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**Datasheet for the decision
of 19 February 2019**

Case Number: T 1407/14 - 3.4.03

Application Number: 03730540.6

Publication Number: 1400152

IPC: H05B33/14, C09K11/06

Language of the proceedings: EN

Title of invention:

ORGANIC LIGHT-EMITTING ELEMENT AND DISPLAY DEVICE

Patent Proprietor:

CANON KABUSHIKI KAISHA

Opponent:

Merck Patent GmbH

Headword:

Relevant legal provisions:

EPC Art. 101(3)(b)
EPC 1973 Art. 54

Keyword:

Novelty - (no)

Decisions cited:

Catchword:



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Case Number: T 1407/14 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 19 February 2019

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Decision under appeal: **Decision of the Opposition Division of the
European Patent Office posted on 22 April 2014
revoking European patent No. 1400152 pursuant to
Article 101(3) (b) EPC.**

Composition of the Board:

Chairman G. Eliasson
Members: M. Stenger
C. Heath

Summary of Facts and Submissions

- I. The appeal of the proprietor/appellant concerns the decision of the Opposition Division to revoke European patent EP1400152. With respect to the first auxiliary request, the Opposition Division came to the conclusion that the subject-matter of its claim 1 lacked novelty.
- II. At the end of the oral proceedings before the Board, the proprietor requested that the contested decision be set aside and that the patent be maintained according to a main request filed with the grounds for appeal (corresponding to the first auxiliary request on which the contested decision is based) or an auxiliary request filed with letter dated 18 April 2016.
- III. At the end of the oral proceedings before the Board, the opponent/respondent requested that the appeal be dismissed.
- IV. Reference will be made to the following documents:
- D2: US2001/0052462 A1
- D9: Rainer Waser: "Nanoelectronics and Information Technology", Wiley-VCH Verlag GmbH & Co. KGaA 2005, pages 916 to 923
- D16: Jung-Hyun Kim et al.: "Blue light emitting diode with 1,1,4,4-tetraphenyl-1,3-butadiene (TPB)", Synthetic Metals 117 (2001), 227 to 228

D18: Brand Fortner and Theodore E. Meyer: "NUMBER BY COLORS: A Guide To Using Color To Understand Technical Data", Springer-Verlag New York Inc., 1997, pages 37, 47 to 56, 95 to 98 and 104 to 107

D19: German Wikipedia-Article concerning the CIE-system: "CIE-Normvalenzsystem", last processed 18 December 2018, retrieved 14 January 2019.

V. The following abbreviations will be used in the present decision:

TPB for 1,1,4,4-tetraphenyl butadiene

TPA for triphenylamine

Ir(ppy)3 for tris(2-phenylpyridine)iridium

Ir(phq)2 acac for bis(2-phenylquinoline)
(acetylacetonate)iridium

Ir(piq)3 for tris(1-phenylisoquinoline)iridium

DCM for 4-(dicyanomethylene)-2-methyl-6-(4-dimethylaminostyryl)-4H-pyran

PVK for polyvinyl carbazole

BAlq for Bis(2-methyl-8-quinolinolato-N1,O8)-1,1'-Biphenyl-4-olato)aluminium

VI. Independent claim 1 of the main request has the following wording:

An organic white light-emitting element comprising at least one light-emitting layer (23; 605) between a pair of electrodes (22, 24; 604, 606) formed on a substrate (21; 601), wherein the light-emitting layer comprises a host material and three light emission center materials; the three light emission center materials are a blue emitting material, a green emitting material, and a red emitting material; and the blue emitting material is a fluorescent light-emitting material, and the green emitting material and the red emitting material are a phosphorescent light-emitting material, respectively.

- VII. Independent claim 1 of the auxiliary request differs from claim 1 of the main request in that at its end it comprises the following additional feature:

and an excitation lifetime of the light emission center material that emits light having a shortest wavelength is shorter than an excitation lifetime of the other light emission center materials.

- VIII. The arguments of the proprietor, as far as they are relevant to the present decision, may be summarised as follows:

(a) White light

The term *white light* was generally well defined as corresponding to the central elliptic area designated *White* in the CIE 1931 diagram as shown in figure 5.11 of D18. Although no more specific definition of the term was given explicitly in the patent specification, the intended use of the light sources as backlight

source for LCDs (paragraph 14 of the opposed patent) further indirectly indicated to the skilled person a suitable range of colour mixes.

(b) D2

Document D2 was generally directed at light-emitting elements capable of emitting light of any colour; the emission of *white* light was just one example and was disclosed only in combination with light-emitting materials which did not correspond to the materials defined in claim 1. For example, the red light-emitting material DCM mentioned in paragraph 18 was not a phosphorescent material.

With respect to example 2, which admittedly disclosed a phosphorescent red light-emitting material, D2 was silent concerning the colour of the emitted light. Thus, the subject-matter of claim 1 differed from example 2 of D2 in that the light emitted by the element was *white*.

(c) "Additional Experiment"

The Additional Experiment was filed in response to the non-admission of experiments by the Opposition Division; it could not have been filed earlier because it was difficult to obtain government approval for using the cancerogene solvent dichloroethane.

The Additional Experiment related to example 2 of D2 was thus highly relevant for assessing novelty and should therefore be admitted into the procedure.

In particular, the Additional Experiment indicated that no light emission at all could be obtained under the circumstances and parameters of example 2 of D2. At a much higher voltage, only green light-emission was obtained; blue and red light emission was not observed in the Additional Experiment even at these higher

voltages. Without the presence of blue and red light, no white light-emission was possible.

The physical reasons that blue light-emission was not observed in the Additional Experiment were that the S1 level of the green emitter Ir(ppy)₃ (3,27 eV) was closer to the S1 level of the host PVK (3,5 eV) than the S1 level of the blue emitter TPB (3,19 eV), whereby the green emitter, as compared to the blue one, had an advantage in the competition for populating the respective S1 states from the host S1 states. Overcoming the problems caused by such competition was the very problem the patent was aiming to solve (see paragraphs 34 and 40 to 42 of the patent specification).

Moreover, the result of the Additional Experiment was in line with figure 5 of D16 where the same blue light-emitting material was used as in D2 (TPB) and according to which light was only emitted at a high applied voltage well above 10 V.

A further reason for the absence of blue light was that the concentration of the blue light-emitting material according to example 2 of D2 (and thus in the Additional Experiment) was very low.

The physical reasons that emission of red light was not observed in the Additional Experiment were that the T1 level of the blue light-emitter TPB (1,83 eV) was lower than the T1 level of the red light-emitter Ir(phq)₂ acac (2,2 eV). Thereby the T1 level of the red light-emitter could not be populated by the T1-level of the blue light-emitter, resulting in the absence of the emission of red light.

A light-emitting element according to example 2 of D2 could thus for physical reasons emit neither blue nor red light as evidenced by the Additional Experiment. Thereby, this example would not enable the skilled person to produce a white light-emitting element.

Concerning example 2 of the patent, BA1q (instead of TPB) was used as a blue light-emitter, having a T1-level (2,2 eV) above the T1-level of the red light-emitter Ir(piq)3 (2,0 eV). Thereby, the T1 level of the red emitter could be populated in this case from the T1 level of the blue light-emitter, contrary to example 2 of D2.

IX. The arguments of the opponent, as far as they are relevant to the present decision, may be summarised as follows:

(a) White light

There was a plurality of different definitions for the term white light. One corresponded to the point of equal energy E or W (*Weißpunkt*) indicated in the CIE diagram (*CIE-Normfarbtafel*) in D19. Another one referred to all the points on the *black-body-curve* in the same diagram. A third one, finally, comprised an area above and below this black-body-curve, the limits of this area not being well-defined.

In any case, the boundaries delimiting the different colour areas in figure 5.11 of D18 were arbitrary and did not correspond to any generally accepted definition.

The term *white light* in itself thus did not have a clear meaning.

Further, the opposed patent did not contain any more specific definition of the term.

The term *white light* was therefore not clear according to Article 84 EPC.

(b) D2

Document D2 as a whole was directed at the generation of *white light*. No other specific light colour was mentioned in the document. The skilled person would therefore directly and unambiguously read D2 such that all examples given related to the emission of white light. This applied to example 2 as well. That D2 mentioned in a general manner that *any colour* could be produced in a device according to the invention only related to additional possibilities for using the light-emitting materials mentioned but did not put into question that white light was produced according to the examples.

Further, D2 related, just as the patent, to light sources to be used as back light. The light emitted by the devices of D2 should thus be similar to the light emitted by the devices described in the opposed patent, i.e., it should be considered to be *white light* in the sense of the opposed patent.

(c) "Additional Experiment"

The Additional Experiment could already have been filed during the first instance proceedings and was thus late filed.

Further, the production of organic LEDs in which the light-emitting layer was arranged directly between the anode and the cathode was complicated and could easily fail for reasons which were not related to the technical teaching of D2 concerning the light-emitting

materials used (see page 3, paragraphs 2 and 3 of the reply to the appeal). Thus, the Additional Experiment was not relevant.

Since the Additional Experiment was late filed and not relevant, it should not be admitted into the procedure.

Irrespective of that, the relations between the energy levels of the light-emitters used in example 2 of D2 were very similar to the ones used in example 2 of the opposed patent (see paragraphs 80 to 89).

In particular, in both cases, the S1 levels of the blue light-emitters (in D2 TPB: 3,19 eV, in the patent BA1q: 2,9 eV) were not only below the S1 level of the host material (in both cases PVK: 3,5 eV), but also below the S1 level of the green light-emitter (in both cases Ir(ppy)3: 3,27 eV).

Thus, even if there was a competition for population of the excited S1 levels between the blue and the green light-emitters in example 2 of D2, example 2 of the opposed patent indicated that such a competition would not prejudice the emission of blue light (necessary for obtaining white light in the end) in the sense of the opposed patent.

Figure 5 of D16 was not relevant for the Additional Experiment since it concerned varying concentrations of a different material, namely TPA.

Moreover, according to figure 5.11 of D18, light consisting of a mix of 0,45 red light, 0,43 green light and only 0,02 of blue light was still inside the elliptic area labelled *White* used by the proprietor for defining the term *white light*. It was thus possible to obtain *white light* using only a very small fraction of blue light and therefore, a low concentration of a blue

light-emitting material would be sufficient to obtain the emission of white light even according to the definition of the proprietor.

Further, in both example 2 of D2 and example 2 of the opposed patent, the T1 level of the green light-emitter (in both cases Ir(ppy)₃: 2,4 eV) was above the T1 level of the red emitters (in D2 Ir(phq)₂ acac: 2,2 eV; in example 2 of the patent Ir(piq)₃: 2,0 eV). Thus, in both cases, the red T1 level could be populated from the green T1 level and would thus not necessarily have to be populated from the blue T1 level. Thus, in view of example 2 of the opposed patent, the material combination of example 2 of D2 could not be responsible for the non-observation of the emission of red light by the proprietor in the Additional Experiment.

As a consequence, the particular light-emitting materials used in example 2 of D2 could not be the reason for the proprietor not being capable of producing white light in the Additional Experiment.

Instead, the high voltage necessary to produce light emission at all and the low efficiency indicated that the element produced in the Additional Experiment was defective for other reasons. Normally, a failed attempt to reproduce a device that is expected to work would entail a series of further experiments to try to reproduce the device. This was not done in the present case (see page 3, paragraph 4 of the reply to the appeal), whereby the results of the Additional Experiment could not be regarded as meaningful.

Thus, the Additional Experiment did not prove that example 2 of D2 related to a non-enabling disclosure.

Reasons for the Decision

1. The appeal is admissible.

2. Fluorescence / Phosphorescence

Both parties understand the term *fluorescence* as referring to transitions from a singlet state S and the term *phosphorescence* as referring to transitions from a triplet state T. This is in line with the definition in the contested patent (paragraph 17) and further corresponds to the use of these terms in the prior art (D2, paragraph 5).

The Board sees no reason to adopt a different interpretation of these terms.

The Board further notes that transitions from a triplet state T are related to a longer excitation lifetime than transitions from a singlet state S for quantum mechanical reasons (see, e.g., D9, section 3.1).

3. The opposed patent

The invention according to the opposed patent is directed at a light-emitting element which mixes blue, green and red light generated by corresponding light-emitting materials, respectively, to obtain white light which is suitable to be used as, e.g., a backlight source for LCDs (see, e.g., paragraphs 14 and 15). To achieve a higher efficiency, phosphorescent light-emitting materials are used (see, e.g., paragraph 23).

In order to avoid competition for populating the excitation states by the transfer of excitation states from the blue light-emitting material to the green or red light-emitting material, however, only the green and red light-emitting materials are phosphorescent while the blue light-emitting material is fluorescent (see paragraphs 34 and 40 to 42).

4. White light / Article 84 EPC 1973 (see sections VIII (a) and IX (a) above)

The Board notes that the feature that the light-emitting element emits *white light* was not comprised in the claims as granted and is thus, according to G3/14, in principle open to objections relating to Article 84 EPC.

The Board agrees with the proprietor in so far as the skilled person would interpret the term *white light* as corresponding to an area around the point of equal energy E/W (*Weißpunkt*) in the CIE colour space or diagram.

The Board also agrees, however, with the opponent that the limits of this area are not as well defined as it might seem from figure 5.11 of D18.

Nonetheless, the Board holds that the skilled person would have no difficulties to decide for any specific mix of blue, green and red light if it corresponded to white light in the sense of the opposed patent or not, particularly taking into account the intended use of the light as backlight for LCD displays, as submitted by the proprietor.

The skilled person would, for instance, not regard light that corresponds to the temperature of 1500 K on the *black-body-curve* (CIE colour space in D19, section *Die Normfarbtafel*) as being white, contrary to the submission of the opponent. Instead, he would regard this light as being red or orange. In particular, he would not consider this light to be suitable for use as backlight in LCDs.

The Board concludes that the term *white light* in the context of the opposed patent is clear to the skilled person in the sense of Article 84 EPC.

However, since the limits of what the skilled person would regard as white light in the CIE diagram are not precisely defined, the term has to be given a broad interpretation in line with the overall content of the opposed patent. This broad interpretation includes a plurality of colour tones / hues as long as the light in question is suitable for the intended use, i.e. as backlight source for LCDs; it comprises, but is not necessarily limited to, the central elliptic area designated *White* in figure 5.11 of D18.

5. D2 (see sections VIII (b) and IX (b) above)

D2 relates to organic light-emitting devices for replacing fluorescent tubes as back light or illumination light sources (see paragraphs 1 and 6). D2 explicitly mentions that efficiency can be improved by using phosphorescent light-emitting materials (see paragraph 5). The device comprises a light emitting layer which contains two or more different kinds of light-emitting materials (see paragraph 49) and emits light with high efficiency P and luminance L (see

paragraphs 7, 12 and 18 as well as table 1 on page 6). Each of the examples 1 to 4 given in D2 relates to a mix of blue, green and red light (see table 1 on page 6, column *Peak Wavelength*).

5.1 Claim 1 of the main request compared to D2

It was undisputed that D2 discloses, in relation to example 2, the following features in the words of claim 1 of the main request:

An organic light-emitting element comprising at least one light-emitting layer between a pair of electrodes formed on a substrate (see paragraph 9), wherein

- the light-emitting layer comprises a host material (PVK) and three light emission centers (see paragraph 23 in combination with paragraph 13, see also paragraph 52);
- the three light emission center materials are a blue emitting material, a green emitting material, and a red emitting material (see paragraph 13); and
- the blue emitting material (TPB) is a fluorescent light-emitting material, and
- the green emitting material (*Ir(ppy)3*) and the red emitting material (*Ir(phq)2 acac*) are a phosphorescent light-emitting material, respectively (see example 2 in paragraphs 52 and 57).

5.2 Disputed (differentiating) feature

The proprietor disputed, however, that D2 disclosed the emission of *white* light in connection with the light-emitting materials of example 2.

The Board accepts that D2 does not explicitly mention that the device according to example 2 emits *white* light.

However, the devices disclosed in D2 are intended to replace fluorescent tubes used as back light (see paragraph 6). In the absence of any indication to the contrary, the skilled person would thus read D2 such that the elements according to all examples are suitable to replace fluorescent tubes.

Since fluorescent tubes emit white light at least in the broad sense that has to be applied in the context of the opposed patent, the skilled person would thus interpret D2 such that the devices according to all examples given, including example 2, emit white light in that broad sense.

Moreover, D2 explicitly discloses that a white light-emitting device can be obtained by selecting a blue light-emitting material, a green light-emitting material and a red light-emitting material as long as they fulfill certain wavelength requirements (see paragraph 18, right column: *It is particularly preferred ... a white light-emitting device can be obtained*). The light-emitting materials used in example 2 have peak wavelengths that fulfill these wavelength requirements (namely, 450nm, 515nm and 599nm; see table 1). This would further cause the skilled person to interpret D2 such that the device according to example 2 emits white light.

More particularly, the device of example 2 of D2 differs from the device according to example 1 of D2 only in that Ir(phq)₂ is used instead of DCM as the red light-emitting material (see paragraph 57). However, both these red light-emitting materials have a very

similar peak wavelength (namely, 599 nm as opposed to 604 nm, see table 1). The skilled person would thus read D2 such that the colour of the light emitted according to example 2 is generally very similar to the one emitted according to example 1, with possibly a slight variation of hue. The difference between example 1 and example 2 of D2 would be understood by the skilled person to be only that a light-emitting element according to example 1 produced light with a higher luminance L , while a light-emitting element according to example 2 produced light with a higher efficiency P (see table 1).

The light-emitting material combination of example 1, however, corresponds to the light-material combination of the last sentence of paragraph 18 which is explicitly directed to generate white light. For that reason also, the skilled person would interpret D2 such that according to example 2, just as according to example 1, *white light* is emitted at least in the broad sense in which the term has to be interpreted according to the opposed patent.

The Board accepts the argument of the proprietor that D2 explicitly mentions that the device of the invention can emit light of *any desired* colour (see first sentence of paragraph 18 and last sentence of paragraph 49). However, the skilled person is well aware that by combining the light of three individual light sources in different proportions, light of *any* colour can be created as long as it corresponds to the area defined by the triangle spanned up by these individual light sources in the CIE diagram (see, e.g., figure 5.9 of D18). Thus, in the context of D2 as a whole, the skilled person would interpret the above mentioned passages such that it corresponded to further possible

uses of the individual light-emitting materials disclosed in D2, not putting into question the capability of the elements according to the examples to emit white light, as submitted by the opponent.

In view of the above, the Board comes to the conclusion that the skilled person would derive directly and unambiguously from the content of D2, taking into account its implicit features, that an element according to example 2 of D2 emits white light in the same manner as the elements as defined in the opposed patent when operated.

Thus, example 2 of D2 discloses all the features of claim 1 of the main request.

6. Enabling disclosure of example 2 of D2/"Additional Experiment" (see sections VIII (c) and IX (c) above)

6.1 Admission of the "Additional Experiment"

The Opposition Division had not admitted two experiments conducted by the proprietor because these experiments differed in a plurality of parameters from example 2 of D2 (page 2, penultimate paragraph to page 3, antepenultimate paragraph of the contested decision).

The Additional Experiment submitted by the proprietor with the notice of appeal takes into account the objections of the Opposition Division in that its parameters are almost identical to the parameters of example 2 of D2, which is the most relevant part of D2 for assessing novelty.

For these reasons, the Board decided to admit the Additional Experiment contrary to the request of the opponent.

6.2 Results of the Additional Experiment

In the Additional Experiment conducted by the proprietor, no light emission was observed under the circumstances and parameters of example 2 of D2 and only green light-emission was obtained when a much higher voltage than in D2 was applied.

These results thus show that is possible to follow the teaching concerning the light-emitting materials given in example 2 of D2 without obtaining the same results concerning the light emission, i.e., without obtaining the emission of white light.

However, as submitted by the opponent, the relations between the energy levels of the light emitting materials used in example 2 of D2 are very similar to the relations between the energy levels of the materials used in example 2 of the opposed patent. In particular, the S1 level of the host material is the highest, followed by the S1 level of the green light-emitter and the blue light-emitter in that order, respectively, in both cases.

Thus, the competition for populating the excited states of the blue and green light-emitting materials should be similar in both cases as well and can not be seen as explaining the absence of emission of blue light in the Additional Experiment.

The Board also agrees with the opponent that figure 5 of D16 relates to a different material combination

involving TPA, and hence does not have any relevance for the material combination of example 2 of D2.

The Board further accepts the argument of the opponent that a low concentration of a blue light-emitting material would still be sufficient to obtain the emission of white light according to the classification given in figure 5.11 of D18 used by the proprietor, and thus also in the broad sense according to the context of the opposed patent.

For these reasons, the Board is convinced that neither the energy levels nor the concentrations of the light-emitting materials involved are the reason that blue light emission was not observed in the Additional Experiment.

Concerning the emission of red light, the Board notes that in example 2 of D2, the T1 level of the green emitting material (Ir(ppy)₃: 2,4 eV) is higher than the T1 level of the red emitting material (Ir(phq)₂ acac: 2,2 eV), as pointed out by the opponent. Further, the concentration of the green light-emitting material is the highest one of all light-emitting materials (5 times as much by weight than the blue and the red light-emitting materials, respectively; see paragraph 52).

Thereby, the T1 levels of the red light-emitting material of this example need not be populated from the T1 levels of the blue emitter; instead, they could be populated from the T1 levels of the green light-emitting material, as submitted by the proprietor.

The lack of emission of red light in the additional experiment can thus not be explained by the energy

levels and concentrations of the involved light-emitting materials, either.

The energy levels and concentrations of the light emitting materials used in example 2 of D2 are thus such that blue and red light should be emitted. It follows therefrom that the absence of such emissions in the additional experiment can not be explained by the energy levels or the concentrations of the light-emitting materials involved. Consequently, there must be other reasons for this absence.

The Board notes the argument of the opponent that organic light emitting devices with a light emitting layer arranged directly between the anode and the cathode are inherently difficult to produce, leading to variations concerning the light emission of these devices (see also reply to the appeal, page 2, first paragraph to page 5, second paragraph).

In that context, possible other reasons for observing neither blue nor red, and consequently no white, light in the additional experiment could then be, for instance, variations of the parameters of the processes used for coating the anode using the dichloroethane solution and for the vacuum deposition of the cathode (see paragraphs 52 and 53 of D2; see also reply to the appeal, page 5, paragraphs 3 and 4).

Further, as pointed out by the opponent, single, isolated experiments are rarely carried out in the art. More specifically, when trying to (re)produce a light-emitting element, the skilled person would normally conduct a series of experiments with at least one varying parameter (see, e.g., figures 2 and 3 of D16, where the concentration of TPA is varied).

In particular after a failed experiment to reproduce a light-emitting element that is described in the prior art, further experiments would normally be conducted with (some) varying parameters in order to investigate the reasons for the failure.

There is, however, no evidence that the proprietor conducted such further experiments to reproduce the results of example 2 of that document after the initial failure to do so, in order to exclude causes not relating to the technical teaching of D2 concerning the light-emitting materials.

For these reasons, the Board holds that the result of the Additional Experiment conducted by the proprietor does not put into question the disclosure of example 2 of D2.

7. Conclusion with respect to the main request

The Board thus comes to the conclusion that example 2 of D2 implicitly discloses the emission of white light and that the Additional Experiment conducted by the proprietor does not put into question this disclosure.

It follows therefrom that the subject-matter of claim 1 of the main request is not new according to Article 54 EPC 1973, since all of its features are already disclosed in D2 with respect to example 2.

The Board thus comes to the same conclusion as the Opposition Division (see section referring to the first auxiliary request on pages 6 to 8 of the contested decision).

8. Auxiliary request

As mentioned above, fluorescent transitions from a singlet state S involve a shorter excitation lifetime than phosphorescent transitions from a triplet state T (see section 2. above).

In a system where the light-emitting materials consist of a blue, a green and a red light-emitting material and where the blue light-emitting material is fluorescent while the green and the red light-emitting materials are both phosphorescent, the light-emitting material with the shortest wavelength (blue) thus *always* has a shorter excitation lifetime than the other (phosphorescent) light-emitting materials.

The additional feature of claim 1 of the auxiliary request thus effectively does not limit further claim 1.

Therefore, the subject-matter of claim 1 of the auxiliary request is not new according to Article 54 EPC 1973 in view of example 2 of D2 for the same reasons as the subject-matter of claim 1 main request.

9. It follows from the above that the subject-matter of the independent device claims of both the main request and the auxiliary request is not new according to Article 54 EPC 1973.

Therefore, taking into consideration the amendments made by the proprietor, none of the requests fulfills the requirement of the EPC (Article 101(3)(b) EPC). Thus, the appeal must fail.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



S. Sánchez Chiquero

G. Eliasson

Decision electronically authenticated