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D E C I S I O N
of 8 May 2003

Case Number: T 0976/01 - 3.2.3

Application Number: 93111867.3

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Language of the proceedings: EN

Title of invention:
Lighting device

Patentee:
MAGNETI MARELLI S.p.A.

Opponent:
Mannesmann VDO AG

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
"Novelty and inventive step - yes"

Decisions cited:
-

Catchword:
-

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Case Number: T 0976/01 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 8 May 2003

Appellant: (Opponent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 11 July 2001 rejecting the opposition filed against European patent No. 0 584 546 pursuant to Article 102(2) EPC.**

Composition of the Board:

Chairman: C. T. Wilson
Members: U. Krause
M. K. S. Auz Castro

Summary of Facts and Submissions

I. The appeal contests the decision of the Opposition Division dated 7 June 2001 and posted on 11 July 2001 to reject the opposition against European patent EP-B-0 584 546. The opposition was based on the grounds of Article 100(a) EPC, lack of novelty and inventive step. The single independent claim 1 of the patent as granted reads as follows:

"1. Lighting device comprising a block of transparent material (1) delimited by a pair of opposite surfaces, a front surface (3) and a rear surface (2), and a source of light radiation (4) located between the planes bearing said surfaces; characterized in that said surfaces are convergent away from said light source (4), diffraction means (5) being located on said rear convergent surface (2) so that the light rays coming from said source are incident on said diffraction means and then emerge towards said front convergent surface (3); said diffraction means (5) being of the type with phase modulation having reliefs of any profile which will give a high efficiency value."

II. The Appellant (Opponent) filed the notice of appeal on 29 August 2001 and paid the appeal fee on the same day. The statement of the grounds of appeal was submitted on 16 November 2001.

On 16 September 2002 the Board issued a communication pursuant to Article 11(2) RPBA informing the parties about its provisional assessment of novelty and inventive step. In response to this communication the Respondent (Proprietor of the patent) filed on 8 April

2003 a set of amended claims 1 to 9 as auxiliary request.

Oral proceedings were held on 8 May 2003.

III. The following prior art was taken into consideration:

D1: EP-A-0 452 815

D2: "High Efficieny Back Light for LCD", IBM Technical Disclosure Bulletin, Vol. 33, No. 9, February 1991, pages 261, 262

D3: US-A-4 257 084

D4: US-A-4 714 983

D5: DE-C-905 448

D6: US-A-4 487 481

D7: A.M.Blumenfeld and S.E.Jones, "Parts That Glow", Machine Design, 29 October 1959, pages 94 to 103

D8: McGraw-Hill Encyclopedia of Science and Technology, Vol. 4, 1960, pages 132, 139

D9: a collection of documents comprising

- Webster Dictionary of English Language, pages 630 and 732
- Engineering Encyclopedia page 192
- "Metallurgy and Metallography", page 26

D10: Enzyklopädie Naturwissenschaft und Technik, Verlag Moderne Industrie 1979, vol. 1, pages 458 and 459

D11: Bergmann-Schäfer, Lehrbuch der Experimentalphysik, 8th edition, vol. 3, pages 416 to 419

D12: a collection of documents (submitted by the Respondent during the oral proceedings) comprising

- E. Hecht, "OPTICS", Third edition, copy of title page and one page with figure 5.63

- enlarged figure 2 of D2

- copy of brochure "3M/OPTICAL SYSTEMS RIGHT ANGLE BACKLIGHTING TECHNOLOGY, DESIGN AID"

IV. The Appellant requests that the decision under appeal be set aside and that the patent be revoked.

His arguments in support of this request can be summarized as follows:

The diffraction means defined in claim 1 could not be distinguished from light scattering means since in both cases the light was deflected by a surface with reliefs of any profile. Thus, claim 1 was anticipated by document D6 disclosing light scattering means (34) on the rear surface of the transparent block as shown in figure 6. A similar effect was described in D7 with respect to the debossed marks or "grid patterns" depicted in figure 2(c) of D7 which was distinguished from claim 1 only by comprising parallel surfaces, rather than convergent surfaces favouring uniform

illumination, as set out in columns 7 and 8 of D6. In any event, no inventive step could be recognised in a possible difference between any regular reliefs or pattern of the diffraction means and irregular reliefs of scattering means because the diffraction means were described in column 2, lines 15 to 25 of the patent as being of a known type and because the skilled person, knowing the superior characteristics of a reflective diffraction grating of the relief type from D10 and D11, would replace the scattering means of D6 by such a diffraction grating, thereby arriving at the subject-matter of claim 1. Likewise, D10 and D11 suggested to replace the micro-prism transmission diffraction grating of D2 by a more efficient reflective grating to be located on the rear surface of the light guide. An application of this technology to the field of lighting devices for vehicles was obvious in view of D1 which demonstrated the simple and compact structure obtained by using diffraction means instead of conventional optical means.

V. The Respondent requests that the appeal be dismissed, auxiliarily with the proviso that the patent be maintained on the basis of claims 1 to 9 filed on 8 April 2003.

He submits essentially the following counterarguments in favour of his main request:

In the patent the term "diffraction" defined, in the common physical sense as set out in documents D8, D9, D10 and D11, the deflection of incoming light with modified intensity into a selected direction at regular obstacles being of the order of magnitude of the wave length of the light, involving interference effects.

This was to be distinguished from scattering incoming light by diffusion for producing a diffuse illumination, as in documents D4, D5, D6 and D7, and from refracting the light at prisms, as in documents D2 and D3. In D2 refraction of the light was derivable from the deflection of individual light rays shown in figure 2 at the prisms, without any interference and modification of the intensity, and from the size of the micro-prisms which could be deduced from its relation to the air gap and from D12, diagram #1 on page 2 of the 3M document, to be in the order of .01 to .02 inch which was at least two orders of magnitude greater than the wave length of light. Further, in the patent a selection among the available diffraction means was made by referring to the "type with phase modulation having reliefs", defining reflection type diffraction gratings having a reflective profile, which are to be distinguished from gratings of the volume type as disclosed in D1. The invention consisted in a combination of the special type of diffraction means with its positioning on the rear surface of two inclined surfaces for redirecting directly incident light rays as well as light rays reflected at the front surface, to arrive at an efficient, structurally simple and compact lighting device having desired optical characteristics for vehicle lighting.

With regard to inventive step the documents relating to backlighting displays, such as D2, D4, D5 or D6, were not a suitable starting point because of the completely different lighting conditions to be met. In fact, these documents included scattering means, such as the thin scattering film of D2 or the light scattering and reflecting element (34) of D6, for providing a uniform diffuse background illumination which was incompatible

with the desired directed light flux provided by the diffraction means of the invention. In D2, since the micro-prism plate was separated from the light guide by an air gap and the light scattering film cooperated with the micro-prism plate by eliminating color aberrations, no modification of one of these elements, for example by transferring the micro-prism plate to the rear surface and making it reflective, was possible without altering the optical characteristics altogether. Thus, the appropriate starting point was D1 which, however, discloses a very specific arrangement of a volume hologram attached to the rear window of a car. This arrangement was bulky and could not be made compact, as achieved in the invention, by locating the diffraction means on the rear surface of a block of transparent material having two convergent surfaces, without giving up the concept of emitting the light from the rear window. Further, whilst relief type diffraction gratings were known from D10 and D11 to be used in the field of spectrometry, they were never applied to lighting devices and could not be used in the device of D1 requiring a transparent grating.

Reasons for the Decision

1. The appeal meets the requirements of Rule 65(1) EPC and is, therefore, admissible.

2. The admissibility of the opposition was disputed by the Respondent in the proceedings before the first instance but no further observations were submitted in the appeal proceedings. The Board has examined this issue ex officio and concurs with the finding in the decision under appeal that the opposition was sufficiently

substantiated so as to be admissible.

3. *Main request: Novelty*

3.1 The Appellant disputed novelty essentially by arguing that the diffraction means defined in claim 1 could not be distinguished from light scattering means since in both cases the light is deflected by a surface with reliefs of any profile, so that claim 1 was anticipated by document D6 disclosing light scattering means 34 on the rear surface of the convergent transparent block as shown in figure 6. This argument was already considered in the decision under appeal outlining the physical difference between scattering and diffraction, implying a corresponding difference in the structure. The Board cannot recognize any errors in this reasoning. In fact, it can be concluded from the detailed description of the diffraction phenomenon in documents D8, D9, D10 and D11 that, as pointed out by the Respondent, diffraction defines the deflection of incident light by interference into a selected direction at regular obstacles being of the order of magnitude of the wave length of the light, which is to be distinguished from scattering incident light into all directions on irregular obstacles and from refracting the light at the surface of obstacles, such as prisms, of a size which is substantially greater than the wave length of the light. Whereas diffraction and refraction may produce, dependent on the collimation and angle of the incident light, a collimated light flux having a selected direction, scattering will always result in a diffuse illumination.

3.2 The lighting device of claim 1 of the main request comprises diffraction means located on the rear

convergent surface of a block of transparent material so that light rays coming from the light source are incident on the diffraction means and then emerge towards the front convergent surface of the block. The diffraction means converts the incident light rays, which may come from the light source either directly or via total reflection at the front convergent surface, into a collimated light flux having a defined orientation. Further, claim 1 defines the diffraction means as "being of the type with phase modulation having reliefs of any profile which will give a high efficiency value". It is evident from the description of the available types of diffraction gratings in documents D10 and D11 that this partly structural and partly functional definition is met by a reflection type diffraction grating having a profiled reflective surface which may be produced by holography or in conventional manner by forming slits or rules in a reflective support. These reflection gratings, which according to D10 and D11 are preferred for their high diffraction efficiency in spectometry, are able to efficiently diffract light arriving within a comparably broad angle of incidence into a light flux of selected orientation which is suitable for use as a stoplight, headlight or other signalling device in vehicles.

3.3 Document D6 refers to a backlighted liquid crystal display. As set forth in the text in column 7, starting from line 35, for the embodiment of figure 6, light emitted from element (35) enters a transparent photoconductor (33) and is scattered at a lower convergent surface thereof covered by a "light scattering and reflecting element" (34) to be converted into a backlight beam illuminating the liquid crystal panel (32). The sloping lower surface serves the

purpose of producing a substantially uniform brightness and contrast throughout the area of the panel (see column 8, lines 32 to 43). Thus, it is clear that D6 is concerned with generating a substantially uniform diffuse illumination by scattering light, rather than with diffracting a light beam to produce a light flux of selected orientation, as in claim 1.

3.4 It follows from the definition of scattering and diffraction made in section 3.1 that documents D4 and D5, both relating to diffuse illumination of displays, do not exhibit diffraction means as defined in claim 1. Document D7 shows, in figure 2, a plurality of embodiments with embodiment (b) clearly relating to scattering, embodiments (c)and (d) relating to reflection at the flanks of debossed or embossed marks and embodiments (e) and (f) combining scattering and reflection.

3.5 The remaining documents D1, D2 and D3 comprise regularly profiled surfaces for deflecting the incoming light rays into a selected direction.

In D1, the surface (111) is a reflection, transmission or rainbow hologram structure which is described as diffracting the light propagated thereto via internal reflections within a rear window (see for example column 3, lines 31 to 41, and the description of figures 2 and 3 in column 5). Since the hologram is of a volume type, which is known from the description on pages 418 and 419 of D11 as being phase modulating but having a three-dimensional diffracting structure acting as reflection grating, it is different from the diffracting means of claim 1 having a profiled reflective surface.

In documents D2 and D3 the profiled surfaces (micro-prism plate of D2 and "diffusing surface" 4 of D3) are described by their structure as consisting of a large number of small prisms and by their function as deflecting the light into a selected direction. Both apply to diffraction and refraction which, as set out under point 3.1 above, are distinguished by the size of the regular obstacles, in this case of the prisms. Both documents are silent about this size so that it must be derived from the other information available in each case whether the prisms should be designed for refraction or diffraction. Regarding D2 the Respondent made reference to the 3M document in D12 showing, in diagram #1 on page 2, a "Right Angle Film (RAF)" having microprisms with a pitch of 0.014 inch, which considerably exceeds the wavelength of the light. This value cannot, however, be applied to D2 because there is no evidence that the micro-prism plate of D2 is identical with the "Right Angle Film" of the 3M document.

On the other hand, the enlarged picture of the light rays in figure 2 of D2, showing the light rays entering a prism of the micro-prism plate via an air gap and leaving it at the prism surface to be individually deflected at the inner and outer surface of the micro-prism plate without any interference effect, corresponds to the path of a light ray which is refracted at the transition from one medium to the other and therefore supports the assertion of the Respondent that the size of the prisms should be chosen so as to refract, rather than diffract, the light entering the micro-prism plate from the light guide into the selected direction. Further, the air gap separating the micro-prism plate from the light guide

is shown to be substantially thinner than the height and width of the prisms in the micro-prism plate. Since diffraction requires the dimensions of the prisms to be of the order of magnitude of the wavelength of light, ie 400 to 700 nm, this would suggest a gap width in figure 2 of about 100 nm. This would not seem to be technically feasible with light guides and plates having the extension of an LCD display.

It is noted, however, that the text on page 261 mentions interference with respect to a thin scattering film overlying the micro-prism plate which film is said to eliminate interference pattern of the micro-prism plate and the pixel arrangement pattern of the LCD display to be illuminated. This could be understood to relate either to interference patterns generated by the micro-prism plate and/or by the pixel arrangement individually or to interference patterns arising from illumination of the pixel arrangement by the deflected light from the micro-prism plate, ie by cooperation of the micro-prism plate with the pixel arrangement. The former meaning could be seen as indicating a deflection by diffraction which is based on interference. It appears, however, that elimination of the interference pattern would not make sense if a deflection based on the effect of interference is desired. Thus, the skilled person will understand this text in the sense of the latter meaning which is unrelated to the type of deflection at the micro-prism plate.

Thus, it is concluded that, taking the disclosure of document D2 as a whole, it teaches to design the micro-prism plate so as to refract the light coming from the light guide into the desired normal direction.

In document D3 the diffusing surface (4) is described as having prismatic "serrations" which will normally be understood as defining prisms of a visible or tangible size, as shown in the figures, which would be incompatible with the size requirements of diffraction gratings. A skilled reader of D3 will, therefore, conclude that the prisms are of a size so as to deflect the light by refraction.

3.6 In summary, none of the available documents discloses a lighting device as defined in claim 1 of the main request which, therefore, is considered to be new.

4. *Main request: Inventive step*

4.1 The lighting device of claim 1 is defined by a reflection type diffraction means of a relief type, ie having a profiled reflective surface, located on the rear one of two opposite convergent surfaces of a block of transparent material having a light source located between the planes of the convergent surfaces. In this manner the light rays emitted from the light source are incident, either directly or via reflection at the front convergent surface, on the diffraction means to be deflected with high efficiency towards the front convergent surface as a collimated light flux having a defined directional characteristic to be used as a stoplight, head light etc. In view of this clearly defined technical designation it is considered inappropriate to start from a document relating to an illumination of displays or marks by diffuse backlighting or edge lighting, such as documents D4, D5, D6 and D7. Thus, documents D1, D2 or D3 remain as possible closest prior art for assessing inventive step.

4.2 D1 discloses a holographic rear window stoplight comprising a light source which is optically coupled to the rear window through a prism attached to the lower part of the rear window, and a hologram which is likewise attached to the rear window at a higher level, whereby the light from the source is propagated by internal reflections within the rear window to the hologram for diffraction into a rearward light flux emitted from the rear window. Since any obscurations of the driver's rearward field of view must be avoided, the hologram must be transparent and the light source should be outside such field of view, using the rear window itself for transmission of the light from the light source to the hologram. This requirement can be met with the volume hologram described in D1 but excludes the diffraction means of the relief type defined in claim 1 which have an opaque profiled reflective surface. Furthermore, the diffraction means must be attached to the window itself and cannot be attached to a transparent block having convergent surfaces, as also defined in claim 1, which would distort the rearward view. Hence, the particular arrangement of D1 cannot be modified by including the distinguishing features of claim 1, ie diffraction means of the type with phase modulation having reliefs of any profile and locating the diffraction means on the rear one of two convergent surfaces including, between their planes, the light source, without giving up the core concept of emitting the light from the rear window. The skilled person would not, therefore, consider such a modification of D1 even if the distinguishing features were known *per se.*

4.3 Document D2 is comparable to documents D4, D5 and D6 in that it is also concerned with backlighting an LCD

display. In contrast to the diffuse backlight of these documents, however, it produces a backlight having a strong intensity distribution to the normal direction to the backlight surface by combining a micro-prism plate with an overlying thin scattering film. A light flux having this normal direction is obtained by refracting the light incident on the micro-prism plate from the edge-lighting type light guide, and a fraction of this directed light flux is scattered by the scattering film which is said to be "employed to eliminate interference pattern of the micro-prism plate and LCD's pixel arrangement pattern". Thus, this device is clearly designed for the specific purpose of backlighting an LCD display and will hardly be taken into consideration for producing a collimated light flux having a defined directional characteristic, as in the patent under appeal. Moreover, a replacement of the refracting micro-prism plate by available diffraction means as described in D1, D10 and D11 for deflecting the light to the normal direction, which in the case of the reflection grating of the relief type described in D11 would have to be moved from the front surface to the rear surface of the light guide, would in principle be possible but raise the question as to how this would affect the elimination of interference pattern by the scattering film. It is, therefore, believed that such modifications are theoretically possible but would require further considerations by the skilled person which would go beyond of what can normally be expected.

4.4 D3 relates to a light-projection device for digital instrumentation, the device comprising a transparent body having a rear mounting surface (5) and a first reflecting front surface (3) and a second "diffusing" front surface (4) with prismatic serrations for

deflecting the reflected light into a selected direction. Thus, this device is designed to generate a collimated light flux having desired optical characteristics, but any modification to replace the refracting prismatic serrations at the front surface by a reflecting diffraction grating of the relief type at the rear surface would be excluded by the fact that the light reflected at the first front surface does not impinge on the rear surface for deflection.

4.5 The Appellant argues that no inventive step could be recognised in a possible difference between any regular reliefs or pattern of the diffraction means and irregular reliefs of scattering means because the diffraction means were described in column 2, lines 15 to 25 of the patent as being of a known type and because the skilled person, knowing the superior characteristics of a reflective diffraction grating of the relief type from D10 and D11, would replace the scattering means of D6 by such a diffraction grating, thereby arriving at the subject-matter of claim 1.

This argument is not convincing because the skilled person knowing the diffraction means referred to in the patent is also aware of the differences between scattering means and diffraction means as regards the collimation of the light. Hence, he would not employ diffraction means, however efficient, if it is desired, as in the case of the light scattering and reflecting element (34) of D6, to produce a diffuse illumination of uniform intensity for backlighting a liquid crystal panel.

4.6 Since other combinations of the available prior art are even less indicated, the subject-matter of independent

claim 1 of the main request is considered to meet the requirement of inventive step. This also applies to the dependent claims referring to further developments of the device defined in claim 1.

5. *Auxiliary request*

Since the grounds of opposition do not prejudice maintenance of the patent on the basis of the claims as granted, it is not necessary to deal with the auxiliary request.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Dainese C. T. Wilson