/84.

4.2.4 Decision T 939/92 relates to a claim concerning a group of chemical compounds *per se* and to alleged technical effects that are not a part of the definition of the claimed compounds (*see point 2.2.2 of the Reasons*). Thus that decision concerns a factual situation which differs from the present case, in that the present claims are directed to electrochemical batteries, i.e. to technical devices inherently having a technical effect. For this reason, the criteria laid down in Decision T 939/92 are not applicable for the assessment of inventive step of the claimed subject-matter.

4.2.5 According to the patent specification, page 3, lines 39 to 44, the objectives of the invention are (1) to provide a non-aqueous secondary electrochemical battery which can prevent the electrolyte from decomposing, thereby protecting the layer structure of the carbon material; (2) to provide a non-aqueous secondary electrochemical battery having improved cycle life capabilities; and (3) to provide a non-aqueous secondary electrochemical battery having improved discharge performance and low temperature performance.

As pointed out by appellant II, in D1 it is disclosed that the non-aqueous battery from that document has excellent cycling and autodischarge properties. The problem of decomposition of the electrolyte solvent which, according to the patent specification, page 2, lines 33 to 40, is a problem related to the use of an intercalating carbon anode, is not discussed in D1. Since it would appear that for a given anode/cathode combination (*here: intercalating electrode materials*) the above recited objectives are all related to the composition of the electrolyte (*salt and solvents*) and are therefore *interrelated* it follows that the selection of the electrolyte will necessarily affect the performance of the battery in *all* aspects simultaneously, because maximising the battery performance in one aspect may lead to a less than optimum performance in another of the objectives. Therefore, for a correct application of the problem/solution approach in the present case it would not be proper to disregard the aspects concerning the cycle life and discharge properties because it cannot *a priori* be predicted whether a further optimisation of the prior art battery known from document D1 with

respect to its low temperature behaviour, for instance by modifying the electrolyte, would not have a detrimental effect on its cycle life and discharge properties. Hence, the technical problem cannot be seen in merely "optimising the low temperature behaviour of the battery" in isolation, but rather in "optimising this behaviour, while simultaneously considering the further objectives (*prevention of the electrolyte of decomposing; improved life cycle capabilities; improved discharge performance*).

4.2.6 In the opinion of appellant II, starting from document D1 as the closest prior art the skilled person would arrive at the subject-matter of Claims 1 and 3 by applying the teachings of document D4 or, equally, D8.

4.2.7 Document D4 discloses a non-aqueous liquid electrolyte cell using an organic electroconductive polymer, typically polyaniline as the positive electrode active material and lithium or lithium alloy as the negative electrode active material (*column 1, lines 4-8*). A problem in the prior art to D4 in relation to the use of polyaniline as the positive electrode material was the less than satisfactory battery properties at relatively high discharge capacity (*column 1, lines 25 to 31*) and a known solution was the use of an electrolyte solvent which was a solvent mixture of propylene carbonate and ethylene carbonate (*column 1, lines 45 and 46*). A problem related to the use of the latter cyclic carbonates was their reduced ionic conductivity at low temperatures (*column 1, lines 53 to 56*). According to D4, further problems follow from the use of metallic lithium as the negative electrode (*dendrite formation, see column 1, lines 57 to 68*) or a

lithium aluminium alloy (*desintegration of the electrode, column 2, lines 1 to 20*). These problems are solved by using as a solvent a combination of cyclic and non-cyclic carbonates (*column 2, lines 38 to 42; see also Claim 1 of D4*). Document D4 discloses that by selecting this mixture of solvents a non-aqueous liquid electrolyte cell can be fabricated in which the positive electrode active material is composed of a conductive organic polymer and the negative electrode active material is composed of lithium or lithium alloy. The resulting cell has a practically satisfactory cell life and maintains a sufficient discharge capacity at low temperatures below 0°C (*column 2, lines 42 to 51*). Therefore the skilled person learns from this document that for the type of batteries having the kind of electrodes (*cathode and anode*) as in D4 with the problems related to these particular electrodes a satisfactory performance (*factory shell, discharge and autodischarge life; low temperature discharge capacity*) may be obtained by selecting a mixture of non-cyclic and cyclic carbonates.

In the opinion of appellant II the skilled person was aware that the problem of low temperature performance of non-aqueous liquid electrolyte cells was related to the composition of the solvent and that he therefore, in order to improve the low temperature properties of the battery of document D1, would apply the teaching of document D4 by selecting in this battery also the electrolyte mixture of cyclic and non-cyclic carbonates as disclosed in D4.

The Board cannot agree with this argument. As can be concluded from the various passages in document D4

cited above, the teaching of this document is focused on improving a particular type of battery in respect of the prior art problems inherent to the particular type of (*electroconductive polymer and lithium-metal alloy based*) electrodes. The issue of the low temperature behaviour of that battery is just one amongst several points in which the prior art battery should be improved. Furthermore, the problems related to the choice of an intercalating compound (*carbon*) electrode of the type used in document D1 and discussed in the patent in suit do not occur in the device of D4. Therefore, because of the different electrochemical processes at the different electrode systems in documents D1 and D4 and their very specific problems the board is not convinced that the skilled person, when trying to improve the battery type of D1, would have considered modifying the composition of the electrolyte solvent of that battery type by employing the mixture of cyclic and non-cyclic carbonates known from document D4 and used there in a different type of battery. Such a modification is also not obvious because, as set out in point 4.2.5, the objective problem to be addressed resides in an *overall* optimisation of the battery, including, but not exclusively focused on, its low temperature behaviour and the skilled person finds neither in document D1, not in D4, any information how the use of a solvent mixture as in the system of D4 might negatively influence the remaining properties of the battery system of document D1.

- 4.2.8 Since the priority date claimed by the patent is not valid (*see point 3 supra*) document D8 discloses prior

art within the meaning of Article 54(2) EPC and is equally considered for the question of inventive step.

Appellant II has referred to D8 arguing that this document discloses that an improved low temperature behaviour may be obtained by the selection of mixed solvents in batteries having various types of electrodes, which also proved that the skilled person was aware that the low temperature properties of these batteries were a function of the composition of the solvent, and not be related to the electrode properties, whence he would consider a combination of the teachings of D1 and D8 or D1 and D4.

In the passages referred to by appellant II, column 5, lines 52 to 57 (*positive electrode*) and column 5, line 58 to column 6, line 6 (*negative electrode*) indeed a number of possible electrode materials are recited, from which at least the material "lithium-manganese composite oxide" would appear to fall within the definition of the complex oxide for the cathode material of Claim 1. Appellant II also referred to the term "carbon-containing lithium ions" in the group of the negative electrode. The Board has, however, not found any disclosure in document D8 in which these electrode materials are used together, which for the function of a intercalating and deintercalating electrode system would be indispensable. Indeed, the only embodiment in which a complex oxide containing lithium material is disclosed, Example 1, discloses a sheet-like lithium foil as a negative electrode (*column 8, lines 14 to 37*) and none of the embodiments actually includes a negative electrode from a carbon-containing lithium ion material. Furthermore it is

noted that it is an object of document D8, see column 2, line 48 to column 3, line 1 "to provide a non-aqueous electrolyte secondary battery which suppresses degradation in a negative electrode consisting of lithium or lithium-containing material caused by a non-aqueous electrolyte, and suppresses precipitation of lithium or lithium-containing material in the form of a dendrite or a small sphere caused by repetitive charge/discharge, thereby improving a charge/discharge cycle life"; as a further object D8 discloses "to provide a non-aqueous electrolyte secondary battery which improves stability of a non-aqueous electrolyte to improve storage properties"; and as a still another object "to provide a non-aqueous electrolyte secondary battery which improves operation characteristics at low temperatures". Since in the embodiments of Examples 2 to 17, the corresponding Control Examples, and Examples 20 to 35 the electrodes are all "*similar to those in Example 1*"; and since in Examples 18 and 19 similarly a "*sheet-like lithium foil*" is employed as a negative electrode it must be concluded that the disclosure in document D8 indeed is limited to battery systems in which the negative electrode is metallic lithium, similar as the systems addressed in document D4. Furthermore according to document D8, in the solvent systems based on esters ("*Non-aqueous Electrolyte (a)*", column 6, line 11 to column 7, line 8) the composition of the electrolyte must contain 2-methyltetrahydrofuran next to ethylene carbonate, and a further ester which may be dimethyl carbonate. This constituent, 2-methyltetrahydrofuran, is equally defined in all independent Claims 1, 5, 11, 14 and 17, therefore it is apparently an essential component of the mixture. However, according to

column 6, lines 28 to 33, its function in the solvent mixture is "*reducing the viscosity of the non-aqueous electrolyte and is stable with respect to lithium*". Since in the intercalation battery system in D1 the problems related to lithium metal electrodes discussed in D8 do not arise, it cannot be seen why the skilled person would have considered to apply the solvent mixture of D8 in the quite different electrode system of the battery of D1.

- 4.2.9 In conclusion, in spite of the isolated mentioning of lithium manganese composite oxide as a material for a positive electrode and (*in a different list of negative electrodes*) of carbon-containing lithium ions in document D8, considering the disclosure of this document as a whole the board is not convinced that the skilled person, striving at improving the properties of a intercalation compound battery such as the one known from document D1, would have replaced the electrolyte solvent by a solvent mixture employed in a different battery system and disclosed for solving a different technical problem.

It is therefore concluded that the subject-matter of Claims 1 and 3 is not derivable in an obvious way from the prior art. These claims, and Claims 2 and 4 as appended thereto, therefore meet the requirements of Articles 52(1) and 56 EPC.

5. Accordingly, taking into consideration the amendments made to the patent, the patent and the invention to which it relates meet the requirements of the Convention. The patent as so amended can therefore be maintained (Article 102(3) EPC).

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 the following documents:

Claims: 1 to 4 filed at the oral proceedings;

description: pages 2 to 8 filed at the oral proceedings; and

Figures: 1 to 3 of the patent specification.

The Registrar:

P. Martorana



The Chairman:

A. Klein