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**Datasheet for the decision
of 25 May 2023**

Case Number: T 0471/21 - 3.3.05

Application Number: 11876580.9

Publication Number: 2703504

IPC: C22B7/00, C22B23/02, H01M10/54

Language of the proceedings: EN

Title of invention:
METHOD FOR RECOVERING VALUABLE METAL

Patent Proprietor:
Sumitomo Metal Mining Co., Ltd.

Opponent:
Berton, Anthony Christian Jacques

Headword:
Metal recovery/Sumitomo Metal Mining

Relevant legal provisions:
EPC Art. 100(a), 56, 83

Keyword:

Inventive step - main request (no) - first auxiliary request
(no) - second auxiliary request (yes) - non-obvious
alternative
Sufficiency of disclosure - (yes)

Decisions cited:

T 1791/08, T 1179/16

Catchword:



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Case Number: T 0471/21 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 25 May 2023

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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted on 24 February 2021 rejecting the opposition filed against European patent No. 2703504 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chairman G. Glod
Members: S. Besselmann
R. Winkelhofer

Summary of Facts and Submissions

I. The appeal in this case lies from the opposition division's decision to reject the opposition against European patent EP 2 703 504 B1.

The patent in suit concerns a method for recovering valuable metal.

II. The following documents are of relevance here.

D1 US 7,169,206 B2

D7 Extractive Metallurgy of Nickel, Cobalt and Platinum Group Metals, 1st edition, Elsevier, 5 August 2011, pp. 67-83

D8 RT Jones et al., Recovery of cobalt from slag in a DC arc furnace at Chambishi, Zambia; Copper Cobalt Nickel and Zinc Recovery Conference, Victoria Falls, Zimbabwe, 16-18 July 2001, pp. 1-8

D9 Wikipedia entry "Electric arc furnace", retrieved on 30 January 2021

III. In their grounds of appeal, the opponent (appellant) maintained objections under Article 100(b) EPC and Article 100(a) EPC in conjunction with Article 56 EPC against the patent as granted. They also raised objections against the auxiliary requests. They filed the following documents with their statement of grounds of appeal:

D9a Wikipedia entry "Electric arc furnace", as edited on 23 November 2011

D10 Wikipedia entry "Hochofen", as edited on
19 November 2011

- IV. In the course of the appeal proceedings, the appellant submitted simplified calculated examples (see submission of 7 December 2021), and provided a calculation relating to the examples in the patent in suit (see submission of 9 June 2022).
- V. In their reply to the appeal, the patent proprietor (respondent) defended the patent as granted (main request) and alternatively as amended on the basis of one of the first to third auxiliary requests filed with the opposition division.
- VI. Claim 1 of the main request reads as follows.
*"1. A method for recovering a valuable metal from a waste battery containing aluminium and iron, comprising:
 a melting step comprising melting the waste battery to form a melt;
 a slag separation step comprising separating slag from the melt; and
 an alloy separation step comprising separating an alloy of a valuable metal from the melt, wherein silicon dioxide and calcium oxide are added as fluxes in the melting step,
 the slag has an aluminium oxide content of 25% by weight to 75% by weight and an iron content of 5% by weight to 40% by weight, calculated as metallic iron,
 and the melting step is performed at at least 1,500°C and at most 1,650°C."*
- VII. Claim 1 of the first auxiliary request differs from the main request in that the melting point is additionally

defined, as shown (additions underlined, deletions struck through).

"...an alloy separation step comprising separating an alloy of a valuable metal from the melt, wherein ~~silicon dioxide and calcium oxide are added as fluxes in the melting step,~~ the slag has an aluminium oxide content of 25% by weight to 75% by weight and an iron content of 5% by weight to 40% by weight, calculated as metallic iron, and silicon dioxide and calcium oxide are added as fluxes in the melting step, so that the slag has a melting point of at least 1,500°C to at most 1,650°C, and ..."

VIII. Claim 1 of the second auxiliary request differs from the main request in that the following feature is added at the end of the claim:

", and wherein the melting step is performed in an electric furnace".

Dependent claims 2 and 3 relate to preferred embodiments.

IX. The appellant's arguments, where relevant to the present decision, can be summarised as follows.

The claimed method according to the main request constituted an obvious alternative in view of Example 1 of D1. This also applied to the method in the first auxiliary request.

The claimed invention was insufficiently disclosed. The underlying application associated an alumina content of 20 wt.% with a melting point of about 1500°C. It was not taught how a melting point of 1500°C could be obtained if, for example, the slag had an alumina

content of 25 wt.% and an iron content of 5 wt.%, considering that adding more alumina increased the melting point.

The claimed invention was also insufficiently disclosed because the skilled person did not learn how they could ensure that a slag having the required contents of alumina and iron was formed. The patent in suit gave no details as to how the method steps, in particular the melting step, were to be performed. It was not known why the examples and comparative examples had different results even though the described method was the same.

The additional feature in claim 1 of the second auxiliary request did not support an inventive step. The objective technical problem remained that of providing an alternative. The general teaching of D1 was not limited to using a shaft furnace (abstract; col. 1, lines 57 to col. 2, line 7). Electric furnaces were conventional in the art, as shown in D7 to D9a. They could easily be operated at the relevant temperatures. They also enabled carrying out a preheating step. Plastics pyrolysis also occurred because the necessary temperature was inevitably reached. Injecting oxygen and adding slag formers were also known.

Moreover, an electric furnace could be operated in a batch manner with sequential steps corresponding to the zones of the shaft furnace.

The claimed process constituted a foreseeable disadvantageous modification of the prior art. Omitting the preheating step from D1 had the consequence that the waste batteries could explode, as known from D1. Nothing inventive could be seen in a method which

merely tolerated disadvantages and thus constituted a step backwards in relation to the prior art.

- X. The respondent's arguments, where relevant to the present decision, can be summarised as follows.

Example 1 of D1 constituted the closest prior art. The distinguishing features of the claimed method according to the main request were the higher alumina content and the higher melting step temperature in the claim. There was an error in the indicated alumina content in D1. The correct value was only 19.9 wt.%, which was even farther from the claimed range of 25 wt.% to 75 wt.%.

The claimed method had the advantage that waste batteries which resulted in a high level of alumina in the slag could be treated directly, this being more efficient in terms of energy and additional materials consumption. The high alumina content in the slag had the effect of leading to a decrease in the proportion of iron distributed in the alloy, thus facilitating the subsequent recovery of the valuable metals. This was demonstrated by the examples. The skilled person could have calculated the details of the starting material composition, as the appellant had done in their submission of 9 June 2022. The examples had to be taken as they were. The technical problem was therefore that of providing an improved method. Even if the problem were merely that of providing an alternative, the proposed solution was not obvious because the prior art did not teach towards it.

Claim 1 in the first auxiliary request involved an inventive step for the same reason.

The invention was sufficiently disclosed.

Claim 1 of the second auxiliary request was additionally distinguished from D1 because an electric furnace was used. This was contrary to D1, according to which using a shaft furnace was essential.

- XI. The appellant requests that the decision under appeal be set aside and amended such that the patent be revoked.

The respondent requests that the appeal be dismissed, (main request), or alternatively that the patent be maintained on the basis of one of the first to third auxiliary requests filed with the opposition division on 3 December 2020.

Reasons for the Decision

Main request (patent as granted)

1. Inventive step (Article 100(a) EPC)
 - 1.1 The patent in suit relates to a method for efficiently recovering valuable metals from waste batteries, such as lithium-ion batteries (paragraph [0001]).
 - 1.2 D1 relates to the same general purpose (col. 1, lines 7-11). It was common ground that D1, in particular Example 1 of D1, constitutes the closest prior art. It was also common ground that this example differs from the claimed method in that the alumina content in the slag and the melting step temperature are below the lower limits stipulated in claim 1.

- 1.3 According to the respondent, there was an error in Table 1 of D1. They explained that re-calculating the aluminium balance showed that the alumina content in the slag was not 22.8 wt.% but in fact only 19.9 wt.%, meaning that the difference between the alumina content in Example 1 and the claimed range was even larger than initially assumed.

Irrespective of whether this point, which was brought up for the first time during the oral proceedings before the board, should be taken into account under Article 13(2) RPBA 2020, the alleged discrepancy can only be identified by performing complex calculations. It is not proven that the only possible correction of the error would be the proposed correction of the alumina content in the slag composition, and not of another value, for instance concerning the starting composition. The disclosed slag composition as such is entirely credible and in line with the general teaching of D1. The skilled person would therefore take it at face value, and would construe Table 1 as the result of an analysis of an actual slag.

- 1.4 It was debated whether the distinguishing features resulted in an advantageous technical effect.
- 1.5 The patent in suit is directed towards a method which can reduce the viscosity of the slag to make a lower-temperature process possible and to ensure reliable separation of slag and alloy (paragraph [0008]).

However, this problem is already solved in D1. The process known from D1 is carried out at a lower temperature, as indicated (point 1.2), and there is no reason to doubt that the slag and alloy are reliably separated there (paragraph bridging columns 2 and 3).

- 1.6 According to the respondent, the claimed method made it possible to treat waste batteries which result in a high level of alumina in the slag. This was achieved by controlling the melting point by selecting 5 to 40% iron and using fluxes.

However, the iron content in the slag and the use of fluxes (SiO_2 and CaO) are already known from D1. The same type of waste batteries are contemplated therein, including waste batteries with aluminium cans (paragraph [0018] of the patent; column 3, lines 53-63 and column 4, lines 6-23 of D1).

- 1.7 There is no evidence either that the claimed process, which involves a *higher* melting step temperature, would overall be more efficient in terms of energy and additional materials requirements.

- 1.8 The respondent also submitted that, by allowing a higher alumina content in the slag, a much lower proportion of iron was distributed in the alloy, meaning that the subsequent recovery of the valuable metals (cobalt, nickel) from the alloy would be easier.

It was not contested that a low iron content in the alloy was desirable for this reason (paragraph [0003] of the patent in suit; col. 4, lines 24-31 of D1). However, it was debatable whether it could be derived from the patent in suit that the alumina content in the slag had the alleged effect on iron distribution.

The slag is formed from the added slag-forming materials, from the alumina resulting from the oxidation of aluminium in the waste, and from any oxidised iron and possibly other oxidised metals

(paragraphs [0006], [0018], [0020] and [0034] of the patent in suit). This implies that, if less iron distributes as iron oxide into the slag, less slag is formed (for a given starting material composition). Its alumina content, relative to the total amount of slag, is consequently higher, as demonstrated by the appellant's calculations of 7 December 2021. This would be the opposite of the effect invoked by the respondent.

There is no explicit teaching in the patent in suit that the alumina content of the slag would affect the iron distribution. This alleged effect in particular cannot be derived from the (comparative) examples provided in the patent in suit (Table 1). In contrast to the respondent's line of argument, it is not apparent that a *higher* alumina content of the slag results in a *higher* proportion of the total iron partitioning into the slag.

It is established case law that, if comparative tests are chosen to demonstrate an inventive step on the basis of an improved effect over a claimed area, the nature of the comparison with the closest state of the art must be such that the alleged advantage or effect is convincingly shown to have its origin in the distinguishing feature of the invention compared with the closest state of the art (Case Law of the Boards of Appeal of the EPO, 10th edition, 2022, I.D.4.3.2).

In Table 1 of the patent in suit, the composition of the starting materials, the composition of the alloy and the relative amounts of alloy and slag are all unknown. Obtaining widely differing alumina contents in the slag despite adding the same amounts of flux (7.3 g flux per 23 g waste lithium-ion battery) points to

other differences between the various examples, relating for instance to the selected waste or to the oxygen blowing step. According to the appellant's calculations (submission of 9 June 2022), on which the respondent also relied, the Fe:Al₂O₃ ratios in the starting material ranged from 0.9 to 3.7, thus differing by a factor of 4. It can therefore be seen that the starting materials were different, but their actual compositions remain unknown; the full composition does not derive from the Fe:Al₂O₃ ratio alone.

The conditions of the oxygen blowing step are also unknown. This step affects the oxidation of iron and other metals (e.g. cobalt) and thus their distribution between the alloy and the slag. According to Table 1, the various examples have different cobalt distribution rates, varying between 73% and 99%. This suggests that the conditions of the oxygen blowing step were indeed different.

In summary, while the proportion of total iron that partitioned into the slag was higher in the examples than in the comparative examples, this effect cannot unequivocally be associated with the alumina content in the slag. It thus cannot form the basis for formulating the objective technical problem.

- 1.9 In the light of the above, the technical problem needs to be formulated in a less ambitious manner, such that it is merely providing an alternative method for recovering a valuable metal from a waste battery.
- 1.10 The skilled person, starting from D1 and faced with the not-very-ambitious technical problem of providing an alternative, would readily contemplate an alumina

content in the slag of 25 wt%, because this value is only marginally above the upper limit of *less than* 25 wt% taught in D1 (col. 4, lines 19-23). This is all the more the case given that a slag having an alumina content of 22.8 wt.% is disclosed (Table 1; see also point 1.3 above), which is close to this value. D1 even teaches a benefit in relation to alumina, namely that the oxidation of aluminium in the feed to alumina provides the energy for melting the other products (D1, col. 4, lines 7-11). The reason given in D1 as to why the alumina content in the slag is limited is to keep the viscosity of the slag sufficiently low (col. 4, lines 19-23). In the light of the above, obtaining less than 25 wt.% of alumina in the slag, which in any case is not a feature of the process claimed in D1, cannot be understood as a strict limit that must not even be slightly exceeded, let alone as a teaching away.

1.11 The respondent was of the opinion that an alumina content of 25 wt.% constituted a non-obvious alternative because this value had not been mentioned in the prior art, and there was no teaching towards it. They cited the Case Law of the Boards of Appeal of the EPO, 10th edn., 2022, I.D.4.5 referring to T 1791/08 and T 1179/16.

1.12 However, this case law does not lead to a different conclusion.

T 1179/16 (Reasons 3.4.4) held that, if the technical problem was providing an alternative, then it was usually appropriate to consider that the skilled reader would take into account any alternative known in the underlying technical field (unless the closest prior art teaches away from it); and it might not be required to justify the selection of a particular solution. This

is the case here.

T 1791/08, by contrast, related to a case where there was a teaching away (Reasons 12.2) and where the prior art did not provide a solution to the specific technical problem under consideration (Reasons 10 and 11). The respondent thus has nothing to gain therefrom either.

Moreover, in the case at hand, all the relevant teaching derives from D1. There is no need to rely on any other document.

- 1.13 The skilled person faced with the problem of providing an alternative method for recovering a valuable metal from a waste battery would thus consider an alumina content of 25 wt.%.

- 1.14 The skilled person would be able to adjust the alumina content in the slag, for instance by reducing the amount of slag-forming materials accordingly, based on the corresponding teaching in D1 (col. 4, lines 19-23). The respondent's observation that it would instead be necessary to increase the amount of aluminium in the feed does not change this conclusion. In fact, there is no clear difference between the two measures, since reducing the relative amount of slag-forming materials equates to an increase in the relative amount of aluminium. Even where the slag-forming materials themselves contain alumina (where slag is used as slag-forming material; col. 4. line 19 and Example 1 of D1), it is self-evident that the skilled person would take this into account. In any case, the major portion of the alumina results from the waste (Table 1).

1.15 D1 furthermore mentions in the same context that the alumina content in the slag affects its viscosity (col. 4, lines 19-23), as indicated. The skilled person would thus be aware that a higher alumina content may lead to a higher viscosity of the slag. They would thus adjust the melting step temperature accordingly, for instance to 1500°C, which is also only slightly above the upper limit of 1450°C taught in D1 (col. 3, lines 1-3) and exemplified in Example 1 of D1. It was not contested that it is common general knowledge that the viscosity of the slag will be reduced if the temperature is increased (see also paragraph [0006] of the patent in suit).

1.16 It cannot be assumed that using a shaft furnace would have prevented the skilled person from increasing the temperature to e.g. 1500°C, also considering D10 which confirms that higher temperatures are generally possible.

1.17 For these reasons, the subject-matter of claim 1 lacks an inventive step.

2. The main request is not allowable.

First auxiliary request

3. Irrespective of whether the added feature meets the requirements of Article 123(2) EPC, it does not change the conclusion regarding inventive step as set out for the main request. The same considerations relating to a melting step temperature of e.g. 1500°C are relevant for selecting a melting point of e.g. 1500°C.

The first auxiliary request is also not allowable because the subject-matter of claim 1 lacks an inventive step.

Second auxiliary request

4. Sufficiency of disclosure, Article 83 EPC
- 4.1 According to established jurisprudence (Case Law of the Boards of Appeal of the EPO, 10th edition, 2022, II.C. 9), a successful objection of insufficient disclosure presupposes that there are serious doubts, substantiated by verifiable facts. In *inter partes* proceedings, the burden of proof generally lies with the opponent.
- 4.2 The appellant argued that it would not be possible to carry out the claimed process across the entire range of melting step temperature values specified in the claim, in particular not if using a melting step temperature of 1500°C to 1505°C.

This objection is based on the teaching in the application as originally filed *that the slag with an alumina content of 20% by weight has a melting point of about 1500°C* (page 15, second paragraph). The appellant concludes therefrom that higher alumina contents of at least 25% must be associated with higher melting points, considering that alumina increases the melting point of the slag (paragraph [0006] of the patent in suit).

The objection is additionally based on the observation that the examples of the patent involve a melting step temperature of at least 1505°C even when the alumina

content is less than stipulated in the claim (20.2 wt% in one comparative example, table 1).

- 4.3 According to the teaching of the patent in suit, alumina increases the melting point of the slag (paragraph [0006]) while the addition of the SiO_2/CaO based flux and the co-presence of iron oxide lower it (paragraph [0009]). The melting point of the slag thus does not depend on the alumina content alone, but also on the composition of the remainder of the slag. In the light of this, the indication that the slag with an alumina content of 20% by weight has a melting point of about 1500°C cannot be understood as a strict correlation.

Furthermore, the melting points of the slags in the examples might be lower than the indicated melting step (i.e. holding) temperatures. Carrying out the melting step at a temperature above the melting point is not excluded by the claimed method. There is no evidence that the skilled person would have been unable to provide a slag composition within the scope of the claim to which a melting step temperature of 1500°C can be applied.

Furthermore, it does not follow from the requirement of sufficiency of disclosure that the entire melting step temperature range stipulated in the claim can be applied to every slag composition generically encompassed by the claim. In particular, it does not follow from the claim that the skilled person would need to be able to adjust the melting point of a slag containing 25 wt% alumina in combination with 5 wt% iron to specifically 1500°C .

4.4 The appellant also objected that the patent in suit did not explain how the melting step should be performed to achieve the alumina and iron contents. The compositions of the starting materials used in the examples were unknown, as were the details of the melting step in which a predetermined amount of oxygen was blown through the slag.

Irrespective of whether this objection constituted an amendment to the appellant's case and whether it should be considered under Article 12(4) and (6) RPBA 2020, as contested by the respondent, this objection is not convincing.

While the level of detail provided in the examples of the patent in suit is indeed low, there is no evidence that the skilled person would be unable to perform the claimed melting step accordingly by adjusting the starting material composition and the oxygen blowing step in a routine manner. In a similar context, D1 also describes that "*the man of the art knows how to interpret the phase analysis and act so as to optimise the redox potential*" (col. 3, lines 16 to 18). The appellant did not attempt to rework the invention to support their case.

4.5 The objection of insufficient disclosure is thus not convincing.

5. Inventive step (Article 56 EPC)

5.1 Reference is made to the considerations regarding the main request (point 1.).

5.2 The subject-matter of claim 1 additionally differs from D1 in that an electric furnace is used.

5.3 There is no evidence that using an electric furnace results in a technical effect. The objective technical problem may thus again be seen to be that of providing an alternative method.

5.4 D1 aims to overcome the problems encountered in both known hydro- and pyro-processes by using a single furnace process (col. 1, lines 57 to 59). The solution disclosed in D1 involves using a shaft furnace as an essential feature. This derives not only from the claims (claim 1), but also from the general description of the method (col. 1, line 57 to col. 2, line 7, in particular line 65; abstract, in particular the sixth line).

D1 describes three distinct zones in the shaft furnace with different temperatures and purposes, namely slow evaporation of the electrolyte in the preheating zone, plastics pyrolysis in the second zone, and smelting and reducing in the last zone in which a proper redox potential is maintained (column 2, line 44 to column 3, line 11). These zones are directly linked to the use of a shaft furnace, thus further supporting the idea that it is an essential feature. By contrast, there is nothing in D1 that would suggest that another furnace could alternatively be used.

5.5 According to the appellant, the skilled person would readily have used an electric furnace as an alternative. Electric furnaces were generally known and used in the relevant technical field, as was clear from D7 to D9a. They were more flexible and could easily be operated at temperatures in the range of 1500°C to

1650°C. In the appellant's view, they provided the required functionality. It was known that preheated scrap could be provided to the furnace. When applied to waste batteries, such a preheating step provided for evaporation of the electrolyte. During further heat-up in the oven, the plastics would inevitably pyrolyse. This would not have been considered detrimental because carbon was usually added in an electric furnace. It was also possible to inject oxygen into an electric furnace to set the redox potential. Adding slag formers was also known. Further according to the appellant, electric furnaces were often operated in batch mode. An electric furnace then provided the same functionalities as a shaft furnace, because the zones of the shaft furnace corresponded to sequential steps in the batch process.

5.6 However, while electric furnaces are generally known and are used in steelmaking, this would not have guided the skilled person to employ them in the process of D1 where the use of a shaft furnace is essential. There is no teaching in the prior art that an electric furnace would provide the same functionality, which is not merely providing the necessary metal bath temperature but in this case is to be seen as the combination of the three zones described D1. Preheating the scrap material in steelmaking cannot be equated with slowly evaporating the electrolyte from waste batteries. Furthermore, neither the appellant's observation that heating the waste batteries to the melt temperature inevitably involves passing through a temperature of 700°C, nor that adding carbon to an electric furnace was known, can be seen as a teaching concerning plastics pyrolysis. D7 to D9a are silent as regards electrolyte evaporation and plastics pyrolysis. Moreover, neither does D1 suggest that the zones could

alternatively be realised in the form of consecutive steps in a batch furnace, nor does any one of D7 to D9a describe a batch process with several distinct steps corresponding to the desired zones.

5.7 It was also argued that the claimed process constituted a foreseeable disadvantageous modification of the prior art. According to the appellant, it was in particular known from D1 that the slow electrolyte evaporation step was needed to avoid the possibility of the batteries exploding due to the over-pressure caused by a sudden evaporation of the electrolyte (D1, col. 1, lines 39 to 42). They concluded that claim 1 at issue encompassed processes where the batteries exploded.

5.8 However, the patent in suit addresses the same question of a possible risk of explosion (paragraph [0015]) and describes a pretreatment step by forming gas-venting holes in the batteries to prevent this. The skilled person would naturally carry out the claimed process in such a way as to avoid explosion. Even if the corresponding measure is not specified in the claim, a suitable measure is taught in the description.

This consideration rather shows that replacing the shaft furnace with an electric furnace in the process of D1 would not be a straightforward modification but would entail additional adaptations to provide for pretreating the batteries, in line with the indication in D1 that the batteries cannot be simply thrown in a molten bath, due to the aforementioned explosion risk (D1, col. 1, lines 42 to 43).

The claimed process might be seen as more complex and in this regard less beneficial than the single furnace process of D1. However, according to the appellant's

own arguments, using an electric furnace has the benefit of being more flexible. It is thus incorrect that using an electric furnace would be a purely disadvantageous modification of the prior art.

Moreover, the method in D1 is not presented as a further development or an improvement over an electric furnace process. There is thus no basis to conclude that taking a step backwards from D1, in the sense of not following a teaching of D1 while taking into account that the associated benefit might not be obtained, would have led the skilled person to the method according to the claim at issue.

- 5.9 In the light of the above, the skilled person would not have found any teaching in the prior art suggesting that an electric furnace could alternatively be used in the process known from D1, where the shaft furnace is taught to be essential. The skilled person would thus not have replaced the shaft furnace with an electric furnace. They would not have arrived in an obvious manner at a method within the scope of claim 1.
- 5.10 The subject-matter of claim 1 thus involves an inventive step.
- 5.11 Claims 2 and 3 are dependent claims. Therefore the same conclusion applies.
- 6. The second auxiliary request is allowable.

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 on the basis of the second auxiliary request as submitted on 3 December 2020, and the description to be adapted.

The Registrar:

The Chair:



C. Vodz

G. Glod

Decision electronically authenticated