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Datasheet for the decision of 23 February 2010

Case Number: T 1732/08 - 3.4.02

Application Number: 03254414.0

Publication Number: 1380878

IPC: G02F 1/1336

Language of the proceedings: EN

Title of invention:
A vertically aligned liquid crystal display device having an optimized viewing angle

Applicant:
SAMSUNG ELECTRONICS CO., LTD.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 123(2)

Relevant legal provisions (EPC 1973):
EPC Art. 84, 56

Keyword:
"Claim 1 (main request) - added subject-matter (yes)"
"Claim 1 (first auxiliary request) - clarity (no)"
"Claim 1 (second auxiliary request) - inventive step (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1732/08 - 3.4.02

D E C I S I O N
of the Technical Board of Appeal 3.4.02
of 23 February 2010

Appellant: SAMSUNG ELECTRONICS CO., LTD.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 24 April 2008 refusing European application No. 03254414.0 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: A. G. Klein
Members: M. Rayner
B. Müller

Summary of Facts and Submissions

I. The applicant appealed against the decision of the examining division refusing European patent application number 03 254 414.0. The patent application concerns a vertically aligned liquid crystal display device.

II. Claims 1, 4, 5 and 8 as originally filed were worded as follows.

"1. A method of building a display device, the method comprising:
providing a liquid crystal panel including liquid crystal molecules contained between glass substrates;
coupling one or more uniaxial compensation films to at least one of the glass substrates such that the one or more uniaxial compensation films provides a total retardation value less than or equal to 200nm for light having a wavelength of about 550nm.

4. A method according to any preceding claim including a single uniaxial compensation film.

5. The method of claim 4, wherein the uniaxial compensation film has a thickness of about 15-25 microns and a retardation value of about 75-85nm, and provides a viewing angle of at least 70 degrees from the top and the sides.

8. The method of any preceding claim further comprising:
dividing the uniaxial compensation film into a first layer and a second layer so that a combined thickness of the first and the second layers are substantially equal to the predetermined thickness;

disposing the first layer so that it is closer to the first glass substrate than to the second glass substrate; and
disposing the second layer so that it is closer to the second glass substrate than to the first glass substrate."

III. In the examination and appeal proceedings, reference has been made to documents including the following:

D2 US-A-2001/030726

D7 LIU H-D; FT AL: "LP-5: Late-News Poster: A Novel Design Wide View Angle Partially Reflective Super Multi-domain Homeotropically Aligned" 2002 SID International Symposium Digest Of Technical Papers, vol. 33, no. 1, pages 558-561, San Jose, CA, USA

IV. The decision under appeal included an assessment of clarity and patentability as follows.

(a) Clarity

Independent claim 1 as presented to the division was not considered clear as to how compensation films with a net retardation value within the range claimed could compensate for the retardation caused by an arbitrary liquid crystal layer of any possible thickness and/or birefringence. Claim 1 defines a vertically aligned active-matrix LCD device which includes the feature of a vertically aligned liquid crystal layer and two compensation layers of the negative C-plate type ($n_x=n_y>n_z$) having a cumulative retardation value of less

than or equal to 160nm at an optical wavelength of 550nm. Claim 1 does not, however, include a feature specifying a particular value for the optical retardation of the vertically aligned liquid crystal layer. The description discloses an optical retardation of 240nm at a wavelength of 550nm. It is however well known that the overall retardation of the LC layer is a very critical parameter for the determination of the optimum net retardation of compensation films contained in an LCD device. Therefore, two compensation layers having a total retardation value of less than or equal to 160nm at an optical wavelength of 550nm are not applicable to LCD devices with a vertically aligned liquid crystal layer of any possible optical retardation without detrimental effects on the viewing angle characteristics of the LCD devices. In other words, it is unclear in the sense of Article 84 EPC how compensation films with a net retardation value within the claimed range could compensate for the retardation caused by an arbitrary liquid crystal layer of any possible thickness and/or birefringence. Hence, claim 1 is not acceptable under Article 84 EPC.

(b) Patentability

The examining division also considered patentability of any subject matter which, upon amendment, it considered could be clearly claimed.

In relation to a phase difference film being of reverse dispersion, the division was of the view that, as in the patent application (see Table 2: "Reverse dispersion $\lambda/4$ plate"), the phase difference films in the LCD device of document D7 are quarterwave plates

(see figure 4: "achromatic wide-view λ/4-plate"). Moreover, the wide view λ/4-plates included in the display device of document D7 are explicitly said to be "achromatic" (see figure 4) or "wideband" (see page 559, line 11). According to document D7, the quarterwave plates used thus have a relatively broad operating spectral bandwidth, which means that the optical retardation of said achromatic λ/4-plates is substantially linearly increasing with the wavelength λ at a slope of ideally 1/4 within said "wide" bandwidth. It is thus an inherent feature of the achromatic λ/4-plates of document D7 that they show an increased absolute value of phase retardation and birefringence with increasing wavelength. The latter dispersion characteristics are also referred to as anomalous or reverse dispersion characteristics. The explicit disclosure of the feature whereby the λ/4-plates used in document D7 are achromatic thus implies that said waveplates reveal an anomalous or reverse dispersion within said "wide" bandwidth. Each of the achromatic phase difference films included in the LCD device of document D7 (figure 4: "achromatic wide-view A/4-plate") therefore inherently also constitutes a reverse dispersion phase difference film.

Concerning inventive step, the examining division was of the view that a skilled person would obviously consider glass substrates as being suitable for forming transparent substrates. It would also be obvious to equip the display known from document D7 with a colour filter array.

Moreover, according to page 560, lines 1-30 and figure 5 of document D7 various different retardation films were used in order to optimise the viewing angle characteristics of the display device using computer simulations. It is known to those skilled in the art that the parameter of the retardation of the LC layer in the thickness direction is very critical for the optimisation of the retardation values of the optical compensation films employed. Provided that a specific retardation value of the LC layer in the thickness direction was given for the LCD device of document D7, the skilled person would thus obviously optimise the retardation of the employed compensation films for the given particular LC retardation value using the straightforward "trial-and-error" computer simulation process described in document D7. In doing so, the skilled person would, according to a first conventional approach suggested e.g. in document D2 (see paragraph [0094]), set the net retardation value (nx-nz)*d caused by all retardation films, including all optical layers positioned between the two outermost polarisers, contained in the display device of document D7 to be equal to that caused by the liquid crystal layer. The retardation values of the compensation films contained in the display device of document D7 alone is thus obviously different from the optical retardation of the liquid crystal layer in the thickness direction. The optical retardation in the thickness direction of a nematic liquid crystal layer of conventional vertically aligned LCD cells is typically of the order of hundreds of nanometres (e.g. between 250nm and 400nm according to paragraph [0019] of document D2; or between 200nm and 450nm according to figure 14 of Dl). An optical retardation of, for example, approximately 240nm in the

thickness direction for the liquid crystal layer of the LCD device of document D7 can thus be assumed. Retardation in the thickness direction of a polariser of, for example, -60nm (cf. e.g. paragraph [0093] of document D2) is also known. Hence, taking into account for example a negative retardation of 60nm caused by each of the two polarisers contained in the display device of document D7, the remaining net retardation to be compensated by said compensation films of document D7 would only be 120nm, i.e. the total retardation of 240nm caused by the LC layer minus twice the retardation of 60nm caused by each of the polarisers. Therefore, depending on the collective retardation of the remaining optical layers different from said compensation films arranged between the two outermost polarisers of the display device of document D7, and assuming that the liquid crystal layer of the LCD device of document D7 causes a retardation of e.g. 240nm in the thickness direction, the skilled person would arrive at an optimum collective retardation value of equal to or less than 160nm for the compensation films.

The fact that either uniaxial or biaxial compensation films were disclosed in document D7 would not have inhibited the skilled person from selecting the former in order to achieve high contrast under oblique viewing directions by compensating for the birefringence of the liquid crystal layer.

V. The appellant requested that the decision under appeal be set aside and a patent granted on the basis of claims according to a main, first (both submitted with the statement of grounds for appeal) or second

auxiliary request (submitted by letter dated 21.01.2010). Oral proceedings were also requested as a precautionary measure.

The case of the appellant can be summarised as follows.

Article 123(2) EPC

Claim 1 of the Main Request has been amended to a much narrower range of retardation values, namely 75-85nm. This was the range of claim 5 of the application as filed. Although at first sight that claim may appear to be restricted to a single film, the dependence of claim 8 on claim 5 in combination with the language of claim 8 makes it clear that the "single" film of the claims as filed may be made up of more than one layer. It is apparent from the description that these two layers can be nothing more than the first and second compensation films. Of course, this highly confusing use of "single" has not been adopted in the amended claim which instead uses the more natural language "two". A further basis is that the embodiment of table 2 shows a C-plate having retardation of 8Onm, the present amended claims being nothing more than "about 8Onm" expressed clearly. 80nm, which is a number with one significant figure, is in fact the same as 75 to 85nm. Further basis may be seen in Claim 24 as filed which requires a plurality of films which together have a retardation value of l6Onm. The only such example contained in the application is example 9 which has two films each with a retardation value of 80n m.

Article 84 EPC 1973

It is clear from the application as filed that the intention was never to limit to the specific retardation value of the liquid crystal of 240nm. It is nevertheless true that the embodiments described do indeed use a retardation value of 240nm for the liquid crystal layer. Nevertheless, the fact that the embodiments described all have the same value of this parameter does not in any event mean that there is no support for other values. The reason for the use of similar parameters in each of the many embodiments disclosed is so that the properties measured can be compared. If parameters of the liquid crystal itself varied between the different measurements taken, it would not be possible to compare the many graphs with different numbers and thicknesses of C-plates as presented in Tables 3, 4, 5 and 6. Therefore the specific value suggested by the Examining Division is not an essential feature of the invention and accordingly should not be added to the claims. Thus, the omission of a precise and specific value of 240nm does not render claim 1 according to the first auxiliary request lacking in clarity.

Novelty and Inventive Step

The order of the features of the claim according to the second auxiliary request has been moved to put the claim into the two-part form based on document D7 and the feature of the optical retardation of the liquid crystal layer being 240nm has been included. Included in the characterising part of the claim are the features identified by the examining division as being

novel in the Decision to refuse and also the recitation of the phase difference film being of negative dispersion.

The examining division alleged that the phase difference films in the LCD device of document D7 inherently constitute a reverse dispersion phase difference film, but the appellant cannot agree that "wideband" λ/4-plates inherently means that an increased absolute value of phase retardation and birefringence with increasing wavelength is shown (i.e. they have the characteristic of reverse dispersion). "Wideband" can only unambiguously mean that the λ/4-plates have a relatively broad operating spectral bandwidth. No inference can be made about how the absolute value of phase retardation and birefringence changes with wavelength simply from the fact the λ/4-plates are "achromatic" or "wideband". Indeed, since general dispersion characteristics are opposite to those of reverse dispersion, it cannot be directly and unambiguously derived from the disclosure of document D7 that the λ/4-plates constitute a reverse dispersion phase difference film. The claimed combination of the compensation film(s) and reverse dispersion phase difference film(s) provides an improved isocontrast curve and/or viewing angle. Thus, the claimed combination of films addresses the problem of improving the viewing angle of an LCD device particularly for off-axis viewing. Accordingly, when starting from document D7, a skilled reader would not be able to devise the claimed arrangement of films in a straightforward manner.

The values of retardation claimed bring specific benefits as may be seen from Tables 5 and 6 of the application as filed. For example a significantly better viewing angle is obtained in cases 8 and 9 of both Tables 5 and 6 compared with the other cases. In particular, case 9 has the best viewing angle for reflective viewing (table 5) than other values and also good transmissive properties (table 6). These transmissive properties have better viewing angles than case 3 in table 4. Accordingly, the data shows that the specific values chosen give the best transflective display. The first two sentences of paragraph [0067] of the application as published describe how tables 5 and 6 show improvement up to a retardation value of l60nm and then deterioration, exactly the range now claimed. Document D7 does not teach the use of uniaxial films alone, but it vaguely merely refers to uniaxial or bi-axial films, with no particular teaching at all of which type of film is used, how many films are used or suitable values for their retardation. Accordingly, the skilled person starting with document D7 would not know to use specifically uniaxial films instead of the bi-axial films also mentioned in this document. Although it is true that at page 560 document D7 does suggest using retardation films to compensate the angular dependence of the dark state, there is simply no teaching of how this is to be achieved. It is not a simple matter of routine experimentation to arrive at the requirement of two films with values of retardation as now recited in the amended claim which give optimal results as demonstrated by the data in the application as filed.

Therefore, the subject matter of claim 1 is not only novel but also involves an inventive step.

VI. Oral proceedings were appointed by the board. In a communication attached to the summons, the board informed the appellant as follows.

Article 123(2) EPC 1973

Claim 4, as originally filed, was explicitly limited to a single uniaxial compensation film and claim 5, which is dependent therefrom, refers to the uniaxial compensation film (i.e. Tables 3 and 4). The reference to any preceding claim in dependent claim 8 as originally filed (seemingly Tables 5 and 6) is thus inconsistent with claim 4 and, accordingly, would not appear to offer any support for two compensation films of 75-85nm as recited in amended claim 1 of the main request. It seemed indeed that case 3 in Table 3 (one 80nm film) is considered best. Moreover, the submission that 75-85nm amounts to nothing more than about 80nm, to a value of one significant figure expressed clearly, did not seem to amount to adequate support for the specific figures claimed.

Article 84 EPC 1973

It seemed the examining division was correct about the overall net retardation being dependent not just on the compensation films but also on the other components of the cell, especially the liquid crystal. What can be understood from the application is only that if the compensation film is either too thin or too thick, it is not satisfactory (see the discussion following the

tables). Specific values like those claimed do not therefore seem clear unless tied to the LC retardation.

Article 56 EPC

It thus seemed that only the subject matter of claim 1 according to the second auxiliary request could reach the stage of being considered for its substantive patentability. It seemed here also that the examining division was correct to argue that it is routine to optimise the retardation films. Therefore, assuming the problem solved by the claimed features novel over document D7 were to provide an improved display device, it would have been obvious to optimise the retardation films. Accordingly, the board doubted whether any inventive step was involved in the subject matter claimed.

VII. The appellant informed the board ahead of the oral proceedings of its intention not to attend.

VIII. The independent claims according to the requests of the appellant are worded as follows.

Main Request

"1. A vertically aligned liquid crystal display device consisting of:
a liquid crystal layer (3) disposed between glass substrates (1, 2), with a common electrode and a pixel electrode coupled to the glass substrates;
at least one uniaxial compensation film (14) coupled to at least one of the glass substrates,

at least one polarization film (22) coupled to the at least one compensation film;
at least one phase difference film (15), located between one film of the at least one compensation films and one polarization film; and
wherein one glass substrate (1) is a TFT panel including a thin film transistor array having a plurality of transistors with gate electrodes connected to gate lines (121), a plurality of silicon layers and a plurality of source electrodes connected to data lines and intersecting the gate lines, a passivation layer (180) formed on the thin film transistor array and having an uneven surface with protrusions and depressions, and a plurality of pixel electrodes (190) connected to the drain electrodes of thin film transistor array and including a reflective electrode made of a reflective material;
characterised in that each of the at least one compensation films has $n_x=n_y>n_z$ for x, y in the plane of the film and there are two compensation films having a total retardation value more than or equal to 75nm and less than or equal to 85nm for light having a wavelength of 550nm;
the phase difference film (15) is a reverse dispersion phase difference film; and
the other glass substrate (2) is a color filter array panel having color filters (230) and a common electrode (270); and
the long axes of liquid crystal molecules are oriented orthogonal to the glass substrates in the absence of an electric field."

First Auxiliary Request

"A vertically aligned liquid crystal display device consisting of:
a liquid crystal layer (3) disposed between glass substrates (1, 2), with a common electrode and a pixel electrode coupled to the glass substrates;
at least one uniaxial compensation film (14) coupled to at least one of the glass substrates,
at least one polarization film (22) coupled to the at least one compensation film;
at least one phase difference film (15), located between one film of the at least one compensation films and one polarization film; and
wherein one glass substrate (1) is a TFT panel including a thin film transistor array having a plurality of transistors with gate electrodes connected to gate lines (121), a plurality of silicon layers and a plurality of source electrodes connected to data lines and intersecting the gate lines, a passivation layer (180) formed on the thin film transistor array and having an uneven surface with protrusions and depressions, and a plurality of pixel electrodes (190) connected to the drain electrodes of thin film transistor array and
including a reflective electrode made of a reflective material;
characterised in that each of the at least one compensation films has $n_x=n_y>n_z$ for x, y in the plane of the film and there are two compensation films having a total retardation value less than or equal to 160nm for light having a wavelength of 550nm;
the phase difference film (15) is a reverse dispersion phase difference film; and

the other glass substrate (2) is a color filter array panel having color filters (230) and a common electrode (270); and
the long axes of liquid crystal molecules are oriented orthogonal to the glass substrates in the absence of an electric field."

Second Auxiliary Request

"1. A vertically aligned liquid crystal display device consisting of:
a liquid crystal layer (3) disposed between substrates (1, 2), with a common electrode and a pixel electrode coupled to the substrates;
at least one uniaxial compensation film (14) coupled to at least one of the substrates,
at least one polarization film (22) coupled to the at least one compensation film;
at least one phase difference film (1 5) located between one film of the at least one compensation films and one polarization film; and
the long axes of liquid crystal molecules are oriented orthogonal to the glass substrates in the absence of an electric field;
wherein one substrate (1) is a TFT panel including a thin film transistor array having a plurality of transistors with gate electrodes connected to gate lines (121), a plurality of silicon layers and a plurality of source electrodes connected to data lines and
intersecting the gate lines, a passivation layer (180) formed on the thin film transistor array
and having an uneven surface with protrusions and depressions, and a plurality of pixel electrodes (190)

connected to the drain electrodes of thin film transistor array and
including a reflective electrode made of a reflective material;
characterised in that:
the substrates (1,2) are glass;
the optical retardation of the liquid crystal layer is 240nm for light having a wavelength of 550nm;
each of the at least one uniaxial compensation films has $n_x=n_y>n_z$ for x, y in the plane of the film and there arc two uniaxial compensation films having a total retardation value less than or equal to to (sic) 160nm for light having a wavelength of 550nm;
the phase difference film (15) is a reverse dispersion phase difference film; and
the other glass substrate (2) is a color filter array panel having color filters (230) and a common electrode (270); and (sic)"

Note: Obvious errors have been marked (sic) by the board, the first being repeated word "to" and the second "; and" instead of ".", consequent to the last feature of the claims according to the main and auxiliary request being moved to lines 13-15 in the second auxiliary request.

IX. Oral proceedings took place in the absence of the appellant and, at the end thereof, the board gave its decision.

Reasons for the Decision

1. The appeal is admissible.

2. Main Request - Added Subject Matter

2.1 The feature in claim 1

"there are two compensation films having a total retardation value more than or equal to 75nm and less than or equal to 85nm for light having a wavelength of 550nm"

is alleged to have been disclosed in the application as filed.

2.2 As the board pointed out in its communication, claim 4, as originally filed, was explicitly limited to a **single** uniaxial compensation film and claim 5, which is dependent therefrom, refers to **the** uniaxial compensation film. The reference to any preceding claim in dependent claim 8 as originally filed is thus, if interpreted as done by the appellant, inconsistent with claim 4 and, accordingly, would not appear to offer any support for **two** compensation films of 75-85nm as recited in amended claim 1 of the main request. Single means single, the board sees no reason why it is more natural to refer to two. The only reference to 75-85nm in the documents as filed occurs in claim 5 and the appellant has not identified any disclosure in the description from which the feature mentioned in point 2.1 can be directly and unambiguously derived.

2.3 The appellant argued that the only example in the application of a plurality of films which together have a retardation value of 169nm is example 9 with two filters of 80nm. Neither this nor the contention that 80 is 75-85 to one significant figure can be considered to disclose the range 75-85 as figures in the range other than 80 are simply not present in the documents as originally filed.

2.4 The appellant did not respond to the negative comments of the board in the summons in relation to the feature mentioned in point 2.1, nor has the board itself found any reason to change its view. Accordingly, the board reached the conclusion that the feature mentioned in point 2.1 relates to added subject matter so that Article 123(2) EPC cannot be considered satisfied.

3. First Auxiliary Request - Clarity

3.1 As the board pointed out in its communication, it considered the examining division was correct about the overall net retardation being dependent not just on the compensation films but also on the other components of the cell, especially the liquid crystal. Insofar as arguing that if parameters of the LC vary, different C-plate thicknesses cannot be compared, the argument of the appellant can even be seen as confirming the analysis of the examining division. What can be understood from the application is only that if the compensation film is either too thin or too thick, it is not satisfactory (see the discussion following the tables). Specific values like those claimed are not therefore clear unless tied to the LC retardation as

what is too thick/thin for one retardation is not that for another.

3.2 The appellant did not respond to the negative comments of the board in the summons in relation to clarity, nor has the board itself found any reason to change its view. Accordingly, the board reached the conclusion that claim 1 according to the first auxiliary request cannot be considered clear within the meaning of Article 84 EPC 1973.

4. Second Auxiliary Request - Patentability

4.1 This claim has features rearranged into the two part form with respect to the claim before the examining division. In relation to the preamble of claim 1, the board sees no reason to question the agreed view of the examining division and appellant about features other than the reverse dispersion films lacking novelty over the disclosure of document D7.

4.2 Reverse dispersion films

The approach of the appellant disputes the analysis of the examining division in relation to the phase difference film as concerned with use of reverse dispersion $\lambda/4$-plates. However, the skilled person knows that retardation is given by Δnd and that a film has a given thickness. Consequently, as the examining division explained the disclosure of document D7 implies that the $\lambda/4$-plates exhibit reverse dispersion. The counter approach of the appellant exhausted itself in disagreeing with the examining division by remarking that wideband can only unambiguously mean the $\lambda/4$-plates

have a relatively broad operating spectrum and there are other opposite dispersion film types. The appellant did not, however, explain why the analysis of the examining division about implicit disclosure is wrong nor was any counter argument submitted, for example, explaining why plates with such opposite dispersion characteristics function in the teaching of document D7. Accordingly the board had to consider the approach of the appellant to amount merely to an allegation which it did not find persuasive against the analysis advanced by the examining division. Therefore, the board considers the division to have been correct about the lack of novelty of the feature.

4.3 The negative view of the examining division in respect of inventive step of features concerning glass substrates and colour filters has not been disputed by the appellant.

The remaining novel features of the claim relate to

(1) the optical retardation of the liquid crystal layer being 240nm for light having a wavelength of 550nm; and
(2) there are two uniaxial compensation films having a total retardation value less than or equal to 160nm for light having a wavelength of 550nm.

The appellant has included a feature concerning at least one uniaxial compensation film in the preamble of the claim, but also sees the choice of uniaxial films as contributing to inventive step over document D7.

4.4 As the board set out in the summons, the problem addressed by the claimed features novel over document

D7 was to provide an improved display device. The solution amounts to optimising the compensation to the LC retardation. As also set out in the summons, the board considers the examining division to have been correct in its analysis, attention can be focussed in particular onto the LC retardation of 240nm and the derivation of <= 160nm for the compensation films in that analysis, which the appellant did not dispute in its appeal submissions. The analysis has therefore been taken as valid by the board.

4.5 The approach of the appellant related more to superficial features such as providing two films, this approach being supported by comparing example 9 at 160nm (=two films of 80nm) with some other cases in the application. In the board's view, example 9 only confirms as correct the analysis of the examining division that a retardation value of equal to or less than 160nm for the compensation films as arrived at by the skilled person from document D7 would indeed have resulted from an optimisation as discussed by the division. Further confirmation is provided by the description itself, which, as mentioned in the summons, describes example 3 (only one film at 80nm) as having the optimal characteristics (see paragraph 0059 of the "A" publication). Thus, no contribution to inventive step is made by the number two of films used, as, just as the examining division argued, it is the retardation of the LC layer in the thickness direction and the effect of other components which are taken into account and critical for the optimisation of the retardation values of the optical compensation films employed. Likewise, in view of the disclosure of uniaxial or biaxial films in document D7, the board does not share

any view of the appellant that use of the former can be considered to involve an inventive step.

4.6 Therefore, the board reached the conclusion that the subject matter of claim 1 according to the second auxiliary request could not be considered to involve an inventive step within the meaning of Article 56 EPC 1973.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar The Chairman

L. Fernández Gómez A. G. Klein