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**Datasheet for the decision  
of 13 May 2014**

**Case Number:** T 0754/13 - 3.2.07

**Application Number:** 06708833.6

**Publication Number:** 1839760

**IPC:** B05B7/04

**Language of the proceedings:** EN

**Title of invention:**

METHOD AND DEVICE FOR THE MICROMIXING OF FLUIDS USING A REFLUX  
CELL

**Applicant:**

Universidad de Sevilla

**Headword:**

**Relevant legal provisions:**

EPC Art. 84

**Keyword:**

Claim -

functional definition allows to determine the scope of the  
claim without undue burden (no)

Claim - support in the description (no)

**Decisions cited:**

T 0068/85

**Catchword:**

see point 2



**Beschwerdekammern  
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Case Number: T 0754/13 - 3.2.07

**D E C I S I O N**  
**of Technical Board of Appeal 3.2.07**  
**of 13 May 2014**

**Appellant:** Universidad de Sevilla  
(Applicant) OTRI - Universidad de Sevilla  
Pabellon de Brasil  
Paseo de las Delicias s/n  
E-41012 Sevilla (ES)

**Representative:** Carpmaels & Ransford LLP  
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**Decision under appeal:** **Decision of the Examining Division of the European Patent Office posted on 8 October 2012 refusing European patent application No. 06708833.6 pursuant to Article 97(2) EPC.**

**Composition of the Board:**

**Chairman** H. Meinders  
**Members:** H. Hahn  
O. Loizou

## **Summary of Facts and Submissions**

- I. The applicant has filed appeal against the decision of the Examining Division to refuse the European patent application No. 06 708 833.6.
- II. The following document of the examination proceedings is quoted in the present decision:  
  
D2 = WO-A-00/76673
- III. The Examining Division held that process claim 1 of the (new) main request filed during the oral proceedings, which replaced the (former) main request filed at the beginning of these oral proceedings, of which the device claim 1 was considered to contravene Article 123(2) EPC, contravened Article 84 EPC and lacked inventive step with respect to D2. Furthermore, the added figure 1b and the pages 4 and 5 of the description as filed with letter of 16 April 2010 were considered to contravene Article 123(2) EPC. Therefore the application was refused.
- IV. With its statement of grounds of appeal the appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the claims of the main request, alternatively on the basis of the claims of one of the first to third auxiliary requests, all as submitted together with the statement of grounds of appeal. In case that the Board intended not to allow the main request, oral proceedings were requested.
- V. With a communication annexed to summons for oral proceedings the Board presented its preliminary and non-binding opinion with respect to the claims 1-7 of

the main and first auxiliary requests and claims 1-6 of the second and third auxiliary requests.

The Board stated amongst others that, in accordance with Article 12(4) RPBA in conjunction with Rules 137(3) and 100(1) EPC, it intended not to admit the main request and the first to third auxiliary requests into the appeal proceedings since, by switching (also) to device claims, they created a fresh case compared to the subject-matter of the process claim 1 underlying the impugned decision.

Furthermore, none of the four new requests appeared to comply with Articles 123(2) and/or 84 EPC. Therefore none of these requests appeared to be (formally) allowable.

- VI. With letter dated 3 April 2014 the appellant submitted a new main request restricted to process claims 1-4 in combination with arguments concerning the amendments made and their basis in the application as originally filed and at the same time withdrew its former main request and the first to third auxiliary requests.
- VII. Oral proceedings before the Board were held on 13 May 2014. The issue of Article 84 EPC was discussed in all its aspects with respect to the two features "**... creating a reflux cell ...**" and "**the shape of the exit of the feeding tube ... is sharp-edged**" of claim 1 of the main request (see point VIII below).

The appellant requested to set aside the decision under appeal and to grant a patent on the basis of the claims of the main request.

At the end of the oral proceedings the Board announced its decision.

VIII. Claim 1 of the main request reads as follows (emphasis in bold added by the Board):

"1. Procedure for the combination of phases for the mixing in the case of miscible fluids and for the production of emulsions, aerosols and microfoams in the case of immiscible fluids, comprising:

(a) flowing a higher density fluid at a first velocity through a feeding tube, the feeding tube having an axis, a circular cross-section with an interior diameter (D), and an exit, thereby forming an exit flow of the higher density fluid that exits axially from the feeding tube exit;

(b) directing an approximately perpendicular stream of lower density fluid, radially and centripetally to the axis of the exiting flow of the higher density fluid, to form an area of confluence just opposite to the feeding tube exit, in which the exiting flow of the higher density fluid meets the approximately perpendicular stream of lower density fluid and in which the lower density fluid flows at a second velocity that is at least twice as high and preferably at least five times as high as the first velocity, wherein the higher density fluid is a liquid and the lower density fluid is a gas and the gas to liquid mass flow ratio is between 0.05 and 200, thereby **creating a reflux cell** by the upstream penetration of the lower density fluid into the feeding tube of the higher density fluid;

(c) turbulently mixing the fluids in the reflux cell to generate a product that is dependent on the nature and miscibility of the fluids; and

(d) freely releasing the product so generated through a circular exit orifice having the same diameter (D) as the interior diameter of the feeding tube, wherein the exit of the feeding tube is contained within a plane that is perpendicular to the symmetry axis of the feeding tube and parallel to the plane containing the exit orifice so that the edges of the feeding tube exit and the exit orifice are in front of each other and separated by an axial gap (H) that is less than a half, and preferably less than a quarter, of the diameter (D) of the exit orifice, wherein **the shape of the exit of the feeding tube** of the higher density fluid **is sharp-edged** and wherein the axial gap forms a lateral ring-shaped passage through which the approximately perpendicular stream of lower density fluid is radially and centripetally directed."

IX. The appellant argued, insofar as relevant for the present decision, essentially as follows:

The skilled person is able to perform tests with a particular device and he can verify whether or not a reflux cell is created by observing the result of operating this device. Claim 1 requires the creation of a reflux cell which cannot be obtained with the "laminar" flow of the fluids according to D2 which results in the formation of a focused jet. "Laminar" in this context means that a flow line can be traced. In contrast to D2 the present application requires a turbulent flow (see page 9, lines 15 to 18). The effect thereof is a turbulent mixing which breaks up the jet and creates the reflux cell as well as a change from

essentially laminar to turbulent flow. As a consequence thereof there exists no longer a focused jet as disclosed by D2.

Claim 1 does not require the transition from the focused jet of D2 to the reflux cell. However, whether there is a reflux cell created can be determined by the person skilled in the art simply by using a transparent material such as glass (see e.g. English translation of the application as originally filed, figure 3) for the arrangement and establish whether reflux occurs, by different flows and speeds of the fluid and the gas. This represents a pretty straight-forward test which additionally allows to take photos. It is admitted that an intransparent apparatus creates a problem for the skilled person but for establishing whether he is working within the scope of the claim he can easily use a transparent version. The experiments described in the application are very simple so that no undue burden exists for the skilled person.

As defined in claim 1 the reflux cell is influenced by the nature of the fluids, i.e. a gas and a liquid, the pressure and velocity of the fluids and the geometry of the apparatus.

Only in case that a reflux cell has been created the output of the device, i.e. the droplets of the aerosol, have a homogeneous distribution which means that the distribution of particle sizes is the same in all directions whereas according to D2 the bigger drops are all in the centre of the flow line. The creation of the reflux cell in the feeding tube disrupts such flow line. Any reflux created by the process of D2 is outside the feeding tube.

The effect of the definition "sharp-edged" is described at page 9, lines 1 to 3 of the application as originally filed, i.e. little or even no frictional losses. That is a shape such as that shown in figure 1, which is like the sharp edge of a knife, which is what the skilled person would understand, particularly when considering the Spanish term "afilado" used in the underlying Spanish priority documents.

It is admitted that claim 1 is not restricted to the embodiment of figure 1 but it is argued that the circular cross-section with an interior diameter (D) is present over the entire length of the feeding tube since this claim 1 has to be given a normal meaning and the boundaries should remain comparable to what is mentioned in the description.

For Article 84 EPC the question to be answered is merely whether in a particular case under specific circumstances (i.e. with specific parameters) a reflux cell is created. Thus the skilled person need not ascertain where the boundaries are but he needs only to verify whether or not he is in the scope of claim 1, i.e. whether a reflux cell occurs or not.

The examples of the application give the skilled person guidance in this respect. The example made in accordance with figure 2 specifies four different overpressures of the gas for a given gap (H) of 90  $\mu\text{m}$  for a certain flow of water (20 mL/min) including 0.1% of Tween 80 (i.e. a surfactant) and having a specific surface tension of 40.6 mN/m while the example of figure 3 used pure water with a flow rate of 10 mL/min and different overpressure of the gas (see also page 7, line 29 to page 8, line 8). Ar is a preferred gas (see page 6, line 29).



The existence of a sharp-edge is not essential to the creation of a reflux cell but makes it easier to create one.

There are two formal requirements under Article 84 EPC, namely clarity of the claim and its support by the description. The first is satisfied by claim 1 since everything that falls within the scope of claim 1 can be determined by said visual inspection. Thus the question boils down to whether there is sufficient information to put the invention into practice at least once. This question can be answered positive since there is a specific example with Ar and a specific device using a specific gap (H) with water and Tween 80 (figure 2).

Neither Article 83 EPC nor Article 84 EPC requires the skilled person to predict every single example. It is admitted that the range for the mass flow ratio is large and that the nature of the gases and the viscosities of the liquids are not constrained by claim 1, nor by the description. They would have to be investigated by the skilled person who, however, would not be faced with a situation to perform an infinite number of experiments. This is due to the fact that he is taught by the examples that the particular parameters mentioned are within the scope of claim 1 and represent the most promising area to be explored. It is not difficult to ascertain whether laminar flow has been turned into turbulent flow and it does not need a massive research program to get to those parameters, including specific technical areas and applications.

The notional skilled person also knows that changing one parameter, e.g. the sharp-edge, can be offset by changing another parameter, e.g. the velocity of the gas. All necessary tools are however at his disposal for the extrapolation of the claimed process.

In the present case one example, wherein the result is achieved and which can be directly and positively verified, is sufficient (see T 68/85, OJ EPO 1987, 228) since it requires extrapolating parameters but not extrapolating alternatives. The feature "creating a reflux cell" is not a functional feature in the sense of e.g. a spring since the geometry of the apparatus necessary to obtain this result is now exactly specified in claim 1.

Therefore claim 1 complies with Article 84 EPC.

## **Reasons for the Decision**

### *1. Admissibility of amendments (Article 123(2) EPC)*

Since the Board considers that claim 1 of the (single) main request does not comply with the requirements of Article 84 EPC (see point 2 below) there is no need to consider in this decision whether the amendments made therein comply with Article 123(2) EPC.

### *2. Clarity (Article 84 EPC)*

Article 84 EPC requires that "The claims shall define the matter for which protection is sought. They shall be clear and concise and be supported by the description".

2.1 First of all, the claims *per se* must be clear in themselves when read by a person skilled in the art without any reference to the content of the description. It is further constant jurisprudence of the Boards of Appeal that claims have to be clear for the sake of legal certainty since their purpose is to **enable the protection conferred by the patent to be determined**. Thereby a potential infringer of the subject-matter of the claims should be enabled to determine whether or not he is working within the scope of the claim. The latter brings with it that the skilled person should be able to establish to a sufficient extent the demarcation of the scope of the claim (i.e. its extent of protection) without undue burden. In the context of determining the scope of protection of a claim it has additionally to be considered that Article 84 EPC is not a ground of opposition (see Case Law of the Boards of Appeal, 7<sup>th</sup> edition 2013, sections II.A.1.1 to 1.5 and II.A.3.1) and therefore needs proper attention in examination proceedings.

Taking account of the aforementioned jurisprudence the Board considers that claim 1 of the single request does not comply with Article 84 EPC, for the following reasons.

2.2 Feature (d) of claim 1 defines amongst others that **"the shape of the exit of the feeding tube** of the higher density fluid **is sharp-edged"** (see point VIII above).

2.2.1 The description of the English translation of the application as originally filed (which in the following is always quoted) does **not** contain any definition of the feature that the shape of the exit of the feeding tube is **"sharp-edged"**.

This definition "sharp-edged" has therefore to be interpreted by the person skilled in the art who will consider the complete specification of the application as originally filed but also his common general knowledge. Thus this definition could mean:

- i) an edge having an angle equal to or smaller than  $90^\circ$  (i.e. a sharp or acute angle), or
- ii) an edge that is "sharp", i.e. an edge which is suitable for cutting something.

2.2.2 Figures 1 to 4 of the English translation of the application as originally filed depict an axi-symmetric configuration of a mixing device wherein the exit of a cylindrical feeding tube of constant cross-section for the higher density fluid, i.e. a liquid, has the shape of an outwardly chamfered edge which forms an acute or sharp angle in the range of about  $15^\circ$ - $30^\circ$ . In the context of example 1 with reference to figure 1 the effect of this sharp-edged shape is described. Therein it is stated that it is responsible that the lateral ring-shaped passage section for the gas (which passage section is formed between the exit of the tube and a circular exit orifice having the same diameter (D) as the tube, being arranged in a parallel plane with respect to the plane of the exit of said feeding tube and being separated therefrom by an axial gap of the distance (H)) makes easier a prompt gas release with little or even no losses by friction (see page 8, line 20 to page 9, line 3).

2.2.3 When asked by the Board at the oral proceedings the appellant admitted that the sharp-edged shape of the feeding tube for the liquid could also have the form of an **inwardly** chamfered edge, i.e. the interior diameter

of the tube continuously increases over a certain distance towards the exit of the tube where it ultimately has the exterior diameter. Claim 1, due to the definition in its feature (a) "the tube having an axis, **a circular cross-section with an interior diameter (D)**, and an exit ..." allows for such an embodiment wherein the circular cross-section at the exit has an interior diameter (D) which is larger than an interior diameter of the feeding tube upstream of said exit.

2.2.4 It is therefore clear that claim 1 is **not** restricted to said first embodiment according to figure 1 and example 1 (see point 2.2.2 above) or to both aforementioned embodiments (see also point 2.2.3 above) since the exit of the feeding tube is only defined to be "sharped-edged" and does **not** contain any corresponding further restriction. Therefore the appellant's arguments to the contrary cannot be accepted.

2.2.5 The appellant's arguments based on the effect of the sharp-edged exit of the feeding tube of the device according to figures 1-4 used for the examples (see point 2.2.2 above) cannot hold either.

First of all, this is due to the fact that the application as originally filed nowhere discloses said sharp-edged exit of the feeding tube as an essential feature of the mixing device which would be responsible for creating a reflux cell in the feeding tube.

Secondly, when asked by the Board at the oral proceedings the appellant confirmed that this feature does **not** represent a prerequisite for the formation of the reflux cell. In this context it admitted that a shape of the exit different than that shown in the

- figures 1-4, e.g. the one mentioned in point 2.2.3 above with an inwardly chamfered edge, would also be suitable for creating a reflux cell in the feeding tube. Such an embodiment would, however, result in frictional losses which would mean that the velocity of the gas and/or its pressure would have to be increased in order to compensate for said losses.
- 2.2.6 Likewise the appellant's argument that the feature "sharp-edged" - based on the Spanish term "afilado" which was used in the Spanish original application WO-A-2006/089984 underlying the present application - has to be interpreted as meaning an edge in the form of a knife cannot hold since this Spanish term "afilado" can also be interpreted as meaning "sharpened".
- 2.2.7 Taking account of the conclusion in point 2.2.5 above it is evident that the uncertainty concerning the meaning of the feature "sharp-edged" shape of the exit of the feeding tube results in an additional parameter (at least the angle) that must be considered in order to compensate for any frictional losses when making experiments for creating the claimed reflux cell.
- 2.2.8 This uncertainty concerning the meaning of this definition "sharp-edged" shape of the exit of the feeding tube leads also to the conclusion that the shapes of the feeding tube exits according to the figures 3 and 4 of D2 - which have an angle of less than 90° or of 90°, respectively, but in combination with a tapered edge - are **not** necessarily excluded from the subject-matter of claim 1.
- 2.3 Feature (b) of claim 1 of the single request specifies that the lower density fluid is **a gas** while the higher density fluid is **a liquid** and that they meet in a

specific manner in an area of confluence just opposite at the feeding tube exit wherein the **gas** flows with a **velocity that is at least twice as high as that of the liquid** and with a **gas to liquid mass flow ratio between 0.05 and 200** and at its end defines "... thereby **creating a reflux cell** by the upstream penetration of the lower density fluid into the feeding tube of the higher density fluid" (see point VIII above). The Board thus considers that feature (b) defines a result to be achieved, namely that of a reflux cell inside the feeding tube.

- 2.3.1 The features (a) and (d) of claim 1 define amongst others an axi-symmetric mixing device including said feeding tube having a circular cross-section with an interior diameter (D) and said exit having a sharp-edged shape, and a circular exit orifice having the same diameter (D) as the interior diameter of the feeding tube which are opposite each other in two parallel planes that are separated by an axial gap (H) that is less than half of the diameter (D) (see points 2.2.2 and VIII above). The essential geometric dimensions (D) and (H) of this mixing device are thus **not** defined by absolute dimensions but only by relative dimensions.

The specification of the English translation of the application as originally filed is silent with respect to either general or preferred ranges for the diameter (D) and/or the axial gap (H). Only the example with reference to figure 2 discloses a single value for the distance (H) that is 90  $\mu\text{m}$  (see page 7, line 29 to page 8, line 3 and figure 2).

- 2.3.2 Taking account of the above, the person skilled in the art is taught by claim 1 that he has to select the

following parameters for carrying out the mixing process defined in claim 1 of the single request:

- a) a gas (any gas or a mixture of gases such as air);
- b) a liquid (any liquid which may be chosen within a very large range of possible viscosities and which additionally can be a mixture of liquids, see page 8, lines 1 and 2);
- c) a diameter (D);
- d) a height of the axial gap (H) that is less than half of said diameter (D);
- e) a velocity of the gas in the confluence area that is at least twice as high as that of the liquid (which implies a certain pressure of the selected gas);
- f) a gas to liquid mass flow ratio between 0.05 and 200 (which represents a very large range); and
- g) a "sharp-edged" shape of the feeding tube exit.

Thus in order to ascertain the boundaries for the scope of claim 1 the person skilled in the art has to select embodiments in accordance with these seven parameters a) to g) and additionally he has to vary the same. In this context it is clear to him that the parameter e) (likewise the implied pressure or pressure difference necessary for creating the gas velocity) is influenced by parameter g).

The appellant did **not** dispute at the oral proceedings that the selection of a gas (which can be one-atomic, two-atomic, three-atomic, etc. or a mixture of gases) represents an individual parameter that influences the creation of a reflux cell.

2.3.3 In this context it is accepted by the Board that the creation of a reflux cell may be easily visually determined by the skilled person when using a



transparent mixing device, e.g. made from glass (see English translation of the application as originally filed, figure 3), and observing the result when operating this device. The process according to claim 1 requires - in contrast to D2 - a turbulent flow to create said reflux cell (see English translation of the application as originally filed, page 9, lines 15 to 18).

2.3.4 However, as already mentioned (see point 2.3.1 above) the application is silent with respect to absolute dimensions of said diameter (D) and said height (H) of the mixing device to be used for creating the reflux cell so that these parameters c) and d) are totally open ones since claim 1 does **not** contain any restriction in these respects.

2.3.5 Also the examples of the English translation of the application as originally filed are considered **not** to be particularly helpful to the person skilled in the art in this context. Contrary to the appellant's arguments they do not give the skilled person much guidance to create said reflux cell, let alone establish where the boundaries lie.

The example made in accordance with figure 2 specifies four different overpressures of 513 mBar, 765 mBar, 1560 mBar and 2770 mBar (i.e. the pressure difference between the pressure of the gas in the mixing chamber of the mixing device and the outside) of the unspecified gas for a given gap (H) of 90  $\mu\text{m}$  for a certain flow of water (20 mL/min) including 0.1% of Tween 80 (i.e. a surfactant) and having a specific surface tension of 40.6 mN/m. Thus the dimension of the diameter (D), the used gas and the gas to liquid mass flow ratio as well as the value of the sharp angle of

the tapered edge of the exit of the feeding tube are **not** specified for this example (see page 7, line 29 to page 8, line 3 and figure 2).

The other example according to figure 3 used pure water with a flow rate of 10 mL/min and a different overpressure of 2500 mBar of the unspecified gas. Therefore the dimensions of the diameter (D) and the height (H), the used gas and the gas to liquid mass flow ratio as well as the value of the sharp angle of the tapered edge of the exit of the feeding tube are **not** specified for this second example (see page 8, lines 5 to 8).

Contrary to the appellant's arguments Ar is only mentioned as the preferred gas for a preferred use of the claimed process in optic or mass atomic spectroscopy (see page 6, lines 26 to 29) but is **not** mentioned in the context of these two examples.

2.3.6 Considering the disclosure of the specification of the English translation of the application as originally filed the skilled person, most presumably, will start from the parameters given in the first example of the application and will use said specified height (H) to select a diameter (D) for the exit of the feeding tube and the exit orifice of the mixing device that is at least the double of this height (H).

However, already when trying to repeat these two examples on the basis of the disclosed parameters the person skilled in the art has to make additional selections for the missing unspecified parameters - namely the parameters a), c), f) and g) and only for the second example additionally the parameter d) - and as a consequence thereof has to carry out a large

number of additional experiments to verify these two examples in order to create a reflux cell.

- 2.3.7 Other gases than Ar or other liquids different from water (which may contain the surfactant Tween 80) are **not** mentioned in the specification but are encompassed by the definitions "a gas" and "a liquid" of claim 1. However, it belongs to the common general knowledge of the person skilled in the art that a high viscosity of the used liquid or mixture of liquids will strongly influence the creation of a reflux cell in the feeding tube. Claim 1 is, however, not restricted to low viscosity liquids.

In this context it is remarked that the appellant at the oral proceedings admitted that the nature of the gases and the viscosities of the liquids are not constrained by claim 1 and would have to be investigated by the skilled person.

- 2.3.8 Taking account of the above, the Board considers that, although the experiments described in the application appear to be very simple, there exists an undue burden for the skilled person since he has to carry out at least a small research program based on said seven parameters a) to g) to ascertain the boundaries of the scope of claim 1 of the main request.

The Board further considers, as mentioned at the oral proceedings, that the very broad subject-matter of claim 1 of the main request, which encompasses all kinds of gases and liquids, is not supported - as required by Article 84 EPC - by the description of the English translation of the application as originally filed with respect to the small number of only two examples which were only made with water (optionally in

combination with a small amount of a surfactant, i.e. Tween 80) as said liquid in combination with an unspecified gas (see point 2.3.5 above).

2.3.9 The appellant's arguments to the contrary cannot hold for the following reasons.

As derivable from point 2.1 above the question to be answered is not whether in a particular case under specific circumstances (i.e. with specific parameters) a reflux cell is or is not created. According to the jurisprudence the skilled person must be in a position to ascertain where the boundaries of the scope of claim 1 are and not only to verify whether or not he is infringing the process of claim 1. In the present case he does not know these boundaries from the definitions of claim 1 and to determine the same he is confronted with a small research program, which is an undue burden, as considered by the Board.

The Board agrees that the notional skilled person knows that changing one parameter, e.g. the sharp-edge according to parameter f), can be offset by changing another parameter, e.g. parameter e) and the velocity of the gas and that the necessary tools are at the disposal of the skilled person for carrying out the claimed process. This fact, however, does not alleviate the burden on the skilled person to have to carry out said small research program to determine the scope of claim 1.

Likewise, the arguments based on decision T 68/85 (see OJ EPO 1987, 228) cannot hold. First of all, this decision dealt with an application containing a functional definition (or a result to be achieved) was considered admissible under Article 84 EPC. However,

the Board pointed out in this respect: "On the other hand, the effort to define a feature in functional terms must stop short where it jeopardises the clarity of a claim as required by Article 84 EPC. That clarity demands not only that a skilled person be able to understand the teaching of the claim but also that he be able to implement it. In other words, the feature must provide instructions which are sufficiently clear for the expert to reduce them to practice **without undue burden**, if necessary with reasonable experiments" (see point 8.4.3 of the reasons; emphasis added by the Board).

Hence, already this decision sets the standard at preventing undue burden. Furthermore, since the issuing of this decision the jurisprudence concerning clarity has been further developed with respect to establishing the boundaries of the claim (see Case Law of the Boards of Appeal, 7<sup>th</sup> edition 2013, sections II.A.1.1 and II.A.3.4).

2.3.10 The Board therefore considers that claim 1 of the main request does not comply with Article 84 EPC. The main request is therefore not allowable.

**Order**

**For these reasons it is decided that:**

The appeal is dismissed.

The Registrar:

The Chairman:



G. Nachtigall

H. Meinders

Decision electronically authenticated