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D E C I S I O N
of 5 February 2002

Case Number: T 0199/99 - 3.3.5

Application Number: 93115683.0

Publication Number: 0645348

IPC: C03C 3/078

Language of the proceedings: EN

Title of invention:
Optical glass

Patentee:
KABUSHIKI KAISHA OHARA

Opponent:
Schott Glas

Headword:
Optical glass

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0199/99 - 3.3.5

D E C I S I O N
of the Technical Board of Appeal 3.3.5
of 5 February 2002

Appellant: (Proprietor of the patent)
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Respondent: (Opponent)
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Representative:
-

Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 30 December 1998 revoking European patent No. 0 645 348 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: R. K. Spangenberg
Members: M. M. Eberhard
M. B. Günzel

Summary of Facts and Submissions

I. European patent No. 0 645 348 was granted on the basis of one claim. This claim reads as follows:

"An optical glass consisting of in weight percent:

SiO_2	48-65%
TiO_2	21-30%
$Na_2O + K_2O$	10-30%
in which Na_2O	0-25%
K_2O	5-30%
$MgO + CaO + SrO + BaO + ZnO$	2-15%
in which $MgO + CaO$	0-4%
and in which MgO	0-4%
CaO	0-4%
SrO	0-10%
BaO	0-15%
ZnO	0-10%
Nb_2O_5	0-2%
Al_2O_3	0-2%
ZrO_2	0-2%
Li_2O	0-2%
WO_3	0-5%
As_2O_3	0-1%
Sb_2O_3	0-1%

and having a refractive index (Nd) of 1.58-1.75 and Abbe number (íd) of 28-45."

II. The respondent (opponent) filed a notice of opposition requesting revocation of the patent on the ground of lack of inventive step with respect to US-A-2 554 952 (D1) and FR-A-2 320 031 (D2).

III. The opposition division held that the subject-matter of amended claim 1 according to the main request filed on

8 December 1998 lacked an inventive step. In view of the teaching of D1, the skilled person would have seriously contemplated using up to 25-30 wt% TiO_2 in the glass of D1 in order to prepare glasses with a very high refractive index. In D2 the amount of TiO_2 was 21 wt% and 26 wt% in examples I and II even in the presence of ZrO_2. The content of 46% silica in example I was not far removed from the lowest limit of 48% stated in claim 1. ZrO_2 and Nb_2O_5 were optional components. As potential advantages associated with the deletion of ZrO_2 were not invoked by the appellant, the claimed optical glasses could not even be considered to result from a selection invention.

IV. The appellant lodged an appeal against this decision and submitted an amended claim 1 with the grounds of appeal as well as comparative transmittance curves. In reply to a communication from the board, the appellant filed two amended claims with his letter dated 21 December 2001 as the main request and the first auxiliary request. Claim 1 of the main request differs from granted claim 1 in that the optional constituents Al_2O_3, ZrO_2, Li_2O, WO_3 and As_2O_3 are deleted and the following transmittance characteristics have been introduced at the end of the claim: "**and a light transmittance of 80% in a specimen of glass having two polished surfaces and thickness of 10mm in the range of 380 to 295nm**". Oral proceedings took place on 5 February 2002.

V. The appellant requested that the decision under appeal be set aside and that the patent be maintained with claim 1 of the main request filed with his letter of 21 December 2001 and a description as adapted by pages 3 and 4 filed during the oral proceedings. As an

auxiliary request, he requested maintenance of the patent with claim 1 and the description of the auxiliary request both submitted with the letter dated 21 December 2001. The respondent requested that the appeal be dismissed.

VI. The appellant's arguments can be summarised as follows:

D1 was an old document concerning a glass for use in glass reflectors for illumination and not an optical glass for lens systems for which specific values of refractive index and Abbe number were required. It was not the appropriate starting point for assessing inventive step. The content of 25-30 wt% TiO_2 disclosed in D1 was expressed with respect to the silica and this amounted to an upper limit of 22.5 wt% in the glass. The substitution rules disclosed in D1 were not clear and contained inconsistencies. The sole clear teaching was the composition stated in the claim of D1. According to D1 the most desirable glasses were produced when no more than 15% of each of TiO_2 and ZrO_2 was used. The re-working of the glass composition of D1 showed that the transmittance value was not satisfactory. As D1 warned against using too a high amount of TiO_2 in the glass because of the yellow colouration and the unworkability, the skilled person would have been led away from using a high TiO_2 content. As shown by the comparative transmittance curves, the glasses of D2 exhibit a very low transmittance compared to the claimed glasses. It could be inferred from examples I and II of D2 that ZrO_2 and Nb_2O_5 were necessary to obtain the desired values of refractive index and Abbe number. Although it was well-known that a quartz glass had a high transmittance, D2 gave no indication as to which component, in particular ZrO_2 or

TiO_2, had to be decreased when the silica content was increased. The skilled person would have expected both an increase of the silica content and the omission of ZrO_2 to decrease the refractive index and furthermore D1 disclosed a number of other possible substitutions. By the combination of the specific ranges stated in claim 1 for SiO_2, TiO_2, K_2O and BaO, it had been possible to provide a glass with the desired optical constants and exhibiting an excellent transmittance in the near UV and superior transmittance in the visible region notwithstanding the large amount of TiO_2.

VII. The respondent presented the following arguments:

Although D1 was an old publication, the skilled person would have considered it since it concerned lead-free glasses and disclosed substitution rules for improving colouration. The upper limit of 25-30 wt% TiO_2 was clearly expressed with respect to the total glass composition and not with respect to the silica; otherwise the composition given in column 3 and in claim 1 of D1 would not add up to 100%. The claimed glass was a selection from the broad TiO_2 content (10-30 wt%) and from the alkaline earth content (0-12.5 wt%) disclosed in D1. Both D1 and the patent in suit addressed the problem of obtaining a glass with a high refractive index. D1 warned against the use of a too high TiO_2 amount because of the colouration and taught a preferred amount of 15 wt%. However, it also gave instruction as to how the colouration could be avoided by further substitutions when using high amounts of TiO_2. In particular, it taught that the use of both K_2O and alkaline earths was mandatory. D1 was concerned with an optical glass as it dealt with the problem of increasing the refractive index of the

glass. A glass with a high refractive index for use in lamp reflectors was also suitable for use as an optical glass. With respect to D2 as the closest prior art, the claimed solution would also have been obvious to the skilled person. The skilled person faced with the problem of increasing the transmittance of the glasses of Examples I or II of D2 would have increased the silica content since it was well-known that quartz glass was a very clear glass with high transmittance. As a consequence he would have had to change the amounts of other constituents in order for the composition to add up to 100%. As ZrO_2 and Nb_2O_5 were optional in the glasses of D2, he would first of all have omitted these components. Doing this he would have arrived at the claimed glass at least with the glass of example I. As the refractive index of example I of D1 was relatively high he would have expected the index of refraction to remain in the desired range when omitting ZrO_2 and Nb_2O_5. There was enough space between the value 1.66 reported in example I of D2 and the claimed value of 1.58.

Reasons for the Decision

1. The appeal is admissible.

2. The amendments in claim 1 of the main request and in the description meet the requirements of Article 123(2) and (3) EPC. The deletion of Al_2O_3, ZrO_2, Li_2O, WO_3 and As_2O_3 is allowable since according to the application as filed (see page 5, second paragraph) and the granted patent (see page 3, line 57 to page 4, line 2) these components are optional. The additional features concerning the transmittance are disclosed in the

application as filed, page 7, last paragraph, corresponding to page 4, lines 7-10, of the patent in suit. The scope of protection of claim 1 has not been extended with respect to that of claim 1 as granted.

3. The optical glass of claim 1 according to the main request is new over the disclosure of either of D1 and D2. This was not in dispute at the appeal stage so that detailed reasons for this finding are not necessary.

4. The question arises which of D1 and D2 represents the closest prior art. The glass composition as claimed in D1 might be considered to have more features in common with the claimed composition than the glass compositions of D2. However, D1 concerns a glass for use in glass reflectors for illumination and discloses only the refractive index of the glass, whereas D2 concerns an optical glass for use in spectacles and accordingly reports both the refractive index and the Abbe number which are usually used for characterising optical glasses. Under these circumstances the board considers that D2 is a more appropriate starting point for assessing inventive step than D1. However, the outcome of the decision would not be changed if D1 were taken as the closest prior art (see points 4.3 and 4.4 hereinafter).

4.1 D2 discloses a lead-free glass composition suitable for spectacles, having a high refractive index of from 1.65 to 1.75 and a low specific gravity of about $3g/cm^3$. It contains (in weight %) SiO_2 36-47, Li_2O 0-2, Na_2O 0-14, K_2O 3-17, CaO+Bao+SrO 6-14, TiO_2 20-30, ZrO_2 0-3.5, Nb_2O_5 0-3.5. The three exemplified glasses have an index of refraction of 1.66, 1.70 and 1.75 and an Abbe number of 33.7, 30.3 and 26.6 respectively. The preferred glass,

ie that of example II, contains (expressed in wt%) SiO_2 41.0, Na_2O 7, K_2O 10, BaO 10, TiO_2 26, ZrO_2 3.5, Nb_2O_5 2.5. The reproduction of the glasses of examples I to III by the appellant and the measurement of the transmittance between about 330 and 700nm (see the transmittance curves submitted with the grounds of appeal) show that their transmittance in the near UV region and in the visible region is not satisfactory.

Starting from D2, the technical problem underlying the claimed glass composition can been seen in the provision of a lead-free glass having the same optical constants (refractive index Nd and Abbe number íd) as a lead-containing glass while exhibiting an improved transmittance in the near UV region and in the visible region.

It is proposed to solve this problem by the optical glass as defined in claim 1. The claimed composition differs in particular from those of examples I and II of D2, which have values of refractive index and Abbe number falling within the claimed ranges, in that the SiO_2 content is higher, the Nb_2O_5 content is lower and ZrO_2 is omitted. The transmittance curves submitted by the appellant show that the claimed glass has a higher transmittance than the glasses of examples I, II and III of D2 as well in the near UV region (380-400 nm) as in the visible region. In view of the examples of the patent in suit and of these comparative transmission curves, the board considers it credible that the problem stated above has actually been solved by the optical glass defined in claim 1. This was not disputed by the respondent.

4.2 D2 itself does not deal with the problem of improving

the transmittance of the glass in the near UV and visible regions of the spectrum and contains no indication as to how this improvement might be achieved. The appellant argued that the skilled person would have increased the SiO_2 content of the glass of D2 in order to improve its transmittance since it was well-known that a quartz glass has a very high transmittance. Assuming that the skilled person would actually have contemplated increasing the silica content of the glass in examples I or II of D2 on the basis of the said uncontested general knowledge, then he would have had several possibilities. He could have left the amounts of the remaining components unchanged and then the re-calculated relative amounts of each of the remaining components expressed in wt.% would have been lower. However this would not have led to the claimed glass since the latter contains no zirconia. As a further alternative, the skilled person could have decreased the amount of one or two of the remaining components so as to compensate the increase of silica. However, D2 contains no instruction as to which of the remaining components might be decreased. The respondent argued in this respect that the skilled person would have omitted ZrO_2 and Nb_2O_5 from the glass composition of example I since these two components were optional. These arguments are not convincing taking into consideration the additional teaching in D1 about the effect of the constituents TiO_2, ZrO_2, BaO and K_2O either on the refractive index or on the colouration of the glass, ie on its transmittance in the visible region.

D1 starts from a silica-soda lime glass and teaches that titania in amounts up to 30% produces progressively increasing index of refraction with a tendency toward yellow or amber colour, and zirconia in

amounts up to nearly 30% produces a greenish glass with moderate increase in index of refraction. While titania has more effect on the index than zirconia, it affects the colour of the glass tending to make it somewhat yellow but further investigations have shown that the substitution of barium oxide for some of the lime would make an improvement in the colour. The substitution of K_2O for some of the Na_2O would also make an improvement in the colour (see column 2, lines 11-29 and 52-54). Accordingly the formulations of the invention of D1 are based on the substitution of either ZrO_2 or TiO_2, or both, for SiO_2, the substitution of K_2O for part of the Na_2O, and the substitution of BaO or MgO in varying proportions for the CaO of the typical basic formula for a silica-soda-lime glass. D1 further discloses ranges for the alkali content, the alkaline earth content and the titania and zirconia contents in the substituted glass. According to column 3, lines 4-25, there would be at least 10% of titania or zirconia substituted for silica in order to have a sufficient effect on the index of refraction and the upper limit of zirconia and titania imposed by colour and unworkability of melt is in the region of about 25% to 30% for these elements singly or combined. The two oxides may be used in combination in percentages totalling up to about 30% and the most desirable glasses are produced when not more than 15% of each oxide is used. Excellent results are obtained from glass compositions employing 15% TiO_2, 9.5% BaO, 57.5% SiO_2 and 18% alkali, all of which may be Na_2O or up to 6% K_2O. The glass composition as claimed in the claim of D1 comprises SiO_2 57.5%, Na_2O 12%, K_2O 6%, BaO 9.5% and TiO_2 15%.

Therefore the skilled person would have inferred from

the teaching of D1 that the optimal or most desirable compositions resulting from the said substitutions are those in which the TiO_2 or ZrO_2 content is about 15%. In view of the warning in D1 that high amounts of titania or zirconia up to 25 or 30% produce a colouration of the glass and taking into account that after having performed the said substitutions the resulting optimal glass compositions of D1 contain only 15% TiO_2, the skilled person would have expected the high TiO_2 content of 21 or 26 wt% in examples I and II of D2 rather than the comparatively small amount of ZrO_2 (ie 3.5 wt%) to have a negative effect on the colouration of the glass and thus on the low transmittance values. Thus, assuming that the skilled person faced with the problem stated above would have contemplated increasing the silica content in examples I and II of D2, then he would have decreased the TiO_2 content of these glasses rather than omitting ZrO_2 because he would have expected this first measure to contribute to a greater extent to the improvement of the transmittance. Doing so, he would have gone in a direction which does not lead to the claimed glass composition. The fact that ZrO_2 and Nb_2O_5 are optional components in the compositions of D2 indicated on page 1 and in claim 1 is, under these circumstances, not sufficient to give the skilled person faced with the problem stated above an incentive to omit these components, all the more so since the ZrO_2- and Nb_2O_5-free glass of example III exhibits a relatively low Abbe number lying outside the desired range. Furthermore Na_2O is also optional in the glass of D2 and its content might have been decreased. Therefore, the appellant's arguments that the skilled person would have omitted the zirconia is based, in the board's judgement, on an ex-post facto analysis of the case, knowing which composition should be arrived at.

4.3 According to the respondent's re-working of the preferred glass of D1 (see Annex 1 to the letter dated 12 September 1997), the latter exhibits a refractive index and an Abbe number which both fall within the claimed ranges. Starting from D1 instead of D2 as the closest prior art, the problem to be solved by the claimed optical glass would have been to provide a lead-free glass having the same optical constants (refractive index and Abbe number) as a lead-containing glass while exhibiting an improved transmittance in the visible region of the spectrum.

In view of the examples in the patent in suit and of the comparative transmittance curves submitted by the appellant, it is credible that the said problem has actually been solved by the claimed glass. The latter differs from the glass disclosed in column 3, lines 26-29, and in the claim of D1 in that it has a much higher content of TiO_2 (21-30 wt% instead of 15%). D1 discloses a range of 0-12.5% for the content of alkaline earths and a range of 10-25% (or 30%) for the content of TiO_2 in the glass (see column 3, lines 1-13). The claimed glass differs from this glass at least by the selection of the titania content within the upper portion of the known range, which in combination with the specific ranges as defined in claim 1 for the alkaline and alkaline earths leads to the improved transmittance.

4.4 As already indicated above D1 warns against the use of too a high titania amount because of the tendency toward a yellow or amber colouration when increasing the titania content to up to about 25 to 30%. Although D1 discloses substitution rules in order to achieve an improvement of the colour and thus of the transmittance

in the visible region (see column 2 and column 3, second paragraph, already mentioned above), it discloses that the optimal glass contains not more than 15% TiO_2 and the preferred glasses obtained after application of the disclosed substitution rules contain 15% TiO_2, 9.5% BaO, 57.5 SiO_2 and 18% alkali, all of which may be Na_2O or up to 6% K_2O. Therefore, the skilled person would not have expected a glass with a much higher titania content to have less colouration or a higher transmittance in the visible region. Thus, he would not have been encouraged to make experimentation in this direction. Although D2 discloses optical glasses having the desired refractive index and Abbe number and containing 21 and 26 wt% TiO_2, this document is completely silent as to the transmittance of these glasses and therefore it could not give the skilled person an incentive to increase the titania content of the glasses of D1 in order to improve their transmittance in the visible region. Furthermore, by reproducing the preferred glass of D2 (ie example 2) the skilled person would have noticed that its transmittance characteristics in the near UV region and in the visible region are inferior to those of the preferred glass of D1.

5. It follows from the above that the subject-matter of claim 1 of the main request meets the requirement of inventive step set out in Articles 52(1) and 56 EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division with the order to maintain the patent with claim 1 of the main request filed with the appellant's letter dated 21 December 2001 and the description of the patent as granted except for pages 3 and 4 which are replaced by amended pages 3 and 4 filed during the oral proceedings.

The Registrar: The Chairman:

P. Martorana R. Spangenberg