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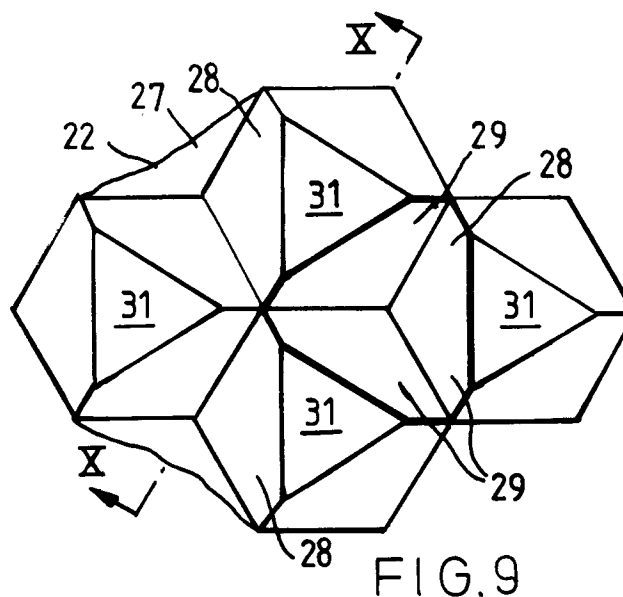
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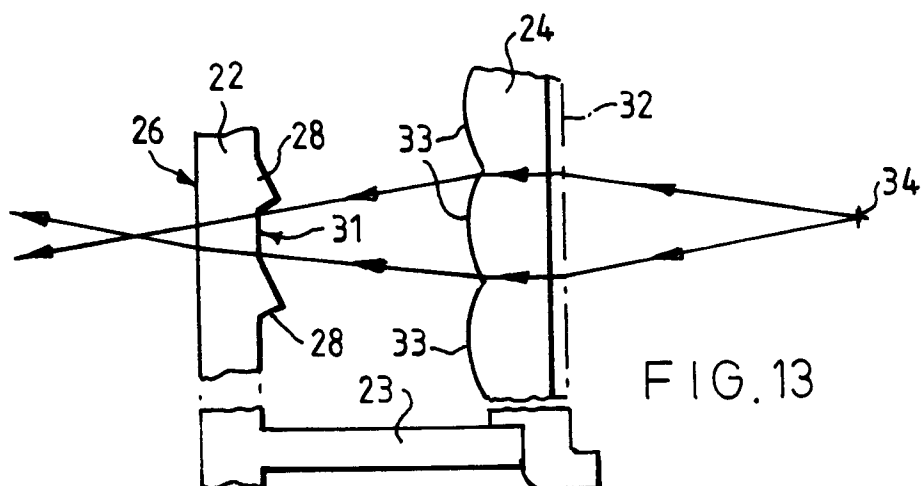
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(54) **Light transmission/reflector for vehicle tail lamp.**

(57) Light from a bulb (34) is focused by an optical plate (24), having an array of convex lens surfaces (33), onto a corresponding array of triangular co-planar light-transmitting regions (31) on one side of a tail lamp transmitter/reflector outer lens (22). The same side has a complementary array of cube corner reflecting cells (28).





This invention relates to vehicle tail lamps.

A vehicle is required by law to have a tail lamp which provides a red light to the rear at night. Another legal requirement is a rear reflector which shines red when illuminated by the headlights of a following vehicle. A brake light is also required, and it is common for the rear lamp assembly on each side of the vehicle to have transparent areas corresponding to a tail lamp, a reflector, and a brake light, and possibly a reversing light, an indicator, and a fog lamp.

In order to save space, it is known to incorporate the reflector into the tail lamp. That is, the light transmitting cover or lens of the tail lamp includes a reflector, in which case the cover can conveniently be termed a transmitter/reflector. Conventionally the light transmitting area is arranged directly behind a light bulb, and a reflecting area is provided in a region remote from the light beam from the bulb. However, it is also known (e.g. from GB-A-1552 577) to provide the reflector in the form of strips extending across the light-transmitting area. In this case, an optical plate serving as a plurality of cylindrical convex lenses is required to ensure that the light from the bulb is concentrated onto the light-transmitting strips between the reflector strips. This type of tail lamp is shown in Figures 1 to 7 of the accompanying drawings.

The known tail lamp comprises a light bulb 1 mounted in a housing 2 which carries a light transmitting (red) outer lens or cover 3 and an inner lens or optical plate 4. The outer surface 6 of the cover 3 is substantially planar and the inner surface 7 has relatively wide light-transmitting strips 8 alternating with narrow reflecting strips 9 extending transversely. Each reflecting strip 9 consists of a row of cube corners 11. Each intermediate light-transmitting strip 8 has concave grooves 12 for spreading the light coming from the bulb 1 via the optical plate 4.

The optical plate 4 has a convex fresnel lens surface 13 facing the cover 3 and a series of cylindrico-convex lens surfaces facing the bulb 1. As can be seen from the optical diagram of Figure 7, the light from the bulb 1 is focussed onto the light-transmitting strips 8 of the cover 3 by way of the optical plate 4. The light-transmitting strips 8 result in undesirably localised bands of light. Also, the overall thickness of the cover 3 has to be sufficiently great to accommodate the grooves 12 whilst providing sufficient mechanical strength for the cover 3. Hence, the thickness of the cover 3 in the areas of the light-transmitting strips 8 cannot be minimised, which reduces the overall illumination provided by the lamp, from the bulb 1, and, for some designs of lamp, makes it difficult to attain the required statutory level of lamp performance. Furthermore, the cover 3 is complicated (and therefore expensive) to manufacture, the moulding tool which defines the surface 7 being made up of a mosaic of pins, having many different forms of shaped and polished end surfaces, stacked side by side. The strip-like appearance of the tail lamp illumination, and of the light reflected from it, is undesirable from styling considerations, since it imposes a limitation on vehicle design.

It would therefore be desirable to provide a tail lamp with a reflector while avoiding or mitigating the problems outlined above.

The present invention provides a light transmitter/reflector for a vehicle tail lamp, comprising (a) an outer lens comprising a first sheet of transparent material having a first, outer side and a second, inner side opposite and generally parallel to the outer side, the second, inner side having a two-dimensional lattice of faceted cells which reflect light rays entering the first sheet through the first, outer side and having a complementary two-dimensional lattice of regions which transmit light rays entering the sheet from either side; and (b) an inner lens comprising a second sheet of transparent material having a rear side which faces the first sheet and a front side which is opposite to the rear side, one of the said sides of the second sheet having a two-dimensional lattice of convex lens surfaces which corresponds to the said lattice of light transmitting regions.

This arrangement enables one to distribute both the reflected and the transmitted light more uniformly over the area of the tail lamp. It is also possible to increase the reflective area without reducing the amount of light transmitted through the light-transmitting regions, thereby substantially improving lamp performance.

In a tail lamp incorporating such a transmitter/reflector, the inner lens focusses the light from a light source as individual beams which strike substantially only the light-transmitting regions of the outer lens.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a rear view of a tail lamp according to the prior art;

Figure 2 is a section on line II-II in Figure 1;

Figure 3 is an enlarged front view of part of the outer cover of the tail lamp shown in Figure 1;

Figure 4 is a section on line IV-IV in Figure 3;

Figure 5 is an enlarged front view of part of an optical plate in the tail lamp of Figure 1;

Figure 6 is a section on line VI-VI in Figure 5;

Figure 7 is an optical diagram of the tail lamp according to the prior art;

Figure 8 is a fragmentary front view (the inner side of) the outer light-transmitting and reflecting cover of a tail lamp according to the present invention;

Figure 9 is an enlarged front view of part of the inner side of the cover shown in Figure 8;

Figure 10 is a section on line X-X in Figure 9;

Figure 11 is an enlarged front view of part of an optical plate in the tail lamp according to the invention;

Figure 12 is a section on line XII-XII in Figure 11;

5 Figure 13 is an optical diagram of the tail lamp according to the invention; and

Figures 14 to 16 are views similar to Figure 9, for three further embodiments of the invention.

The light transmitting/reflecting tail lamp outer lens or cover 21 shown in Figure 8 is part of a one-piece combined cover made of transparent (red) plastics material. A first transmitter/reflector sheet 22 is delimited by an integrally moulded peripheral flange 23 for locating the periphery of an inner lens or optical plate 24 (Fig-
10 ures 11 to 13) comprising a second sheet of transparent (colourless) plastics material. The flange 23 ensures an accurate spacing between the sheets 22, 24.

The first sheet 22 has a first, outer side 26, with a substantially flat polished surface, and a second, inner side 27 which has a two-dimensional array or lattice of three-faceted cells 28 (one of which is boldly outlined in Figure 9) arranged in such a way that the cells in each group of three adjacent cells are located at points
15 which lie at the corners of an equilateral triangle.

Each cell 28 consists of a single cube corner, i.e. it has three facets 29 which are mutually orthogonal. A light ray which enters the sheet 22 (e.g. perpendicularly) through the outer side 26 and enters a faceted cell 28 will be reflected by the three facets 29 in sequence and leave the outer side 26 again in a direction substantially parallel to the incident direction. In the lattice the cells 28 are arranged along three axes at 120°. The
20 cell spacing along all three axes is the same and is equal to the dimension of the cell along the axis, i.e. the cells have three-fold rotational symmetry and are in mutual contact.

It will be seen from Figure 9 that the inner side 27 also has a two-dimensional lattice of co-planar triangular regions 31 which is complementary to the lattice of faceted cells 28, i.e. the two lattices are interposed and fill the side 27, with each triangular region 31 being defined by three adjacent cells 28. In this embodiment the
25 regions 31 are separate from one another and occupy a smaller proportion of the area of the inner side 27 than do the cells 28; in other words, the footprint of each cell 28 is larger in area than each triangular region 31.

The optical plate 24 has a front side with a convex fresnel lens surface 32 and a rear side with a hexagonal array or lattice of convex lens surfaces 33 which corresponds to the lattice of triangular regions 31. As can be
30 seen from Figure 13, a divergent light beam from a bulb 34 on the axis of the fresnel lens surface 32 is focussed by the optical plate 24 onto the triangular regions 31 alone, so that non-parallel rays emerge from the outer side 26 of the cover 22.

Because the light-transmitting regions 31 are uniformly and closely distributed over the area of the tail lamp, the illumination seen is substantially uniform. Similarly, because the retro-reflecting cells 28 are also uniformly
35 distributed over the area of the tail lamp, the reflected illumination also appears substantially uniform. Furthermore, although a major part of the area of the tail lamp is used as a reflector, illumination performance is not sacrificed, since the light projected forwards from the bulb through the optical plate is all transmitted through the triangular regions 31. Furthermore, as the regions 31 are interposed between the cells 28, i.e. bridging portions are provided by the cells 28, they do not weaken the sheet 22, and therefore the thickness
40 of the sheet can be minimised, ensuring that absorption of light, from the bulb 34, by the sheet 22 is kept to a minimum, while mechanical strength is maintained. Additionally, the mould for defining the inner side 27 of the sheet 22 can be made up using only two types of pin, which are relatively easy to fabricate and which can easily be stacked, owing to their regular prismatic shape. The sheet can therefore be manufactured at much lower cost than the strip-type sheet shown in Figures 1 to 4, while providing superior performance.

45 The following Table compares the reflective illumination provided by a transmitter/reflector as described above (Figures 8 to 10) with that provided by a typical transmitter/reflector according to the prior art (Figures 1 to 7), in a standard test carried out in accordance with ECE Regulation No. 3, EEC Directive 76/757/EEC in which a laser beam is aimed at the transmitter/reflector at various vertical and horizontal angles and the re-
flected illumination is detected by a photocell arranged at 20° and 1°30' to the incident beam.

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TABLE

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Angle of Divergence	Illumination Angle (°)	Specified (Minimum)	Measured (Mod/lux)	
			invention	prior art
20'	0 - 0	300	990	314
	10 U - 0	200	968	267
	10 D - 0	200	970	275
	5 U - 20 L	100	912	203
	5 U - 20 R	100	633	115
	5 D - 20 L	100	911	196
	5 D - 20 R	100	622	117
	0 - 0	5	25.2	20.3
1 ° 30'	10 U - 0	2.8	23.0	13.8
	10 D - 0	2.8	24.3	15.9
	5 U - 20 L	2.5	21.1	12.0
	5 U - 20 R	2.5	14.3	9.1
	5 D - 20 L	2.5	21.7	12.4
	5 D - 20 R	2.5	16.5	10.0

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U = up D = down L = left R = right

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It will be seen that for some illumination angles the prior art only just exceeds the minimum performance requirement, whereas the performance achieved by use of the present invention can average 3 times the minimum performance requirement.

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Various modifications may be made within the scope of the invention. For example, the ratio between the areas of the faceted cells 28 and the areas of the triangular regions 31 may be varied. As shown in Figure 14 the areas may be equal. A further increase of the area of the light-transmitting regions 31 causes them to merge into one another as shown in Figure 15. If desired, the triangular regions can be formed as concave lenses which complement the convex lenses of the optical plate 24. A rhombic two-dimensional lattice of rectangular six - faceted cells 36 is shown in Figure 16, each cell comprising two cube corners 37; there is a complementary lattice of rectangular co-planar regions 38. In this last embodiment the optical plate will have a lattice of convex lens surfaces corresponding to the lattice of rectangular regions 38.

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The optical plate may be reversed, as in the prior art, with the fresnel lens surface remote from the light source, if desired. If the light source produces a substantially parallel light beam, e.g. with the aid of a parabolic reflector, the fresnel lens surface may be replaced by a flat surface.

Claims

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1. A light transmitter/reflector for a vehicle tail lamp, comprising an outer lens (21) and an inner lens (24), characterised in that:

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(a) the outer lens (21) comprises a first sheet (22) of transparent material having a first, outer side (26) and a second, inner side (27) opposite and generally parallel to the outer side (26), the second, inner side (27) having a two-dimensional lattice of faceted cells (28; 36) which reflect light rays entering the first sheet (22) through the first, outer side (26) and having a complementary two-dimensional lattice of regions (31;38) which transmit light rays entering the first sheet (22) from either side; and

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(b) the inner lens (24) comprises a second sheet (24) of transparent material having a rear side which faces the first sheet (22) and a front side which is opposite to the rear side, one of the said sides of the second sheet (24) having a two-dimensional lattice of convex lens surfaces (33) which corresponds to the said lattice of light transmitting regions (31;38).

2. A transmitter/reflector as claimed in claim 1, in which the faceted cells (28;36) are arranged along mutually

transverse axes, the spacing of the cells (28;36) along each axis being proportional to the dimension of each cell (28;36) along that axis.

- 5 3. A transmitter/reflector as claimed in claim 1 or 2, in which each faceted cell (28; 36) comprises at least one cube corner (28;37).
4. A transmitter/reflector as claimed in claim 3, in which each faceted cell (28) is a single cube corner.
- 10 5. A transmitter/reflector as claimed in any of claims 1 to 4, in which the faceted cells (28) are arranged along three axes at 120°.
6. A transmitter/reflector as claimed in any of claims 1 to 5, in which the faceted cells (28; 36) are in mutual contact.
- 15 7. A transmitter/reflector as claimed in any of claims 1 to 6, in which the faceted cells (28) occupy a greater area of the second, inner side (27) of the first sheet than do the light transmitting regions (31).
8. A transmitter/reflector as claimed in any preceding claim, in which each light transmitting region (31;38) is planar.
- 20 9. A transmitter/reflector as claimed in claim 8, in which the light transmitting regions (31;38) are co-planar.
10. A transmitter/reflector as claimed in any preceding claim, in which the other of the said sides of the second sheet (24) has a convex fresnel lens surface (33).
- 25 11. A transmitter/reflector as claimed in any preceding claim, in which the said one of the sides of the second sheet (24) is the rear side.
12. A transmitter/reflector as claimed in any preceding claim, in which the first sheet (22) is delimited by a peripheral flange (23) which locates a peripheral portion of the inner lens (24).
- 30 13. A transmitter/reflector as claimed in claim 12, in which the flange (23) serves as a spacer between the first and second sheets (22,24).
14. A vehicle tail lamp comprising a transmitter/reflector according to any preceding claim.

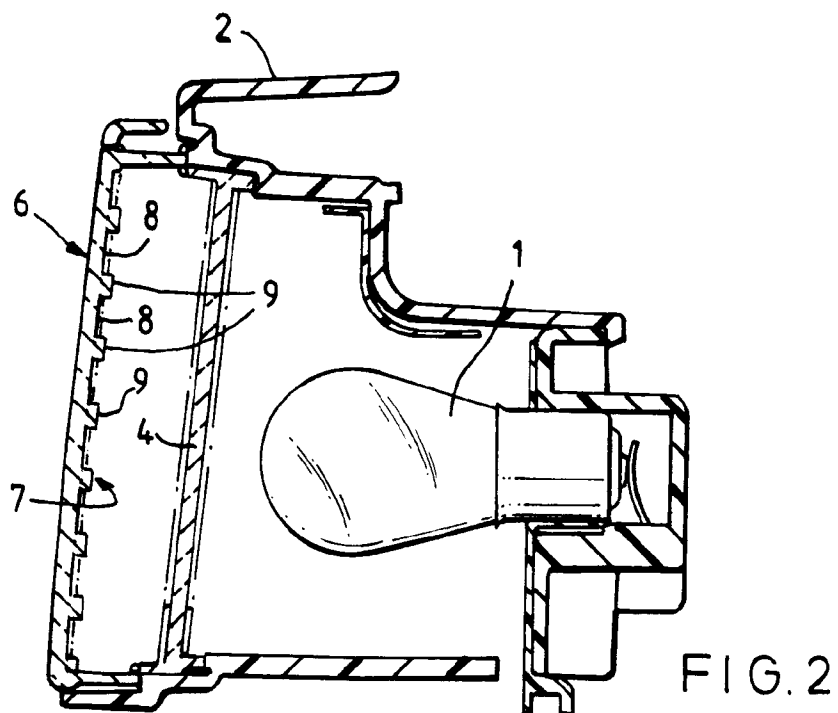
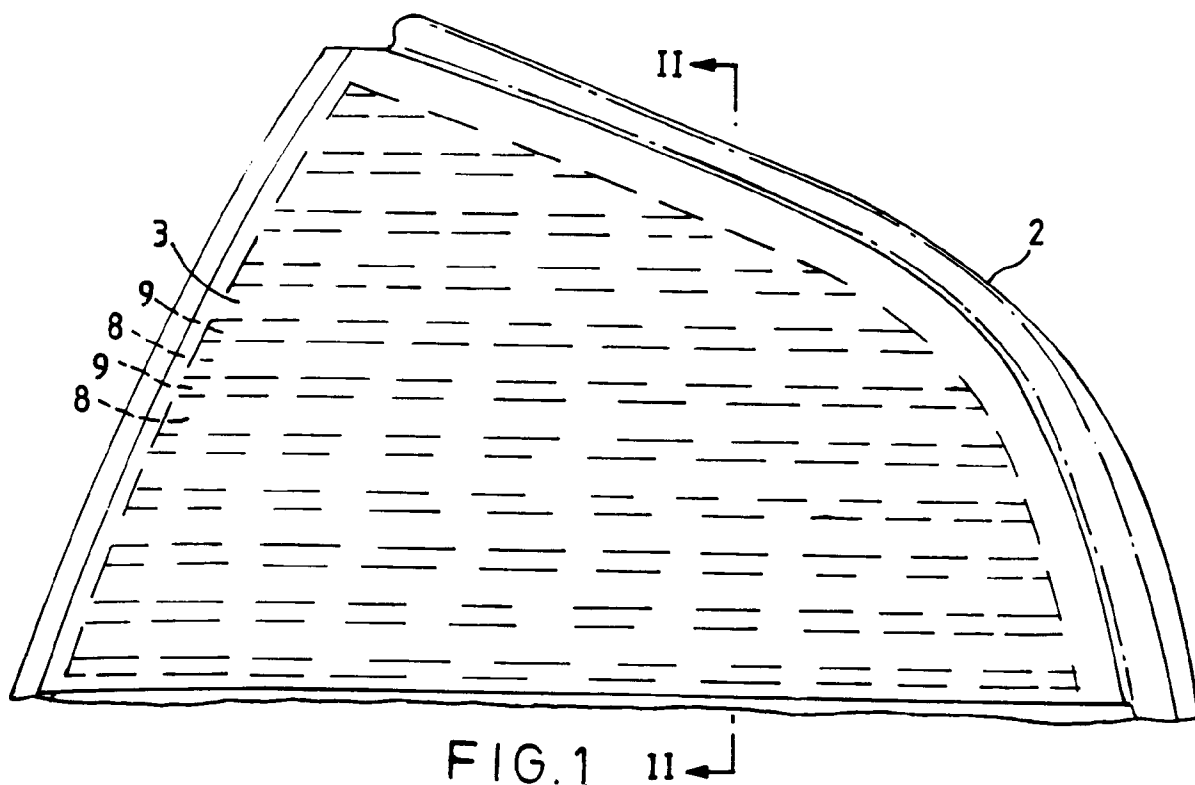
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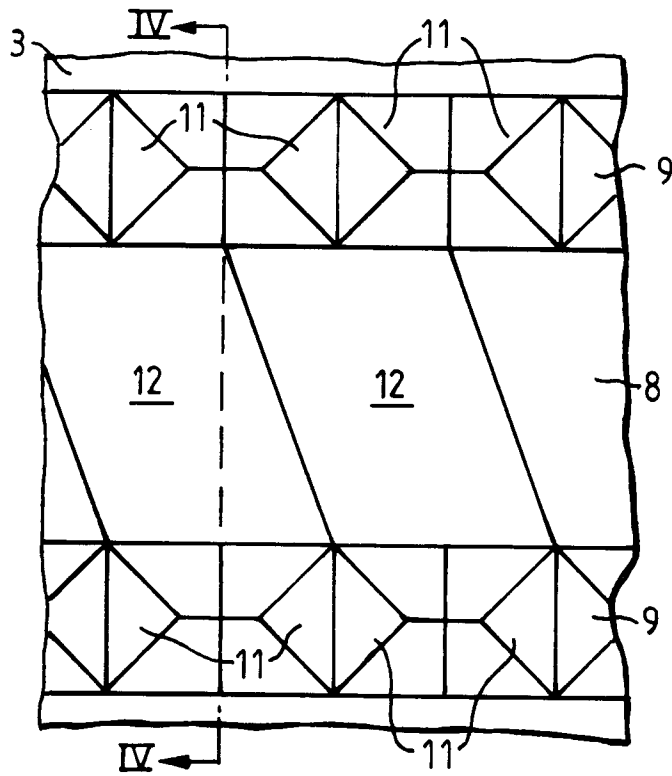


FIG. 3

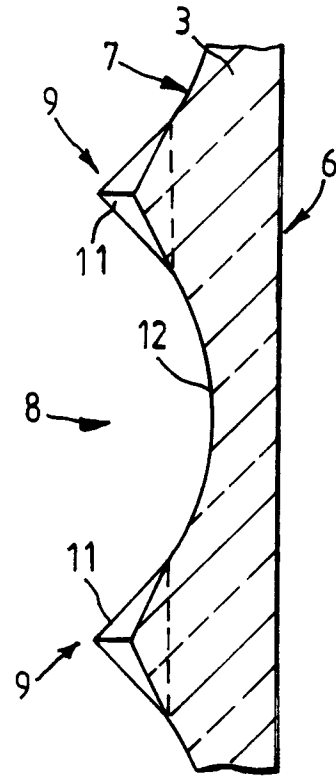


FIG. 4

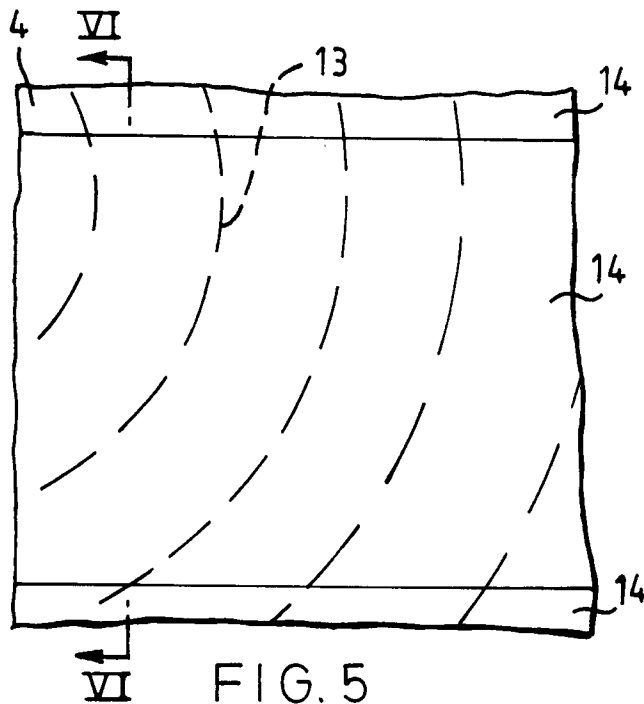


FIG. 5

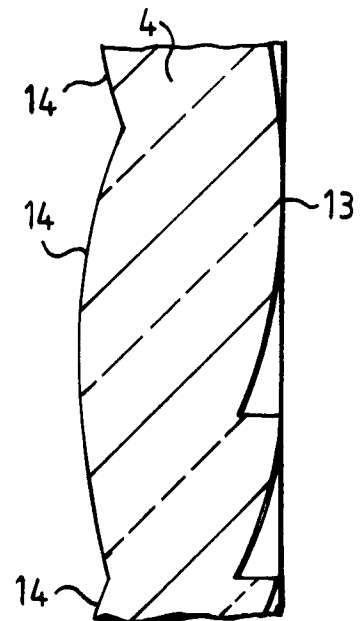


FIG. 6

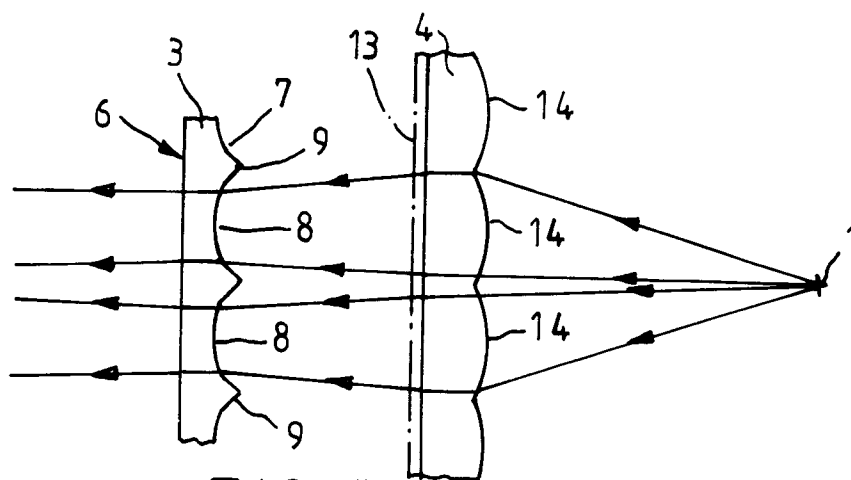


FIG. 7

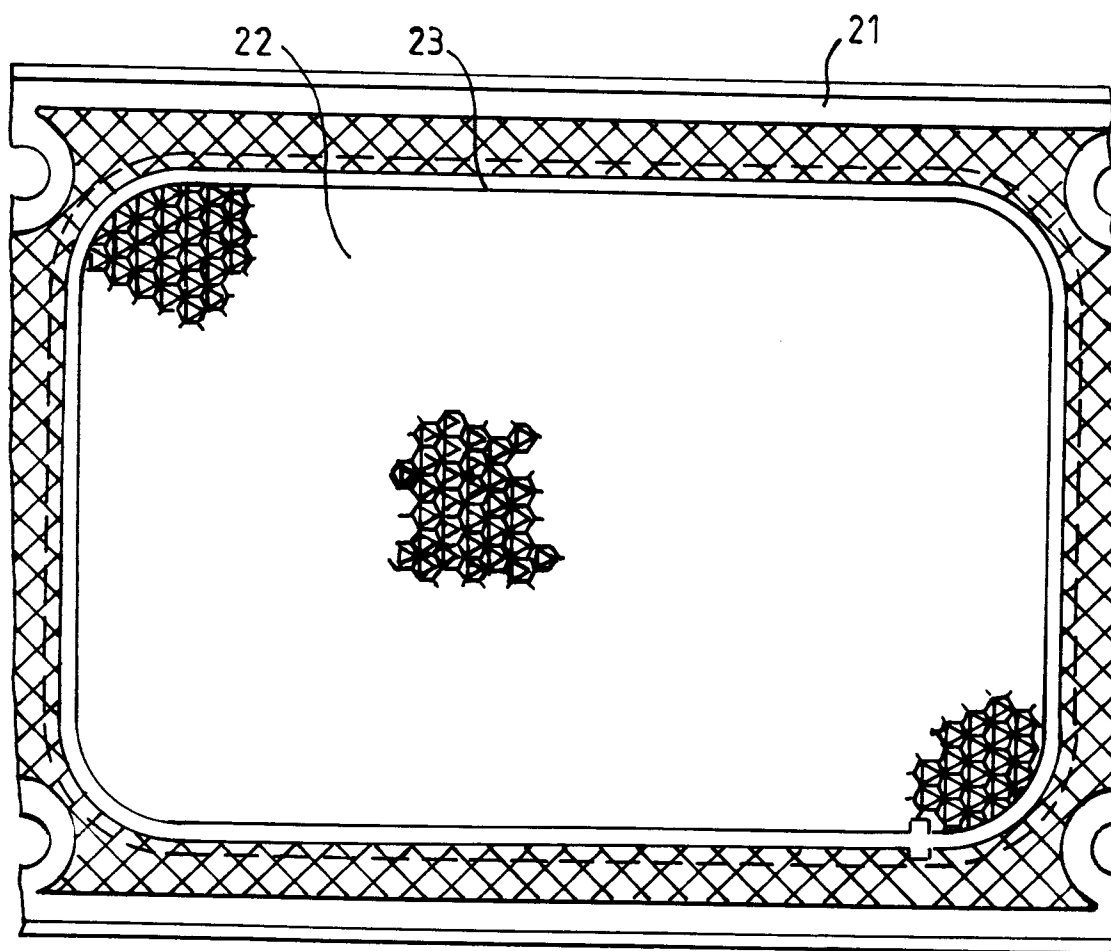
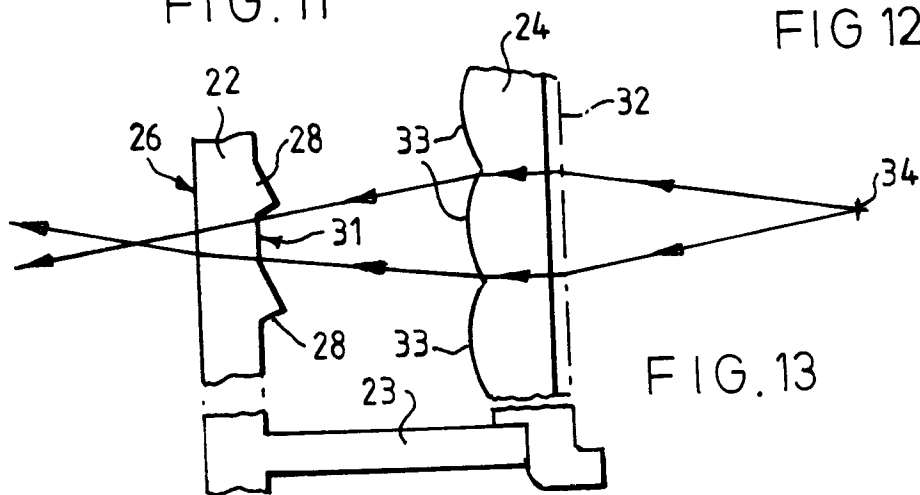
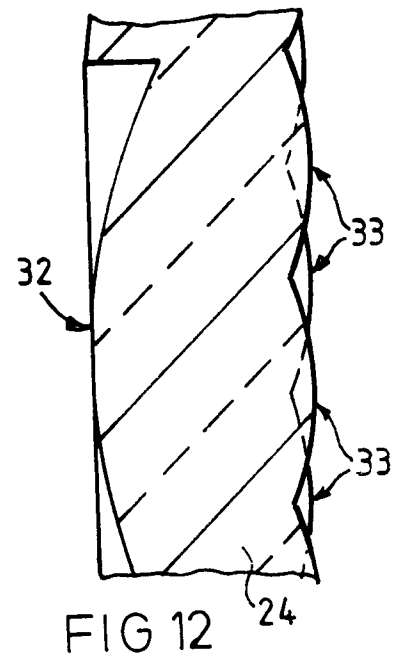
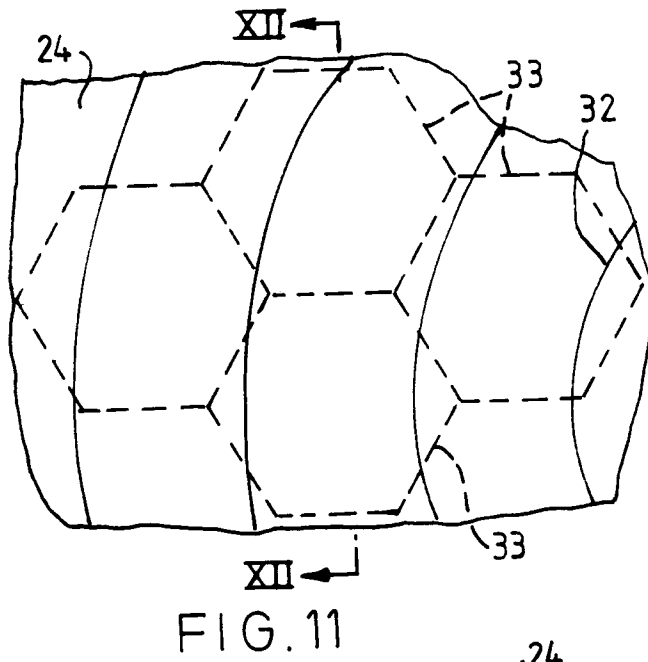
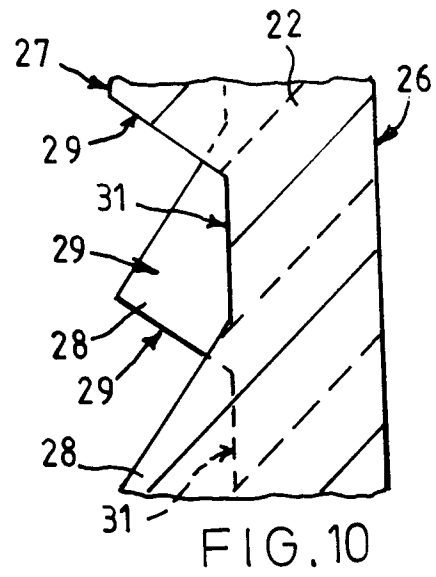
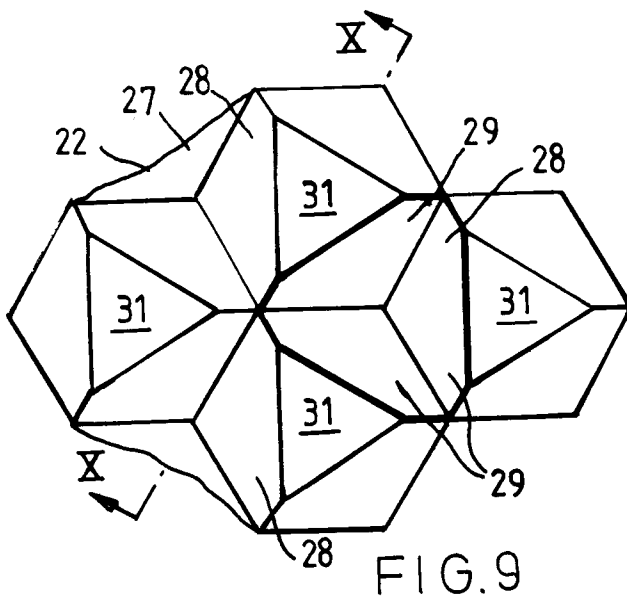


FIG. 8



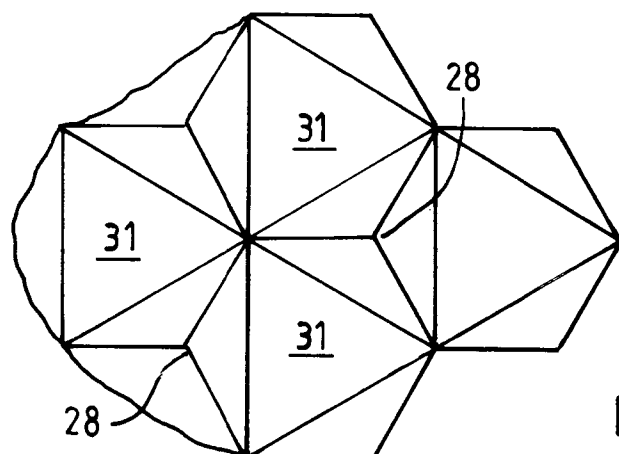


FIG. 14

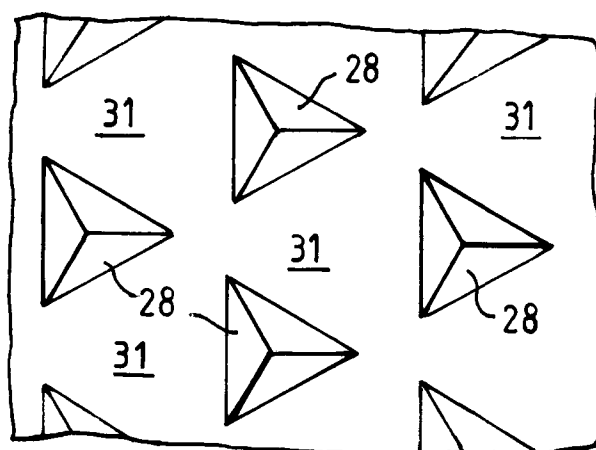


FIG. 15

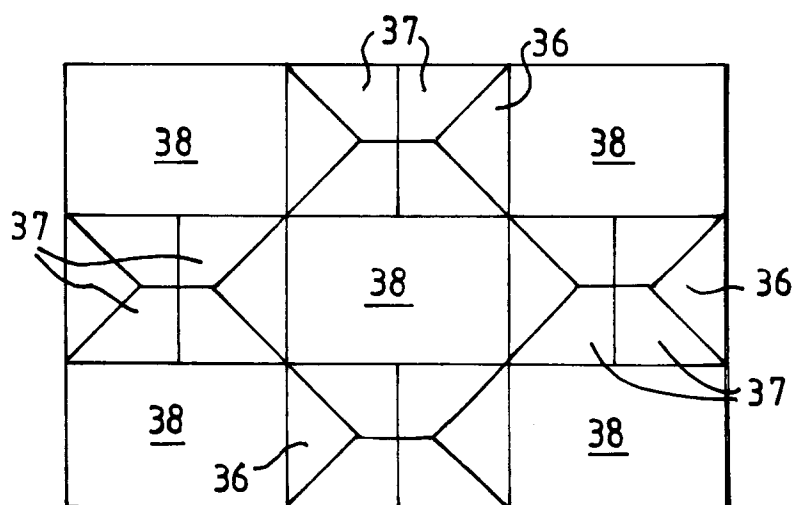


FIG. 16



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3187

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	US-A-3 779 629 (GREEN) * the whole document * ---	1-14	F21Q1/00
X	DE-C-956 566 (WESTFÄLISCHE METALL-INDUSTRIE GMBH) * the whole document * -----	1,2,5-9, 14	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			F21Q F21V
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 29 September 1994	Examiner De Mas, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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