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DECISION of 12 November 2003

T 0430/02 - 3.4.2 Case Number:

Application Number: 91119877.8

Publication Number: 0487086

IPC: G03F 7/027, G03F 7/00,

C08F 2/50

Language of the proceedings: EN

Title of invention:

Volume phase hologram comprising a photosensitive recording medium and method of preparing volume type phase hologram member using same

Applicant:

CANON KABUSIKI KAISHA

Opponent:

Nippon Paint Co., Ltd.

Headword:

Relevant legal provisions:

EPC Art. 54, 56, 84, 100(b)

Keyword:

"Sufficiency of disclosure - objection no longer applicable to patent as amended"

"Novelty (yes)"

"Inventive step (yes)"

Decisions cited:

Catchword:



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Boards of Appeal

Chambres de recours

Case Number: T 0430/02 - 3.4.2

DECISION

of the Technical Board of Appeal 3.4.2 of 12 November 2003

Appellant: C.

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Respondent:
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Decision under appeal:

Decision of the Opposition Division of the European Patent Office posted 5 March 2002 revoking European patent No. 0487086 pursuant

to Article 102(1) EPC.

Composition of the Board:

Chairman: A. G. Klein Members: M. P. Stock

M. J. Vogel

- 2 - T 0430/02

Summary of Facts and Submissions

I. The appellant (patent proprietor) lodged an appeal against the decision of the opposition division revoking European patent No. 0 487 086 (based on application No. 91119877.8).

The opposition filed by the respondent (opponent) against the patent as a whole was based on the grounds of insufficiency of disclosure (Article 100(b) EPC) and lack of novelty and of inventive step (Article 100(a) EPC).

In the decision under appeal the opposition division referred, *inter alia*, to the following documents

D1: US-A-3 993 485

D3: EP-A-0 335 629

and held that claim 1 according to the main and the auxiliary requests then on file did not involve an inventive step (Article 56 EPC) with regard to the disclosure of documents D1 and D3.

II. In a communication accompanying summons to oral proceedings the Board noted, inter alia, that the grounds under Article 100(b) EPC had only been raised with regard to claims 1 to 9 as granted directed to a volume phase hologram and that the amended claims according to the appellant's requests then on file were derived from

- 3 - T 0430/02

claims 10 to 21 as granted directed to a method of producing a volume phase hologram.

III. Oral proceedings before the Board were held on 12 November 2003 in the presence of both parties.

The appellant requested setting aside of the decision under appeal and the maintenance of the patent as amended according to the main or the auxiliary request filed during the oral proceedings.

The respondent for his part requested that the appeal be dismissed.

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

- IV. Claim 1 according to the main request of the appellant reads as follows:
 - "1. A method of producing a volume phase hologram having large difference of refractive index between antinodes and nodes portion containing a step of exposing a photosensitive recording medium to irradiation, the method comprising:

a first step of preparing a photosensitive recording medium for forming a hologram, said medium containing as main constituents a radical-polymerizable monomer, a cationic-polymerizable monomer, a radical-polymerization initiator capable of initiating a polymerization of the radical-polymerizable monomer by exposing the medium to light within a wavelength region where said radical

-4- T 0430/02

polymerization initiator is photosensitive, and a cationic-polymerization initiator capable of initiating a polymerization of the cationic-polymerizable monomer by exposing the medium to light within a wavelength region where said cationic polymerization initiator is photosensitive, different from the wavelength region in which the radical-polymerization initiator is photosensitive, wherein the radical-polymerization initiator are not the same;

a second step of exposing the medium to an interference pattern of coherent laser light selectively in antinodes regions by interference fringe within a wavelength region where only one of the radical-polymerizable monomer and the cationic-polymerizable monomer selectively polymerizes in the antinodes portion for forming a hologram; and

a third step after the second step of exposing the entire region of the medium to light within a wavelength region where both of the radical polymerizable monomer and the cationic-polymerizable monomer are polymerized in the nodes portion, respectively,

wherein the antinodes portion contains the radicalpolymerized polymer of the cationic-polymerized polymer."

Claims 2 to 9 are appended to claim 1.

The wording of the claims according to the auxiliary request is not relevant to the present decision.

V. The arguments of the appellant in support of his requests can be summarized as follows:

Contrary to the invention which requires the selective polymerization of only one of the two monomers during the first exposure step and of both monomers during the second exposure step, the disclosure of document D1 relative to the use of two monomers having different reactivities involves the polymerization of both monomers during the first exposure step (column 4, lines 14 to 17), and the disclosure relative to the use of a monomer and a zero-reactivity component involves the polymerization of one single monomer during both exposure steps. In addition, in document D1 only one initiator is used and the overall second exposure constitutes a mere freezingin or fixing of the polymerization process already carried out during the first exposure step (column 6, lines 43 to 47); therefore, the document does not hint at the different exposure wavelength regions according to the claimed method. The document mentions the use of a second monomer polymerizing by a different mechanism (column 6, lines 59 to 62), but only in the context of preventing phase separation (column 6, lines 31 to 34 and 48 to 58) and the document does neither disclose nor suggest the use of a second initiator or of different exposure wavelength regions. Contrarily to the holograms produced according to document D1 and having in each region a mixture of the two polymeric species (column 4, lines 30 to 35) and therefore a smooth gradient of refractive index, the claimed sequential selective polymerization and the underlying diffusion mechanism leads, as shown in the examples of the patent specification, to a hologram having regions composed of

- 6 - T 0430/02

one single polymerized species and therefore having a large refractive index modulation.

The problem solved by the claimed method is therefore the production of volume phase holograms having an improved difference of refractive index between nodes and antinodes regions and therefore improved resolution and diffraction efficiency. Document D3, however, does not pertain to the formation of a refractive index gradient or to the production of holograms, but to the formation of photolithographic patterns by photocuring and developing techniques (page 6, lines 61 to 63). Thus, document D3 does not address at all the problem considered in the patent and the opposition division followed an *ex-post-facto* analysis when considering the combination of documents D1 and D3.

VI. The arguments put forward by the respondent are essentially the following:

The feature in amended claim 1 relative to the "large difference of refractive index" between the antinodes and the nodes regions of the hologram is rendered indefinite by the use of the term "large".

Document D1 discloses the production of a hologram by polymerization of two monomers having different reactivities and indicates in column 6, lines 48 to 62 that the problem of the random phase separation during polymerization can be solved using two monomers that polymerize following two different polymerization routes, and in particular using a radical and a cationic

- 7 - T 0430/02

polymerizable monomer. The skilled person would follow this alternative approach and would obviously add the appropriate initiator required for the polymerization of the cationic polymerizable monomer and would also use a selective irradiation as implied by the use of two monomers that polymerize following two different polymerization routes, thus arriving at the claimed subject matter. Therefore, the claimed subject matter is rendered obvious by the disclosure of document D1 alone.

Alternatively, the disclosure of document D1 relating to the use of a radical and a cationic polymerizable monomer represents the closest prior art and the skilled person, seeking to implement the corresponding disclosure relative to the polymerization of two monomers following different polymerization mechanisms, would arrive at the claimed method by considering the disclosure of document D3. This document has been classified in the same IPC class as document D1 and the opposed patent, pertains to polymerization techniques that can be used for different purposes and in particular for the production of both holograms and photoresists, and discloses the selective and the subsequent full polymerization of a medium comprising a radical and a cationic polymerizable monomer (abstract).

The formulation of the problem according to the submissions of the patent proprietor is not supported by the claimed subject matter. In particular, the feature relative to the large difference of refractive index is unclear and indefinite and cannot therefore be identified as a distinguishing feature over the disclosure of

- 8 - T 0430/02

document D1; otherwise, the issue of how such a large refractive index difference can be achieved should be addressed. Therefore, the problem solved by the claimed subject matter consists merely in the provision of an alternative method of producing holograms. This alternative method, however, is arbitrary since it has no particular effect on the method known from document D1.

Reasons for the Decision

- 1. The appeal is admissible.
- 2. Main request Compliance of the amendments with the requirements of Articles 123(2), 123(3) and 84 EPC
- 2.1 Claim 1 of the main request is directed to a method of producing a volume phase hologram and results from the combination of independent claim 10 as granted, directed to a method of producing a volume phase hologram according to claim 1 as granted, with the features of the volume phase hologram of claim 1 as granted, the resulting combination including additional features of the method according to the invention. During the oral proceedings the respondent did not dispute the admissibility under Articles 123(2) and (3) EPC of the amended features and, after due consideration of the amendments made, the Board is satisfied that the amendments in claim 1 and in dependent claims 2 to 9 according to the appellant's main request comply with the requirements of Articles 123(2) and (3) EPC.

- 9 - T 0430/02

2.2 During the oral proceedings the respondent submitted that the feature of amended claim 1 relative to the "large difference of refractive index" between antinode and node portions is indefinite due to the relative meaning of the term "large". This objection, however, relates by its nature to Article 84 EPC which does not constitute an admissible ground of opposition under Article 100 EPC. In addition, since present claim 1 derives from claim 10 as granted and the objected feature was already present in claim 1 as granted and thus also incorporated in claim 10 as granted by virtue of the reference in the claim to claim 1 as granted, the objection raised by the respondent under Article 84 EPC does not arise out of the amendments but relates to a feature that was already present in the patent as granted. For these reasons, the Board is barred from considering the objection raised by the respondent under Article 84 EPC (see "Case Law of the Boards of Appeal 4th ed. 2001, chapter VII, section C.10.2).

Notwithstanding the inadmissibility of the objection raised under Article 84 EPC by the respondent, and since the interpretation of the objected feature may influence the assessment of the opposition grounds invoked by the respondent (see points 3 to 5 below), the Board notes that according to the last two features of claim 1, and as supported by the disclosure of the patent specification (see page 3, lines 12 to 15 and lines 23 to 28 and page 12, line 57 to page 13, line 2), the node portions of the resulting hologram contain a mixture of polymers of both the radical and the cationic polymerized

- 10 - T 0430/02

type and the antinode portions contain a polymer of one type. As acknowledged in paragraph [0019] of the patent specification, this polymer distribution in the antinode and node portions determines the difference of refractive index between the antinode and the node portions. The actual value of this difference would, however, depend on other features such as the relative proportion of the constituents of the medium and the value of the refractive index of the polymers resulting from the polymerization of the monomers. Since the claim does not impose any restriction on the latter features, in the context of the claimed subject matter the objected expression "large difference of refractive index between antinodes and nodes portion" is to be construed as referring to the difference of refractive index between antinode and node portions that can actually be achieved with the specific claimed features and in particular with the resulting polymer distribution specified in the claim.

No other objection under Article 84 EPC was raised by the respondent, and the Board is satisfied that the amended features of claims 1 to 9 according to the appellant's main request meet the requirements of Article 84 EPC.

- 3. Main request Ground for opposition under Article 100(b) EPC
- 3.1 As already noted by the Board in the communication accompanying the summons to oral proceedings (see point II above), while the ground for opposition under Article 100(b) EPC raised by the respondent during the first-instance opposition proceedings only related to the

- 11 - T 0430/02

volume phase hologram defined in claims 1 to 9 as granted, the invention as defined in the claims amended by the appellant during the appeal proceedings relates to a method of producing a volume phase hologram. During the subsequent oral proceedings the respondent did not dispute this finding. The Board therefore concludes that the objection raised by the respondent under Article 100(b) EPC during the first-instance opposition proceedings no longer applies to the invention as defined in claims 1 to 9 according to the appellant's main request. Moreover, the Board has no doubts that the patent as amended according to the main request discloses the claimed invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art.

3.2 During the oral proceedings, and in the course of the discussion on the issue of inventive step, the respondent disputed that the method of claim 1 actually achieves a large difference of refractive index between antinode and node portions as specified in the claim, the objection being conditional on the Board construing the corresponding feature as constituting a distinguishing feature over the disclosure of document D1 (see point VI above). However, as it will become apparent from the following discussion on substantive patentability (see in particular point 5.1.3 below), the achievement of a large difference of refractive index between antinode and node portions, interpreted as indicated in the second paragraph of point 2.2 above, does not constitute per se a distinguishing feature over the method disclosed in document D1 and for this reason there is no need to

- 12 - T 0430/02

consider the admissibility, still less to assess the validity of the objection raised by the respondent only on a conditional basis.

4. Main request - Novelty

As it will be clear from the following discussion on inventive step, none of the documents in the opposition file, and in particular none of documents D1 and D3 referred to by the parties during the appeal proceedings, disclose a method of producing a volume phase hologram comprising all the features of the claimed subject matter.

Accordingly, as it has been undisputed by the respondent during the appeal proceedings, the subject matter of claim 1 amended according to the appellant's main request, as well as that of dependent claims 2 to 9 appended thereto, is novel over the prior art considered during the proceedings (Articles 52(1) and 54 EPC).

- 5. Main request Inventive step
- 5.1 Closest prior art and distinguishing features of the claimed subject matter
- 5.1.1 It has been undisputed by the parties that the closest prior art is represented by the method of producing a hologram of the volume phase type disclosed in document D1 (abstract and column 7, lines 64 to 68 together with column 10, lines 44 to 63). According to this method, a photosensitive medium containing as main constituents two components having different photopolymerization

- 13 - T 0430/02

reactivities is exposed to radiation, the exposure process including a first exposure of the medium to an interference fringe pattern of coherent laser light inducing polymerization in the antinode regions followed by a second exposure of the entire medium to radiation inducing the polymerization of the remaining monomers present in the medium (column 3, line 49 to column 4, line 38 and column 6, lines 23 to 34 together with column 12, lines 3 to 9).

5.1.2 Document D1 discloses a first approach in which the two components are two different radical polymerizable monomers and the medium includes a radical polymerization initiator (example I of Table I), and a second approach in which the medium includes a radical polymerizable monomer as one of the two components and a radical polymerization initiator, the other one of the two components being a zero photopolymerization reactivity or inert component (examples II and III of Table I). Contrarily to these approaches, the method of claim 1 according to the main request requires the use of a radical and a cationic polymerizable monomer together with the respective radical and cationic polymerization initiators.

The document proposes in addition a third approach involving the use of a radical polymerizable monomer and a second monomer that polymerizes via a different route and in particular via an ionic or epoxy type reaction (column 6, lines 48 to 62). However, this third approach is only proposed as a possible course of action in the context of the discussion of the problems associated with

- 14 - T 0430/02

the random phase separation of the components. This proposal is certainly to be taken into consideration in the subsequent assessment of inventive step but in view of the rather speculative character of the corresponding discussion (column 6, lines 48 to 58) and of the untested nature of the proposal made (column 6, lines 59 to 62), the Board considers that, contrarily to the respondent's submissions, the proposed third approach does not itself qualify, unlike the two other approaches discussed and exemplified in the disclosure of the document, as realistic starting point for the objective assessment of the inventive step of the claimed subject matter according to the problem-solution approach.

5.1.3 According to document D1, the different photopolymerization reactivities of the two components and the diffusion mechanism underlying the polymerization process give rise to a concentration gradient in the resulting polymerized medium and thus to a difference in refractive index between the antinode and the node portions of the medium (column 3, line 56 to column 4, line 29). In addition, while the node portions include polymers resulting from the polymerization of the two monomeric species, according to the results reported in the document the portions of the medium having a high intensity exposure during the first exposure step, i.e. the antinode portions of the medium, contain an excess of polymer resulting from the polymerization of one of the two components (column 4, lines 7 to 17). The appellant has submitted that the claimed subject matter requires the antinode portions to contain only one of the polymerized polymers and that this feature is not

- 15 - T 0430/02

achieved in the method disclosed in document D1. However, the diffusion mechanism underlying the method of document D1 appears to be similar, if not identical to that underlying the claimed method (see page 3, lines 11 to 13 and lines 23 to 26 of the patent specification) and no evidence or detailed argument has been advanced by the appellant in support of the contention that the diffusion mechanism underlying the claimed method would lead to one of the polymers being excluded from the antinode portions to an extent beyond that achieved according to the method of document D1. In addition, the appellant's submissions in this respect are at variance with the large index changes observed in the holograms obtained with the method disclosed in document D1 and which require, according to the authors of the document, that the component having low reactivity is excluded from the antinode portions (column 4, lines 38 to 52). The Board concludes that the feature of the claimed method relating to the polymerization of both monomers in the node portions is anticipated by the disclosure of document D1 and that, in the absence of evidence or convincing arguments to the contrary, the feature relating to the antinode portions containing one of the two polymerized components cannot be construed as distinguishing the claimed method over the method disclosed in document D1.

In addition, since the distribution of the two polymerized components in the antinode and the node portions according to the claimed method is anticipated by document D1 and since the claimed subject matter does not impose any restriction on other features, such as the relative proportion of the polymers present in the

resulting hologram or the values of the refractive index of the polymers resulting from the polymerization of the monomers used in implementing the claimed method, which, as discussed in the second paragraph of point 2.2 above, would also determine the difference of refractive index between the antinode and node portions, the claim method encompasses embodiments that do not involve a difference of refractive index between antinode and node portions beyond the difference achieved according to the method disclosed in document D1 (column 4, lines 48 to 52 and examples). Thus, in the absence of evidence to the contrary, it has to be concluded, as already anticipated in point 3.2 above, that the claimed feature relating to the large difference of refractive index between antinode and node portions, construed as discussed in the second paragraph of point 2.2 above, does not constitute a distinguishing feature of the claimed subject matter over the disclosure of document D1.

5.1.4 While document D1 relies on the different photopolymerization reactivities of the two components to the exposure radiation used in the exposure process or, in the limit, on the use of a photopolymerizable component and a zero-reactivity or inert component (see point 5.1.2 above), the claimed method requires that the photosensibility of the radical and the cationic photopolymerization initiators and the wavelength regions of the radiation used in the two exposure steps are such that during the first exposure step only one of the two monomers is polymerized and during the second exposure step both the radical and the cationic polymerizable monomers are polymerized.

- 17 - T 0430/02

5.1.5 It follows from the analysis above that the claimed method differs from the closest prior art represented by the approaches exemplified in document D1 (see point 5.1.2 above, second paragraph) by the use of a radical and a cationic polymerizable system each comprising a respective polymerizable monomer and the corresponding initiator (see point 5.1.2 above, first paragraph) and by the features relating to the wavelength-selective exposure of the two polymerizable systems (see point 5.1.4 above).

5.2 Objective problem

According to the appellant's submissions, the effect of the claimed method over the method disclosed in document D1 is the improvement in the difference of refractive index between the antinode and node portions of the hologram and consequently the achievement of an improved resolution and diffraction efficiency. However, this allegation relies on features which, as discussed in point 5.1.3 above, cannot be considered to distinguish the claimed subject matter over the method disclosed in document D1, the further alleged effects relating to the resolution and the diffraction efficiency being also achieved in the method disclosed in document D1 (see first sentence of the abstract and column 1, lines 6 to 14 together with column 9, lines 44 to 52). Consequently, the claimed method encompasses embodiments that do no exhibit the improvements alleged by the appellant and for this reason these improvements cannot be considered in

- 18 - T 0430/02

formulating the objective problem solved by the claimed subject matter.

In addition, none of the distinguishing features identified in point 5.1.5 above supports the achievement over the disclosure of document D1 of the remaining advantages and improvements specified in the patent specification such as the recording of the hologram in a visible region or the durability and storage stability characteristics of the resulting hologram (paragraph [0092]).

In view of the above, and in the absence of evidence that would support an additional technical effect over those achieved by the method of document D1, the objective problem solved by the distinguishing features identified in point 5.1.5 above is restricted to the provision of an alternative method of obtaining a volume phase hologram having large difference of refractive index between antinode and node portions.

5.3 Inventive step

5.3.1 The skilled person seeking an alternative process to that disclosed in document D1 would have focused his attention on the third approach proposed in document D1 and considered in point 5.1.2 above. This approach involves, in addition to the radical polymerizable monomer, the use of an ionic or epoxy polymerizable monomer as second component which implicitly encompasses the polymerization of the corresponding monomer following a cationic polymerization reaction. In addition, as submitted by the

- 19 - T 0430/02

respondent, the photo-polymerization of the ionic or epoxy polymerizable monomer generally requires the use of the corresponding polymerization initiator and for this reason it is obvious, if not implicit, to use the corresponding ionic or epoxy polymerization initiator. However, neither the use of two monomers polymerizing following different routes nor the use of two different polymerization initiators constitute in the Board's view a clear indication leading the skilled person towards the wavelength selective exposure of the monomers, still less towards the selective exposure of only one of the monomers according to an exposure pattern and the subsequent exposure of the remaining monomers as submitted by the respondent. In addition, there is no hint in document D1 that would lead the skilled person to depart from applying to the proposed third approach the specific technical teaching of document D1, i.e. from selecting a radical and an ionic polymerizable monomer having different photo-polymerization reactivities and then carrying out the exposure process as taught in the document (see point 5.1.1 above). Thus, in the absence of any indication to the contrary, the skilled person would have had no incentive to contemplate going beyond the precise teaching of document D1, still less to select the corresponding initiators and the exposure wavelength regions so that only one of the monomers is selectively polymerized during the first of the exposure steps as required by the claimed subject matter.

The skilled person might well have considered to apply to the proposed third approach the limit of the technique taught in document D1 involving the use of a component - 20 - T 0430/02

having zero photopolymerization reactivity (see abstract and paragraphs bridging columns 6 and 7). This limit, however, is consistently implemented in document D1 by means of an inert component, i.e. a component having zero photo-polymerization reactivity within the wavelength regions of both the first and the second exposure steps. In addition, the use of an inert second component would not only fail to reproduce the claimed method but would also be at variance with the third approach itself requiring the use of two components polymerizing following two different routes.

Thus, in the absence of any sufficient reason to presume that the skilled person would have considered the selective polymerization of only one of the monomers during the first exposure step, the line of argument followed by the respondent on the basis of the sole disclosure of document D1 failed to convince the Board.

5.3.2 According to an alternative line of argument developed by the respondent, the skilled person seeking to implement the third approach proposed in document D1 would have looked for other sources of information and would have considered document D3 the teaching of which would, as also maintained by the opposition division, render obvious the claimed subject matter.

Document D3 relates to a two-exposure process for preparing photocured coatings, such as photoresists, in which a composition containing a radical polymerizable system and a cationic cure epoxy system is exposed to a first radiation which initiates reaction of one of the

- 21 - T 0430/02

systems and is subsequently exposed to a second radiation which initiates reaction of the other one of the systems (abstract). Thus, document D3, although classified in the same IPC class (G03) as both document D1 and the contested patent, nonetheless does not relate to the production of holograms or the formation of patterns of refractive index, but, as submitted by the appellant, pertains exclusively to the formation of photolithographic patterns by photocuring and developing techniques. In addition, none of the features of the mechanism underlying the formation of holographic or refractive-index patterns according to document D1 are addressed in document D3. For this reason, even assuming that the skilled person would have contemplated following an alternative exposure process to that taught in document D1, the Board considers that only hindsight knowledge of the claimed invention would have drawn the attention of the skilled person to document D3 and would have led the skilled person towards the application of the exposure techniques disclosed in the document to the exposure process disclosed in document D1. Therefore, the appellant's line of argument based on the combination of documents D1 and D3 also fails to convince the Board.

5.3.3 Thus, documents D1 and D3 do not, either alone or in combination, disclose or suggest the production of a hologram comprising the selective polymerization of two monomers according to the claimed subject matter. The remaining documents in the opposition file are less pertinent and the respective disclosure does not call into question the inventive step of the claimed method.

- 22 - T 0430/02

5.4 Accordingly, the subject matter of claim 1 according to the main request as well as that of dependent claims 2 to 9 appended thereto involve an inventive step (Articles 52(1) and 56 EPC).

6. Auxiliary request

In view of the positive conclusion reached by the Board with regard to the set of claims as amended according to the main request of the appellant, consideration of the set of claims according to the auxiliary request is not necessary in the present decision.

7. Further procedure - Adaptation of the description

The amended set of claims according to the main request requires consequential amendments to the description, and the Board considers it expedient in the circumstances of the present case to exercise its discretion under Article 111(1) EPC and to remit the case to the department of first instance for further prosecution. In adapting the description, care should be taken to amend statements and embodiments that are no longer fully consistent with the subject matter now claimed (Article 84 EPC and Rule 27(1)(c) EPC), see in particular paragraphs [0001], [0012] to [0014], [0016], [0034], [0035] and [0093] of the patent specification. The content of document D1 should also be appropriately acknowledged in the introductory part of the description (Rule 27(1)(b) EPC).

- 23 - T 0430/02

8. In view of the foregoing, the patent can be maintained as amended according to the appellant's main request (Article 102(3) EPC), subject to the adaptation of the description as indicated in point 7 above.

Order

For these reasons it is decided that:

- 1. The decision under appeal is set aside.
- 2. The case is remitted to the first instance with the order to maintain the patent on the basis of
 - claims 1 to 9 according to the main request filed during the oral proceedings, and
 - description to be adapted.

The Registrar: The Chairman:

P. Martorana A. G. Klein