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(54) Semi-recessed luminaire

(57) A semi-recessed luminaire (10) comprising: a housing (12) for a light source (42), the housing being adapted for recessing within a ceiling such that in use a lower surface of the housing is substantially flush with the ceiling, and a light-transmitting cover (14) which is mountable below the housing, the cover having a primary light-transmitting surface (28) which allows light to be transmitted from the light source, or via a reflector, through the cover to an area below the luminaire, and a secondary light-transmitting surface (30) which allows light to be transmitted from the light source, or via a reflector, through the cover to a region of the ceiling positioned to the side of the luminaire.

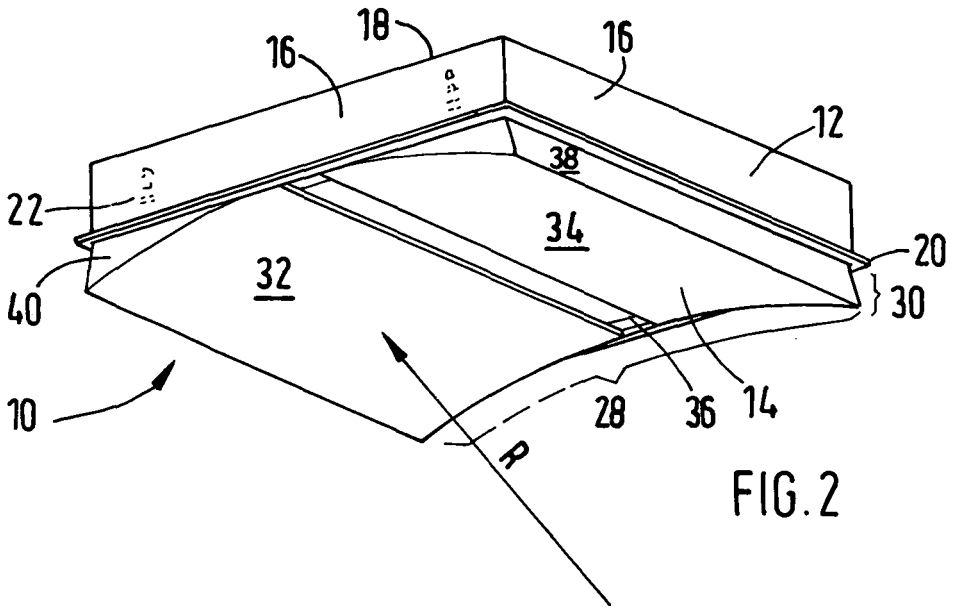


FIG. 2

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Description

[0001] The present invention relates to an improved semi-recessed luminaire, which is aimed, for example, at the office environment to meet the latest lighting standards. In particular, the luminaire provides greater illumination for the ceiling and walls than conventional luminaires intended to satisfy the requirements of Lighting Guide 3.

[0002] Luminaires that fit in place of a ceiling tile in a suspended ceiling have been known for some time. These are typically in the form a metal housing in which one or more fluorescent lamps are fitted. The lamps are usually hidden from view with a cover that extends over the lower surface. This might be in the form of a louvre or diffuser panel. The luminaire includes all the circuitry required to feed power from a lighting circuit to the individual lamps. Usually a range of louvres, straight or parabolic reflectors, diffuser panels and / or shielding panels are provided in the luminaire to modify the light output of the fluorescent lamps so as to create the desired lighting effect. For example, these might be arranged to direct light to particular regions below the luminaire or reduce glare to avoid reflections on computer screens.

[0003] Lighting Guide 3 (LG3 Cat 2) traditionally has been the lighting standard that manufacturers have tried to meet for lighting office environments. LG3 was first published in 1989 and covered the lighting of spaces with visual display units. It was then updated in 1996 taking into account Health & Safety DSE regulations. The recommendations within the document meant that luminance levels had to be kept to less than 200 cd/m^2 (candelas per square metre) at elevations above 65° where negative polarity software was in use. This could be raised to 500 cd/m^2 or 1500 cd/m^2 for positive polarity software and flat screens with anti-reflection coatings.

[0004] The tendency in new offices was, however, to use the LG3 'Cat 2' luminaries by default. This created a 'cavern' effect with dark ceilings and walls, and results in an uncomfortable working environment. The result of this practice led to the withdraw of the category rating system.

[0005] In 2001, an addendum was added by the Society Of Light & Lighting, which took into account the changing standards, new technology and screen types. The Society has recently re-written and published its Lighting Guide 7 (LG7): Office Lighting. This incorporates and updates the earlier LG3 guide for display screen use.

[0006] Lighting Guide 7: Office lighting (New recommendations for wall and ceiling illuminance) provides recommendations to address the dark and gloomy effect that can be created by Cat 2 louvres and reflectors. In order to avoid sharp ceiling cut-offs and bright scallops it stated the following:

> *"Where screens using only positive polarity software are used, the luminaire's luminance limit is 1500 cd/m^2 above the 65° from the vertical". (This also applies to ceiling and walls.)*
>
> *"The average wall illuminance above the working plane, from both the direct and indirect reflected components, should be at least 50% of the average horizontal illuminance on the working plane. (No one wall should be less than 30%)".*
>
> *"For the ceiling not to appear dark, the average illuminance on the ceiling, from both the direct and reflected components, should be at least 30% of the average horizontal illuminance across the working plane.* "
>
> *"Working plane illuminance should be 300 lux for screen based tasks and up to 500 lux mainly paper based tasks.*"

[0007] The LG7 standard is generally achieved by using a mixture of products, for example, downlighters in the ceiling to provide general downward light and up-lighters on the walls to provide light on the ceiling. Task-lights are often provided on the desks (the working plane) to increase light locally where it is required. See Figure 1 of the accompanying drawings.

[0008] Recently a number of luminaire products have been introduced on the market which claim to be LG7 compliant. These fall into two categories. For the first category, the light sources tend to be mounted below the recessed housing of the luminaire and arranged to direct light upwards against a reflector in the luminaire. In some examples the light sources are suspended below the housing in a 'gondola', but in other examples the rigid structure of the luminaire has been adapted to mount the light sources in this suspended arrangement. In the other category, light sources are arranged within the recessed housing, i.e., above the level of the suspended ceiling, and special features are provided to try to direct light to the adjacent walls and the ceiling at a level below the glare limit.

[0009] Viewed from a first aspect the present invention provides a semi-recessed luminaire comprising:

a housing for a light source, the housing being adapted for recessing within a ceiling such that in use a lower surface of the housing is substantially flush with the ceiling, and
a light-transmitting cover which is mountable below the housing, the cover having
a primary light-transmitting surface which allows light to be transmitted from the light source, or via a reflector, through the cover to an area below the luminaire, and
a secondary light-transmitting surface which allows light to be transmitted from the light source, or via a reflector,

through the cover to a region of the ceiling positioned to the side of the luminaire,

wherein the secondary light-transmitting surface is provided with a plurality of features to deflect light that is incident from the light source or a reflector towards a region of the ceiling to the side of the luminaire.

[0010] The present invention is advantageous over conventional LG3 luminaires because additional light is directed to nearby vertical walls and adjacent regions of the ceiling via the secondary light-transmitting surface, providing an improved working environment.

[0011] The plurality of features preferably comprises a plurality of prisms or lenses that are arranged to refract light, and so deviate the path of the light towards the ceiling through the properties of the material. Preferably the light-deflecting features are triangular prisms having one side that is substantially perpendicular to a side of the cover, one side provided by the side of the cover and a hypotenuse which constitutes the lower side. Preferably light incident on either an upper and / or a lower side of the triangular prisms is caused to refract and deviate in its path through the cover. The plurality of prisms may also provide a plurality of reflecting surfaces which are angled to reflect light incident from the light source or reflector (or from generally within the luminaire) towards a region of the ceiling to the side of the luminaire. A reflecting surface may be provided by an upper surface of the prism. A combination of refraction and reflection is preferably used to lead to the overall lighting effect of the luminaire.

[0012] Preferably sufficient light is directed via the secondary light-transmitting surface, so that under normal situations, the average wall illuminance above the working plane, from both direct and indirect components is at least 50% of the average horizontal illuminance on a working plane arranged below the luminaire. Preferably no one wall making up this average figure would be less than 30% of the average horizontal illuminance on the working plane. Any changes in illuminance on the walls are preferably gradual. This helps the walls to avoid appearing gloomy and oppressive.

[0013] Preferably also the average illuminance on the ceiling, from both the direct and reflected components, is at least 30% of the average horizontal illuminance across the working plane. This improves the brightness of the ceiling area and adds to the feeling of a more pleasant working environment.

[0014] Ideally the luminaire's luminance is close to but preferably below 1500 cd/m^2 at locations above the elevation of 65° from the vertical, to avoid bright scallops or patches appearing on the walls that might be seen reflected in display screens. This luminance limit preferably applies to both ceiling and walls.

[0015] The luminaire also generates an illuminance of at least 200 lux on a working plane arranged below the luminaire (the minimum level set by HSE for permanently occupied areas) and preferably achieves an illuminance of between 300 to 500 lux on the working plane so that it is appropriate for screen or paper based tasks.

[0016] Preferably the luminaire is able to meet all of the above requirements in a typical office or other domestic or commercial environment and thereby achieve compliance with LG7.

[0017] Preferably the light deflecting features are provided by an array of prisms arranged on the internal surface of the side of the cover, in particular triangular prisms. These have the advantage that they can be formed easily during an extrusion process. Providing them on the internal surface of the cover means that they are shielded from dust which might deteriorate performance.

[0018] In one embodiment the light deflecting features comprise triangular prisms having an upper surface that is inclined at an angle of 5° or more to the horizontal but not more than 30°. In the most preferred embodiments they are arranged to be between 10° and 22°, and most preferably the average angle is about 16° to the horizontal ($\pm$3°) to provide the best illumination of the ceiling and walls. Preferably the triangular prism is substantially a right angled triangular prism with the upper surface provided by a perpendicular side and the lower surface defining the hypotenuse. Preferably the included angle at the apex between the upper and lower surfaces is between 42° and 52°, more preferably 45° and 49° and most preferably around 47°. Preferably the lower surface of the prism is angled at between 15° and 47° to the horizontal, more preferably between 20° and 42°, yet more preferably between 25° and 37°, and most preferably between 28° and 34°. The most preferred angle is around 31° to the horizontal. However other shapes of prism and lens are envisaged which can deflect light through the 20° to 50° required to create an even illumination of the ceiling are also possible and envisaged within the present invention.

[0019] Preferably the prisms are arranged at slightly different angles to spread the illumination (coming from either the refraction of the light through the prisms or the reflection of the light on the upper surfaces) and to create a more even lighting effect.

[0020] Preferably the side of the cover bows outwardly so that it extends beyond the footprint of the housing. This provides not only a more elegant and distinctive appearance, but also shields the edge of the luminaire housing from view where it fits into the ceiling.

[0021] Preferably the lower surface of the cover has a curved profile and the side of the cover descends smoothly from the housing to join the edge of this lower surface. This profile allows LG7 compliance to be achieved in rooms with normal ceiling heights and reflectances as well as giving the luminaire a distinctive and modern appearance. The extent of the structure which extends from the ceiling is minimal and should not interfere with sprinkler spray patterns.

[0022] Preferably the lower surface and side of the cover are co-extruded to provide a cover member. Preferably the

cover member covers substantially half of the opening of the housing. This has the advantage of allowing manufacturing tolerance in the extrusion process (up to 6%) to be taken up with a portion of frame or a central panel located in the middle of the luminaire. In an alternative embodiment, a single piece cover is provided to cover the entire lower surface of the housing.

[0023] Preferably the luminaire uses existing linear fluorescent lamps as the light source. With the present invention it is possible to provide a working environment that is better lit than with the traditional LG3 Cat luminaires, but with using half the number of fluorescent lamps or fewer, for example, one or two lamps arranged centrally within the luminaire (e.g., a single 55 W lamp). This reduces the operating cost of the luminaire.

[0024] Certain preferred embodiments will now be described in greater detail by way of example only and with reference to the accompanying drawings, in which:

Figure 1 shows a lighting arrangement for a room for achieving compliance with LG7;
Figure 2 shows a perspective view of a preferred embodiment of the luminaire of the present invention viewed from underneath and towards one corner;
Figures 3a, 3b and 3c show the luminaire of Figure 2 as front, side and underside views respectively;
Figure 4 shows another preferred embodiment of the luminaire of the present invention viewed from underneath and towards one corner;
Figures 5a, 5b and 5c show the preferred luminaire of Figure 4 as front, side and underside views respectively;
Figure 6 shows a side elevation in cross-section of the preferred luminaire arranged in the ceiling of a room;
Figure 7a shows the preferred luminaire in cross-section in more detail with Figure 7b showing an enlargement of the plurality of prisms provided on a secondary light-transmitting surface;
Figure 8a shows part of a prototype luminaire that, although was an improvement on conventional LG3 luminaires, created too much glare at certain elevations. The corresponding portion of the preferred luminaire is shown as a comparison in Figure 8b; and
Figures 9a to 9d show a number of further variations that are within the present invention.

[0025] As shown in Figure 1, in order to achieve compliance with the guidelines set out in LG7, light may be provided by a combination of a downlight 1, which is mounted in the ceiling 2 to transmit light onto a working plane 3, and a wall light 4 arranged to illuminate the ceiling 2 and bounce light into the room, thereby also illuminating the walls. The downlight 1, for example, could be a LG3 luminaire generating no glare above an elevation of 65° from the vertical. The wall light 4 will also generate no glare within this elevation. If required, additional light can be provided using a task light 5 provided on the working plane 3.

[0026] Figure 2 illustrates a preferred embodiment of the luminaire 10 of the present invention. The luminaire 10 comprises a housing 12, which is in the form of a box open to its underside, and a cover 14 which conceals the contents of the housing 12 from the observer and reduces glare from the light source (not shown in the figure).

[0027] The housing 12 has sides 16 and a top 18 which define an enclosure for the contents of the luminaire 10. In use, the luminaire 10 is recessed into a space within the ceiling 2, which will be typically a suspended ceiling. The luminaire 10 is preferably of a size corresponding to a standard size of ceiling tile, so that the luminaire 10 can be fitted in place of a ceiling tile. Figure 2 shows a square luminaire 10, which might be used for a 600 x 600 mm opening, for example, and Figure 4 shows a variation on this of a rectangular luminaire 10, which could be used for a 1200 x 600 mm opening. The dimensions of the housing preferably allow the luminaire 10 to be fitted in place of existing LG3 units.

[0028] However the housing 12 is not limited to the shapes and sizes mentioned above and could be of any appropriate shape and size so long as it fits within a corresponding recess of a ceiling 2. For example, the housing 12 could be made to fit within a triangular or hexagonal hole, or be sized to fit within a dimension of 300 mm or 500 mm, if these became popular. The sides 16 of the housing 12 could define a different shape to the cover 14, so long as it does not interfere with the adjacent ceiling tiles of the suspended ceiling. For example, the housing 12 could be circular and have only one side 16 and a top 18, triangular and have three sides 16 and a top 18, hexagonal and have six sides 16 and a top 18, etc..

[0029] Once fitted, the walls 16 and top 18 of the luminaire 10 will be recessed within the void above the suspended ceiling 2. A lower edge of the sides 16 is preferably provided with a lip 20 that can abut flush against the surface of the ceiling 2. The lip 20 is preferably decorative to hide any gaps around the sides 16 of the luminaire 10, but could also provide some structural function in terms of making the housing stiffer and for fixing the luminaire 10 in the ceiling 2. The lip 20 might also conceal a layer of intumescent material (not shown) for improving the fire rating of the luminaire, or a moisture seal (not shown) to prevent moisture from being drawn up into the ceiling void around the side of the luminaire 10. Additional fixing means, for example, in the form of adjustable plates 22, may be provided on opposite sides 16 of the housing 12 to mount the luminaire 10 within the ceiling 2.

[0030] The cover 14 is sized at its upper edge 24 to correspond to a ceiling tile opening, and hence corresponds to the opening of the housing 12. The lower edge 26 of the cover 14 preferably extends beyond the footprint of the opening, for example, for a distance corresponding to the dimensions of the lip 20 at least along two opposed edges, as shown

in Figure 3c.

[0031] The cover 14 extends downwards from the surface of the ceiling 2 and preferably has a curved concave profile when viewed from the side, the curvature following an arc of constant radius R. The underside of the cover 14 provides the primary light-transmitting surface 28 and the sides providing the secondary light-transmitting surface 30 (as will be explained in more detail below). However other profiles are possible, for example, the curve might be parabolic or wavy. It might be straight in cross-section, for example, as a square or rectangular box-like cover 14. The profile might approximate to a curve using straight lines, for example, to provide two shallow triangular regions. The cover 14 might appear from below as a shallow cylinder (almost disc-like) with a flat, concave or convex bottom. In such an embodiment, the primary light-transmitting surface would be circular and the secondary light-transmitting surface would the cylindrical wall extending around the circumference. The cover 14 might be asymmetric. Indeed a variety of shapes for the cover 14 are possible. The main criterion is that the cover 14 should allow the luminaire 10 to achieve LG7 compliance with the appropriate light source and positioning in the room (given normal ceiling heights and reflectance).

[0032] As seen most clearly in Figure 2, the cover 14 has a primary light-transmitting surface 28 provided by the lower surface of the cover 14 which allows light to be transmitted from the light source in a downwards direction to illuminate a working plane 3 arranged below the luminaire 10. The cover 14 also has a secondary light-transmitting surface 30 arranged to allow light from the light source to escape in a sideways direction to illuminate the ceiling 2 and vertical walls 6.

[0033] Figure 2 shows how the primary light-transmitting surface 28 is preferably made of sections having different light-transmitting properties. The left and right curved rectangular faces 32 and 34 of the lower surface of the cover 14 are preferably made of one material or have one set of optical properties, and the central rectangular panel 36 is of a different material or has been processed to have different optical properties, as shall be discussed in more detail below. The secondary light-transmitting surface 30 is preferably also made up of different sections having a variety of orientations and optical properties, for example side panel 38 and the substantially triangular (the hypotenuse is curved with a radius of R) in-fill panel 40, which all assist in transmitting light as part of the secondary light-transmitting surface 30.

[0034] Figures 4 and 5a to 5c show a variation on the luminaire 10 having a substantially rectangular outline. The same reference numbers are used for like parts in Figures 2 and 3a to 3c.

[0035] Figure 6 illustrates the embodiment of the luminaire 10 of Figure 2 now shown in cross-section. It is shown semi-recessed in the ceiling 2 of a room above a working plane 3. The elevation of 65° from the vertical is marked on the figure, above which glare is not permitted. It can be seen from this diagram how light transmitted purely in accordance with LG3 Cat 2 (i.e., with no light transmitted via the secondary light-transmitting surface) would only illuminate the lower region of a vertical wall 6 and create gloomy patches of darkness on the ceiling 2.

[0036] In the present invention the cover 14 for the luminaire 10 has been modified so that light is also directed sideways and upwards towards the ceiling 2, in order to illuminate the walls and ceiling. With the right choice elements to direct sufficient light at the walls and ceiling, it is possible to achieve compliance with LG7. Thus in the present invention, the secondary light-transmitting surface 30 is provided with a plurality of features to deflect light (through refraction or reflection) incident from the light source 42 or reflector 44 towards a region of the ceiling 2 which is to the side of the luminaire 10. The majority of the light will have been first reflected by a reflector 44, preferably a parabolic reflector, arranged above the light source 42 at the top 18 of the housing 12. However some of the light may have come direct from the light source 42 prior to being incident on a light-deflecting feature of the secondary light-transmitting surface 30.

[0037] Figure 7a shows the preferred luminaire 10 in cross-section and in more detail. The cross-section corresponds to both the square and rectangular luminaires 10 shown in Figures 2 and 4.

[0038] As shown in Figure 7a, the housing 12 provides a box for a standard collection of electrical components 46. The components 46 may comprise a ballast and control circuitry, and preferably these are located behind the reflector 44 to hide them from view as well as to protect them from heat. The luminaire 10 is preferably pre-wired so that an electrician needs only to connect up the terminals of the luminaire 10 to a conventional lighting circuit for it to work. Ventilation slots may be provided in the top 18 of the housing 12 to allow excess heat to escape. In one embodiment a layer of intumescent material (not shown) is provided across the internal or external surface of the top 18 to seal the ventilation slots in the event of a fire. Whilst the housing 12 could be made of materials such as plastics, preferably it is made from sheet metal such as aluminium or steel.

[0039] Preferably the light source 42 is a linear fluorescent tube arranged centrally across the width of the housing 12. In other arrangements, such as that illustrated in Figure 6, the light source 42 may comprise two fluorescent lamps arranged side by side, centrally (just on either side of the center line) across the width of the housing 12. The tube of a single lamp may be folded in half to provide a U-shaped fluorescent lamp with two parallel sections.

[0040] As shown, an advantage provided by the present invention is that the light source 42 can be located within the volume defined by the housing 12, so that it is recessed within the ceiling 2 rather than hanging below the level of the ceiling as with many of the prior art luminaires. However, it would be possible to position the light source 42 lower than shown, for example, below the level of the ceiling if desired, and with an appropriate modification to the light deflecting features, the advantages of the present invention, and preferably the compliance with LG7, could still be achieved. From the point of view of aesthetics, the less the luminaire projects down from the ceiling 2, the better, as this makes the

luminaires less obtrusive. It is also likely to be cheaper in terms of materials. In addition, there is less risk that the luminaire will interfere with the sprinkler spray pattern. Hence it is preferred to position the light source 42 above the level of the ceiling 2 towards the bottom of the housing 12.

[0041] In other embodiments where the luminaire 10 is not of square or rectangular shape, for example, it might be desirable to use a light source 42 which is not linear. A circular fluorescent tube could be used in embodiments having a cover 14 with a circular configuration (even where these might be intended to fit in a square or rectangular ceiling tile hole) or a compact cylindrically wound lamp might prove useful by creating a point source of light. Of course other forms of lamp could also be used other than fluorescent lamps, but with these there would be higher operational costs making them prohibitive to the market.

[0042] The light-transmitting cover 14 is preferably made up of different sections. In the examples of Figure 2 and Figure 4, the cover is shown made up of three parts. Figure 7a shows how a cover member 48 can provide (i) a curved rectangular face 32, 34 of the primary light-transmitting surface 28 and (ii) a side panel 38 and the substantially triangular in-fill panel 40 of the secondary light-transmitting surface 30. The cover member 48 extends to cover over nearly half of the opening of the housing 12. Preferably the cover member 48 extends over 40% of the opening, more preferably over 45%. The left and right cover members 48 are preferably the same to keep manufacturing costs lower. However, they could be different, for example, for luminaires positioned with only one side close to a vertical surface where it might be desirable to vary the amount of light being transmitted from different sides of the luminaire 10.

[0043] The cover members have a lower surface 32, 34 (the curved rectangular faces) which is made of a material that allows light from the light source 42 to be transmitted to the working plane 6, either directly from the light source 42 or, more likely, reflected from the parabolic reflector 44 arranged above the light source 42. The material should preferably provide diffuse light to the working surface in order to minimise glare. It preferably has a satin or opal finish. This can be created through providing the surface with an array of tiny formations, for example, dimples or protrusions, to scatter light within desirable limits. Some of the light may also be reflected off the internal surface of this panel and out to the secondary light-transmitting surface. The surface formations might be created by shot peening or stippling with a fine die member, for example, to create conical depressions. Fine raised lines or grooves could also create the desired effect. Preferably the satin effect is uniform across the whole area. However it would be possible to vary the size, pattern or density of the formations to create a varied diffusivity for this lower face 32, 34. The material could also include fine particles or beads of a material with different optical characteristics to create a satin or translucent finish. It could also be created through applying a diffuse translucent material to the cover member 48.

[0044] Indeed this lower face 32, 34 of the cover member 48 could be made of a range of different materials. However preferably the material enables greater than 300 lux to reach the working plane, but preferably not more than 500 lux. Preferably the material appears translucent and sufficiently opaque to the observer to hide the contents of the luminaire from view. Polycarbonate materials are preferred but other plastics such as acrylics or other transparent / translucent materials could also be used where regulations allow.

[0045] In the embodiments illustrated in Figures 2 and 4, the primary light-transmitting surface 28 is made up of the lower faces 32, 34 of the left and right cover members 48 and a central rectangular light-transmitting panel 36 to allow light to be transmitted from the light source directly down on to the working plane 3. In one embodiment (not illustrated) the central panel 36 comprises a section of reflective louvres, either arranged as parallel louvres or, more preferably as a criss-cross arrangement of reflective surfaces to limit possible glare above the 65° elevation in all directions. More preferably the central panel 36 is a strip of material which can provide diffuse light on to the working plane 3.

[0046] The material of the central panel 36 preferably has a satin or opal finish. In one embodiment the surface is provided with an array of conical prism lenses (for example, through moulding or stamping). These disperse the light from the light source to provide an even illumination of the working plane 6. They also limit possible glare to within the 65° conical elevation envelope. Other materials or prism shapes could also be used, as discussed with the cover member 48, providing they allow sufficient light to reach the working plane 6 and do not create glare that extends above the 65° limit. In general, the light reaching the working plane 6 from this central panel 36 will be coming directly, albeit with some reflections from the conical prisms, from the light source 42 to strike the working plane 6. Preferably the material is different to or appears different to that of the cover member 48 to create visual interest to the underside of the luminaire 10.

[0047] The cover member 48 also has a side panel 38 which extends from the lower edge of the housing 12 to the lower edge of the primary light-transmitting surface 28, to provide the whole of or a portion of the secondary light-transmitting surface 30. The side panel 38 is preferably made of a different material or has different optical qualities to the lower face 32, 34. The cover member 48 may be made by co-extrusion of the two materials.

[0048] The side panel 38 is preferably clear to allow as much light as possible out through the cover member 48. However embodiments are envisaged where the side panel 38 has a satin or opal finish in order to reduce possible glare to the observer (greater than 1500 cd/m^2). See, for example, Figures 9b and 9c. The material of choice for the side panel 38 is polycarbonate, though other materials could be used if desired.

[0049] An essential feature of the cover member 48 is that the secondary light-transmitting surface 30 is provided with a plurality of features 50 to deflect light, which is incident from the light source 42 or reflector 44, towards a region of the

ceiling 2 to the side of the luminaire 10. These light-deflecting features 50 are shown provided on the internal surface of the side panel 38 in Figure 7b. If desired, the light-deflecting features 50 could be provided on a secondary surface within the cover 14 and the side panel 38 could act as a window for the already deflected light to be transmitted through, but this is a more costly arrangement. The light-deflecting surfaces 50 could also be provided on the external surface of the side panel 38, but then they would be exposed to dust which would soon collect to reduce their refracting and reflecting properties. Consequently providing the light-deflecting surfaces 50 on the internal surface provides a good solution to these technical problems. They can also be formed easily during the extrusion process. Preferably a plurality of light-deflecting surfaces 50 are provided on the substantially triangular in-fill panels 40 as well.

[0050] The light-deflecting features 50 are preferably provided as an array of horizontally extending triangular prisms. They resemble saw-teeth when viewed in cross-section as shown in Figure 7b. Other arrangements of prisms or projections could be used. The key aspect is that sufficient light should be deflected back towards the ceiling to regions positioned to the side of the luminaire 10 (and also to neighbouring walls), i.e., that the light-deflecting features 50 should be sufficiently numerous, have sufficient refractive properties and/or reflective area to achieve this. In this way the ceiling 2 is illuminated to avoid a dark and oppressive feel. Light will also be reflected off the ceiling 2 and onto the vertical walls 6 to raise the illumination on these surfaces. Preferably sufficient light is directed to the side and upwards by the secondary light-transmitting surface 30 to comply with the requirements of LG7.

[0051] The upper surfaces of the triangular prisms 50 are preferably planar, at least over 75% of their area or more. Preferably the upper surfaces are inclined at an angle of between 5° and 30° (inclusive) to the horizontal, more preferably between 11° and 22°, yet more preferably between 14° and 18°, and most preferably about 16° to the horizontal. The angle of 16° has been found to offer an optimum for a luminaire 10 of width 600 mm where the light source 42 is arranged centrally.

[0052] In the luminaire 10 illustrated in Figure 7b, the top surface of the prism intersects the lower surface of the prism at an apex to define an included angle of between 37° and 57°, more preferably between 42° and 52° and most preferably around 47°. The lower surface will also be responsible for refracting light coming from the light source 42 or reflector 44 and adding to the overall lighting effect of the luminaire. It also assists in reducing glare coming from this region.

[0053] The lower surface of the prism is preferably between 15° and 47° to the horizontal, more preferably between 20° and 42°, yet more preferably between 25° and 37°, and most preferably between 28° and 34°. The most preferred angle is around 31° to the horizontal ($\pm 3°$). However angles greater than 47° could also be useful for providing an improvement over LG3 Cat 2 luminaires as will be discussed below in more detail below.

[0054] Preferably the side panel 38 is provided with at least six prisms 50, more preferably at least nine, yet more preferably at least thirteen, and most preferably sixteen or more prisms 50. The prisms 50 extend for as much of the length of the cover 14 as possible and are preferably continuous for that length.

[0055] The prisms 50 need not have the same inclination, but could vary slightly one from the next to spread the illumination on the ceiling 2. Preferably at least 80% of the prisms 50 have an upper surface inclined at between 11° and 22° to the horizontal, more preferably at least 90%, yet more preferably at least 95% and most preferably all the upper surfaces are within this range of inclination or closer to the most preferred inclination of 16° to the horizontal.

[0056] Preferably at least 80% of the prisms 50 have a lower surface inclined at between 20° and 42° to the horizontal, more preferably at least 90%, yet more preferably at least 95% and most preferably all the lower surfaces are within this range of inclination or closer to the most preferred inclination of 31 ° to the horizontal.

[0057] Whilst the triangular prisms are shown having a substantially right-angled shape, other shapes having the same or similar refractive function could be used. Prismatic shapes corresponding to isosceles, equilateral or irregular triangles could be used. The prism may have more than three sides or incorporate convex or concave surfaces, or there might be a mixture of such prismatic structures.

[0058] Figure 8a illustrates an early prototype in which the side panel 38 is inclined inwardly as it descends from the housing 12 to the primary light-transmitting surface 28. The prisms 50 have an upper surface inclined at an angle α of about 21 ° to the horizontal (inclined in the opposite direction to those of the preferred embodiment illustrated in Figure 8b). The angle β between the upper and lower surfaces of the prisms was 47°. The lower surface would be inclined to the horizontal at around 68°.

[0059] Whilst this prototype was an improvement over the conventional LG3 luminaires, there was too much glare at the side of the luminaire 10 to comply with the LG7 requirements. The luminaire 10 was modified by moving the lower edge of the side panel 38 so that it extended outwardly beyond the footprint of the housing 12 instead of inwardly. The angle β between the upper and lower surfaces of the prisms was maintained at 47°, as to was ninety degree angle of the upper surface to the side of the cover 14. The lower surface was now inclined to the horizontal by an angle of 31 °, meaning that the angle of inclination α for the top surface to the horizontal was now 16°. Thus the prisms had been tilted through an angle of around 37°. The luminance results for this modified arrangement showed that it was possible to achieve the desired 30% illuminance on the ceiling, 50% on the walls etc., as required for LG7 without excessive glare to the observer. The luminance results are illustrated for the luminaires of Figure 8a and Figure 8b in Tables I and II respectively.

[0060] The cover member 48 attaches to the housing 12, preferably using an arrangement of inter-engaging lugs and slots. In the arrangement shown in Figure 7b, one edge of the cover member 48 engages a sprung member (not shown) which urges the opposite edge of the cover member 48 into contact with a side 16 of the housing 12. At the same time a peg 52 locates in the base of a slot 54 in the top edge of the cover member 48 to support its weight. Mounting the cover member 48 in this way allows quick and easy access into the luminaire 10 for changing a failed lamp or servicing the appliance. The central panel 36 is shown located within a track 32 provided by the housing 12 and similarly can be removed readily for access into the luminaire 10. Other arrangements for attaching the cover member 48, to the housing 12 are of course possible and should be considered within the scope of this invention.

[0061] Figures 9a to 9d illustrate a number of further possible variations.

[0062] In Figure 9a, the luminaire 10 is provided with a metal or plastic housing 12. The central panel 36 is a clear prismatic panel of material. The cover member 48 has a lower face 32, 34 of satin diffuser material and a side panel 38 of clear prism material.

[0063] In Figure 9b, the luminaire 10 is provided with a metal or plastic housing 12. The central panel 36 is a clear prismatic panel of material. The cover member 48 has a lower face 32, 34 of satin diffuser material and a side panel 38 of satin diffuser material.

[0064] In Figure 9c, the luminaire 10 is provided with a metal or plastic housing 12. The cover 14 is provided by a single cover member 48. In this embodiment the cover member 48 is a satin one-piece diffuser. An alternative would be to make the side panel of a clear prismatic panel of material and co-extrude the surfaces of the cover 14.

[0065] In Figure 9d, the luminaire 10 is provided with a metal or plastic housing 12. The central panel 36 is a clear prismatic panel of material. The cover member 48 has a lower face 32, 34 of satin diffuser material and a side panel 38 of clear prism material. The figure also shows the substantially triangular in-fill panels 40 made of the clear prism material.

[0066] Thus there has been described an improved luminaire 10 which can avoid the drawbacks of the LG3 Cat 2 luminaires by illuminating the walls 6 and ceiling 2 to create a more pleasant working environment. In preferred embodiments it is possible to achieve compliance with the LG7 recommendations. In preferred embodiments, a linear fluorescent light source 42 provides downward light on the horizontal working plane 3 of at least 300 lux at a normal room height of 2.4 - 2.8 m, through a conical prismatic panel 36 that helps achieve the recommended luminance limit of less than 1500 cd/m^2 above 65° from the vertical. Direct light and reflected light from the parabolic reflector 44 is directed through a clear prismatic lens (side panel 38) that refracts light onto the ceiling surface such that the average illuminance on the ceiling 2 is at least 30% of the average horizontal illuminance on the working plane 3 (at normal ceiling heights and reflectances). Light transmitted through the lower face 32, 34 of the diffuse panel of the cover14 illuminates the vertical walls 6 such that the average illuminance on the walls is at least 50% of the average horizontal illuminance on the working plane 3 (at normal ceiling heights and reflectances).

TABLE I

PHOTOMETRIC RESULTS			
Name:	**Office Lyte 02**		
Number:	01	**Diameter:**	0 mm
Report:	Office Lyte	**Length:**	580 mm
Test no.:	01	**Width:**	580 mm
Lamp type:		**Height:**	65 mm
No. of lamps:	1	**Power:**	0 W
Lamp flux:	4800 lm	**Operator:**	Ian Craig Master
Date:	06/12/2005 13:48:557	**LOR:**	55.3%
Comment:	Office Lyte 1 x55W. Phot centre at mid	point of prisms.	

Luminance [cd/m2] Office Lyte 02 / Cone surfaces

G/C [cd	0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0
45.0	2051.59	2008.32	1975.98	1923.63	1950.59	2010.14	2142.21	2040.12	1982.21
50.0	2005.00	1945.74	1864.93	1816.83	1805.58	1878.87	2003.55	1902.70	1842.07
55.0	2195.62	2088.70	1844.52	1666.19	1621.79	1679.00	1846.58	1730.07	1658.90
60.0	1712.66	1696.48	1591.46	1381.93	1294.24	1295.38	1448.95	1369.40	1305.70
65.0	1183.99	1127.00	1036.68	986.06	875.73	765.37	750.49	738.65	800.11
70.0	1337.27	1253.37	1109.16	896.87	754.49	725.47	675.21	662.80	696.22
75.0	1596.56	1508.27	1260.70	925.69	721.11	613.98	581.58	570.06	626.14
80.0	1783.72	1615.17	1274.75	960.35	718.57	541.07	512.04	461.42	556.13
85.0	2520.11	2190.31	1569.37	1039.92	674.59	503.13	347.01	347.54	501.86

G/C [cd	135.0	150.0	165.0	180.0	195.0	210.0	225.0	240.0	255.0
45.0	1964.80	1992.39	2047.70	2106.18	2041.70	1978.44	1932.78	1938.79	1981.98
50.0	1831.54	1895.75	1940.20	2025.02	1945.17	1874.78	1811.93	1798.25	1845.01
55.0	1667.53	1777.26	2018.50	2234.43	2104.40	1836.36	1659.53	1598.15	1632.76
60.0	1392.22	1571.35	1838.37	2052.63	1891.55	1648.75	1387.81	1264.33	1229.34
65.0	939.74	1114.82	1115.18	1200.24	1121.28	1045.70	971.17	836.11	782.01
70.0	809.10	991.08	1211.74	1360.41	1254.61	1069.43	873.98	722.57	661.25
75.0	786.95	1027.41	1336.26	1525.24	1390.32	1174.06	905.22	706.31	582.42
80.0	750.10	1091.61	1569.36	1944.90	1713.65	1307.34	937.62	688.68	528.56
85.0	776.12	1329.08	2214.83	3089.42	2539.10	1718.85	1078.15	728.53	498.61

G/C [cd	270.0	285.0	300.0	315.0	330.0	345.0
45.0	2116.62	1986.49	1927.15	1891.83	1920.12	1983.56
50.0	1976.04	1845.04	1779.78	1750.50	1818.07	1897.67
55.0	1812.36	1656.28	1571.59	1579.05	1692.60	1965.37
60.0	1258.05	1199.74	1180.45	1267.47	1439.01	1637.73
65.0	725.36	709.52	748.65	861.46	980.29	1056.33
70.0	649.99	636.93	669.96	764.31	933.85	1155.35
75.0	578.85	548.50	604.34	753.83	1009.65	1371.21
80.0	449.53	455.35	552.31	779.54	1037.43	1407.86
85.0	342.21	305.67	528.42	758.01	1142.20	1787.40

TABLE II

PHOTOMETRIC RESULTS			
Name:	**Office Lyte 06S**		
Number:	05	**Diameter:**	0 mm
Report: Test no.:	Office Lyte	**Lenghth:**	580 mm
	01	**Width:**	580 mm
Lamp type:		Height:	65mm
No. of lamps:	1	**Power:**	0 W
Lamp flux:	4800 lm	**Operator:**	Ian Craig
Date:	22/02/2006 13:41:41	**LOR:**	55.7 %
Comment:	Office Lyte 1x55W. Off tool Arrow Prismatic sides angled to 20 deg from vert on both sidesl. No internal covers. Drawing film sides. Phot centre at mid point of prisms. Symmetry conditions favour 0 deg plane		

Luminance [cd/m2] Office Lyte 06S / Cone surfaces

G/C [cd	0.0	15.0	30.0	45.0	60.0	75.0	90.0	105.0	120.0
45.0	1974.73	1941.19	1951.58	1973.64	2006.14	2071.05	2257.01	2071.05	2006.14
50.0	2058.53	1968.48	1839.72	1828.23	1872.07	1946.26	2123.44	1946.26	1872.07
55.0	2059.99	1905.20	1759.30	1665.02	1690.63	1797.34	2010.02	1797.34	1690.63
60.0	1613.36	1520.55	1432.44	1372.33	1366.56	1419.54	1579.63	1419.54	1366.56
65.0	1154.22	1174.54	1142.84	1016.36	905.10	810.28	804.02	810.28	905.10
70.0	1030.10	969.38	901.63	826.02	757.54	739.71	739.07	739.71	757.54
75.0	1081.83	1000.23	888.92	785.01	688.57	656.85	657.01	656.85	688.57
80.0	1215.17	1077.39	892.80	756.97	629.36	566.37	562.24	566.37	629.36
85.0	1492.73	1305.15	986.74	773.02	579.34	475.84	461.69	475.84	579.34

G/C [cd	135.0	150.0	165.0	180.0	195.0	210.0	225.0	240.0	255.0
45.0	1973.64	1951.58	1941.19	1974.73	1941.19	1951.58	1973.64	2006.14	2071.05
50.0	1828.23	1839.72	1968.48	2058.53	1968.48	1839.72	1828.23	1872.07	1946.26
55.0	1665.02	1759.30	1905.20	2059.99	1905.20	1759.30	1665.02	1690.63	1797.34
60.0	1372.33	1432.44	1520.55	1613.36	1520.55	1432.44	1372.33	1366.56	1419.54
65.0	1016.36	1142.84	1174.54	1154.22	1174.54	1142.84	1016.36	905.10	810.28
70.0	826.02	901.63	969.38	1030.10	969.38	901.63	826.02	757.54	739.71
75.0	785.01	888.92	1000.23	1081.83	1000.23	888.92	785.01	688.57	656.85
80.0	756.97	892.80	1077.39	1215.17	1077.39	892.80	756.97	629.36	566.37
85.0	773.02	986.74	1305.15	1492.74	1305.15	986.74	773.02	579.34	475.84

G/C [cd	270.0	285.0	300.0	315.0	330.0	345.0
45.0	2257.01	2071.05	2006.14	1973.64	1951.58	1941.19
50.0	2123.44	1946.26	1872.07	1828.23	1839.72	1968.48
55.0	2010.02	1797.34	1690.63	1665.02	1759.30	1905.20
60.0	1579.63	1419.54	1366.56	1372.33	1432.44	1520.55
65.0	804.02	810.28	905.10	1016.36	1142.84	1174.54
70.0	739.07	739.71	757.54	826.02	901.63	969.38
75.0	657.01	656.85	688.57	785.01	888.92	1000.23
80.0	562.24	566.37	629.36	756.97	892.80	1077.39
85.0	461.69	475.84	579.34	773.02	986.74	1305.15

Key to Figures:

[0067]

1. Downlight
2. Ceiling
3. Working plane
4. Wall light
5. Task light
6. Vertical wall
10. Luminaire
12. Housing
14. Cover
16. Side of 12
18. Top of 12
20. Lip of 12
22. Plates
24. Upper edge of 14
26. Lower edge of 14

28. Primary light-transmitting surface of 14
30. Secondary light-transmitting surface of 14
32. Left curved rectangular face of 28
34. Right curved rectangular face of 28
36. Central rectangular panel of 28
38. Side panel of 30
40. Substantially triangular in-fill panel of 30
42. Light source
44. Reflector
46. Electrical components
48. Cover member
50. Prism
52. Peg
54. Slot

Claims

1. A semi-recessed luminaire comprising:

a housing for a light source, the housing being adapted for recessing within a ceiling such that in use a lower surface of the housing is substantially flush with the ceiling, and
a light-transmitting cover which is mountable below the housing, the cover having
a primary light-transmitting surface which allows light to be transmitted from the light source, or via a reflector, through the cover to an area below the luminaire, and
a secondary light-transmitting surface which allows light to be transmitted from the light source, or via a reflector, through the cover to a region of the ceiling positioned to the side of the luminaire.

2. The luminaire according to claim 1, wherein the secondary light-transmitting surface is provided with a plurality of features to deflect light that is incident from the light source or a reflector towards a region of the ceiling to the side of the luminaire.

3. The luminaire according to claim 2, wherein
the plurality of features preferably comprises a plurality of prisms or lenses that are arranged to refract light.

4. The luminaire according to either of claims 2 or 3, wherein
the plurality of features are triangular prisms having one side that is substantially perpendicular to a side of the cover and/or one side provided by the side of the cover and for a hypotenuse which constitutes a lower side.

5. The luminaire according to either of claims 3 or 4, wherein
the plurality of prisms also provide a plurality of reflecting surfaces which are angled to reflect light incident from the light source or reflector or from generally within the luminaire, towards a region of the ceiling to the side of the luminaire.

6. The luminaire according to any of claims 3 to 5, wherein a reflecting surface is provided by an upper surface of the prism.

7. The luminaire according to any of the previous claims, wherein a combination of refraction and reflection is preferably used to lead to the overall lighting effect of the luminaire.

8. The luminaire according to any of the previous claims, wherein sufficient light is directed via the secondary light-transmitting surface, so that the average wall illuminance above the working plane, from both direct and indirect components is at least 50% of the average horizontal illuminance on a working plane arranged below the luminaire.

9. The luminaire according to any of the previous claims, wherein the average illuminance on the ceiling, from both the direct and reflected components, is at least 30% of the average horizontal illuminance across the working plane.

10. The luminaire according to any of the previous claims, wherein the luminaire's luminance is close to but preferably below 1500 cd/m^2 at locations above the elevation of 65° from the vertical.

11. The luminaire according to any of the previous claims, wherein this luminance limit preferably applies to both ceiling and walls.

12. The luminaire according to any of the previous claims, wherein the luminaire generates an illuminance of at least 200 lux on a working plane arranged below the luminaire.

13. The luminaire according to any of the previous claims, wherein the luminaire generates an illuminance of between 300 to 500 lux on the working plane.

14. The luminaire according to any of the previous claims, wherein the plurality of features is provided by an array of prisms arranged on the internal surface of the side of the cover, in particular triangular prisms.

15. The luminaire according to claim 14, wherein the plurality of features comprise triangular prisms having an upper surface that is inclined at an angle of 5° or more to the horizontal but not more than 30°.

16. The luminaire according to either of claims 14 or 15, wherein the triangular prisms have an upper surface that is inclined at an angle of between 10° and 22°.

17. The luminaire according to any of claims 14 to 16, wherein the triangular prisms have an upper surface that is inclined at an angle of about 16° to the horizontal ($\pm$3°).

18. The luminaire according to any of claims 3 to 17, wherein the triangular prism is substantially a right angled triangular prism with the upper surface provided by a side perpendicular to the cover and a lower surface defining a hypotenuse.

19. The luminaire according to claim 18, wherein the included angle at the apex between the upper and lower surfaces is between 42° and 52°, more preferably 45° and 49° and most preferably around 47°.

20. The luminaire according to any of claims 9 to 19, wherein the lower surface of the prism is angled at between 15° and 47° to the horizontal, more preferably between 20° and 42°, yet more preferably between 25° and 37°, and most preferably between 28° and 34°, the most preferred angle is around 31° to the horizontal.

21. The luminaire according to any of claims 3 to 20, wherein the prisms are arranged at slightly different angles to spread the illumination coming from either the refraction of the light through the prisms or the reflection of the light on the upper surfaces.

22. The luminaire according to any of the previous claims, wherein the side of the cover bows outwardly so that it extends beyond the footprint of the housing.

23. The luminaire according to any of the previous claims, wherein the lower surface of the cover has a curved profile and the side of the cover descends smoothly from the housing to join the edge of this lower surface.

24. The luminaire according to any of the previous claims, wherein the extent of the structure which extends from the ceiling is minimal and should not interfere with sprinkler spray patterns.

25. The luminaire according to any of the previous claims, wherein the lower surface and side of the cover are co-extruded to provide a cover member.

26. The luminaire according to any of the previous claims, wherein the cover member covers substantially half of the opening of the housing.

27. The luminaire according to any of the previous claims, wherein the luminaire uses existing linear fluorescent lamps as the light source.

28. The luminaire according to claim 1, wherein the secondary, light-transmitting surface is clear.

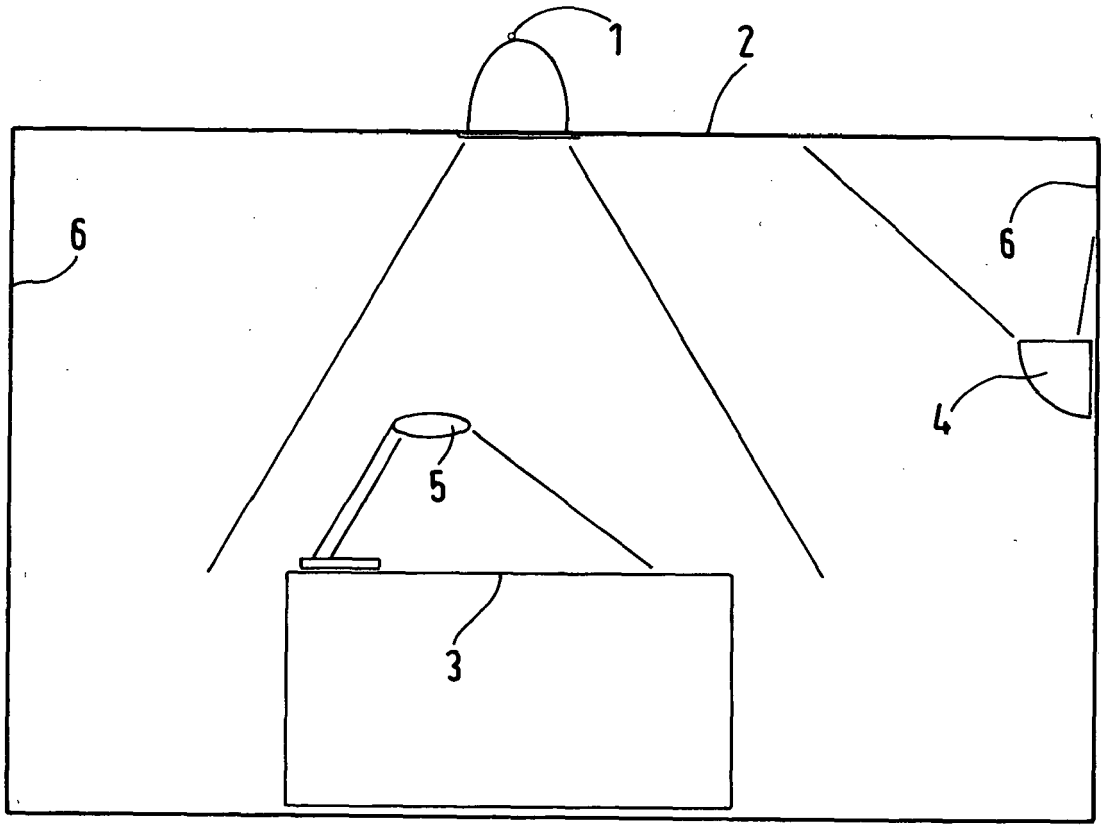


FIG.1

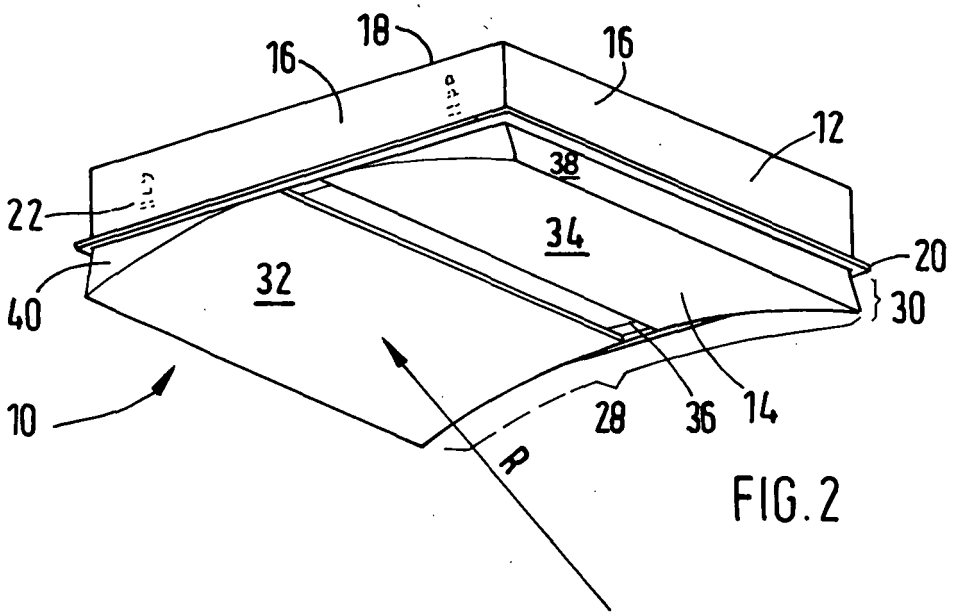


FIG. 2

FIG. 3a

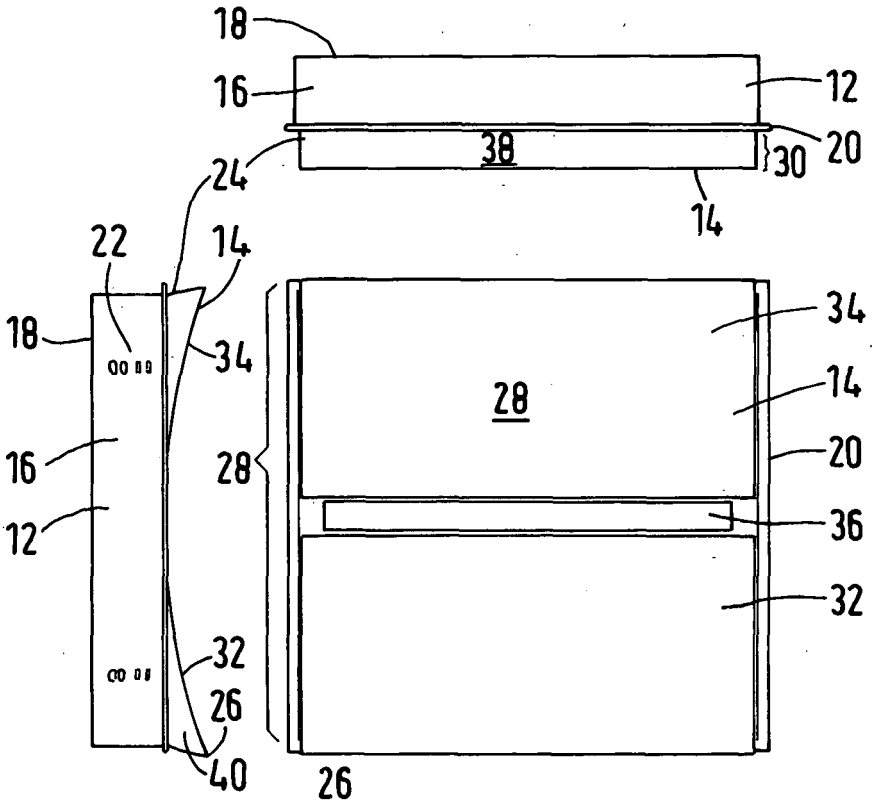


FIG. 3b

FIG. 3c

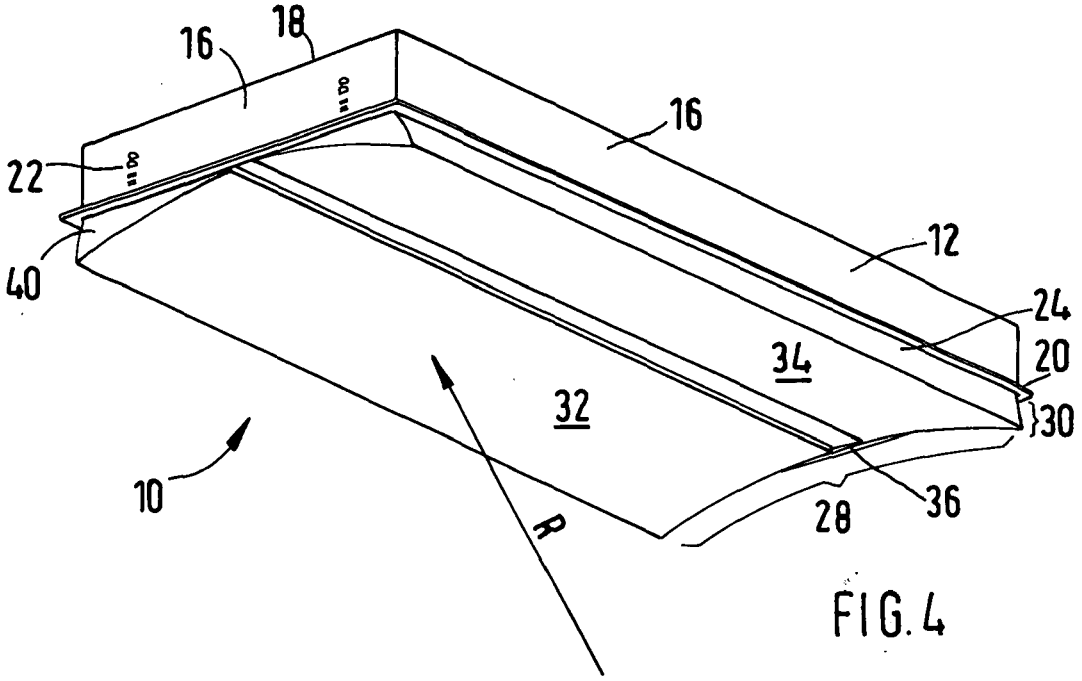


FIG.4

FIG.5a

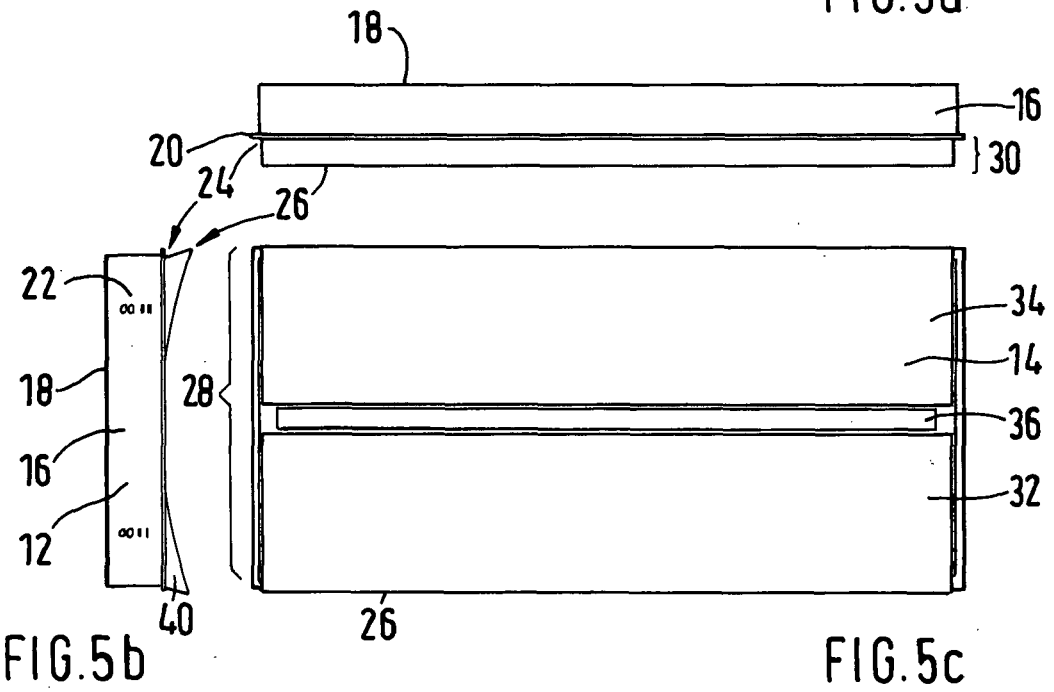


FIG.5b

FIG.5c

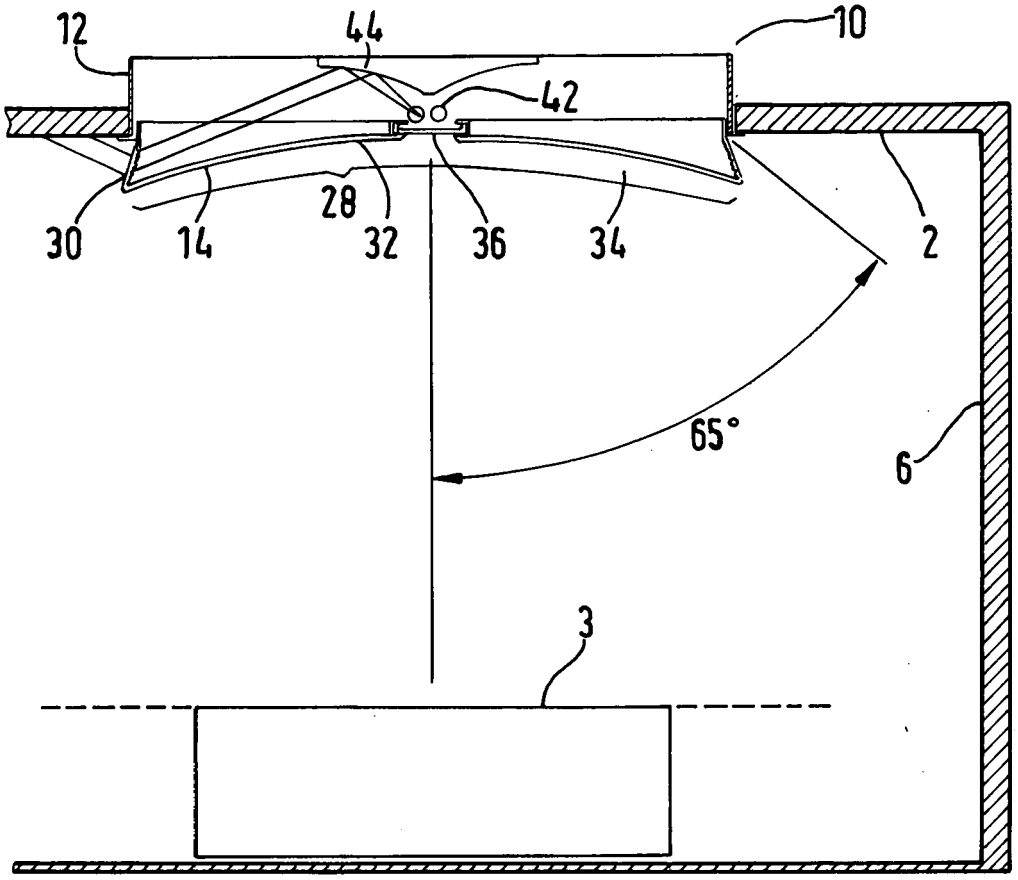


FIG.6

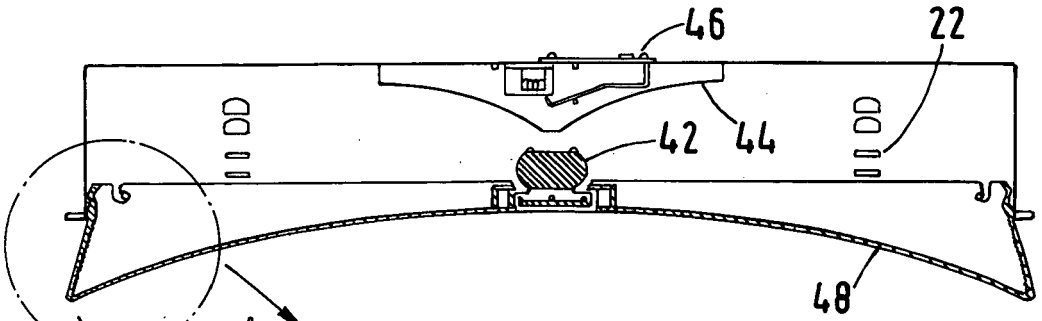


FIG. 7a

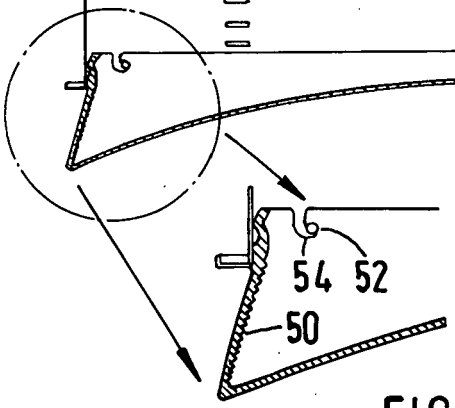


FIG. 7b

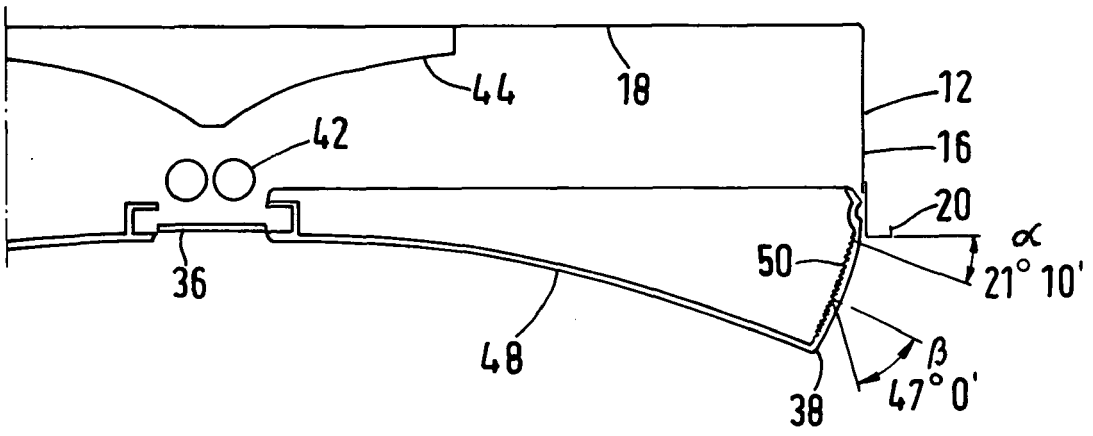

44
18
12
42
16
20
α
21° 10'
50
36
48
β
47° 0'
38

FIG. 8a

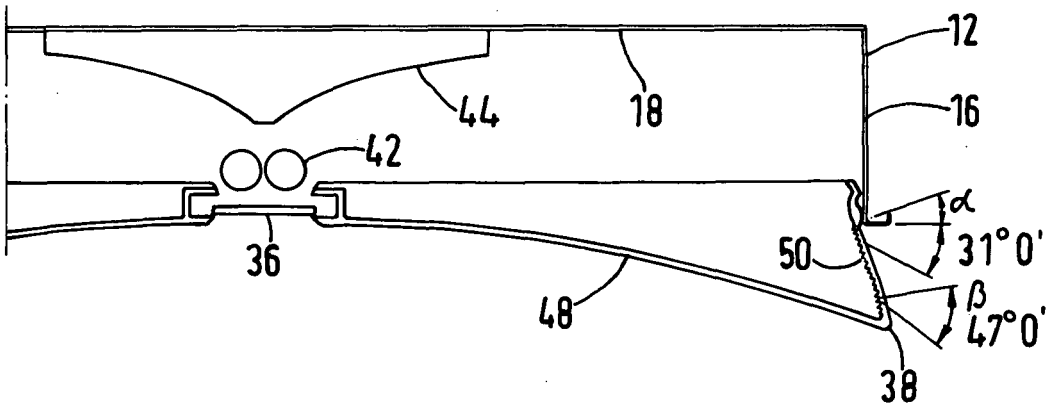

12
44
18
16
42
α
31° 0'
50
36
β
47° 0'
48
38

FIG. 8b

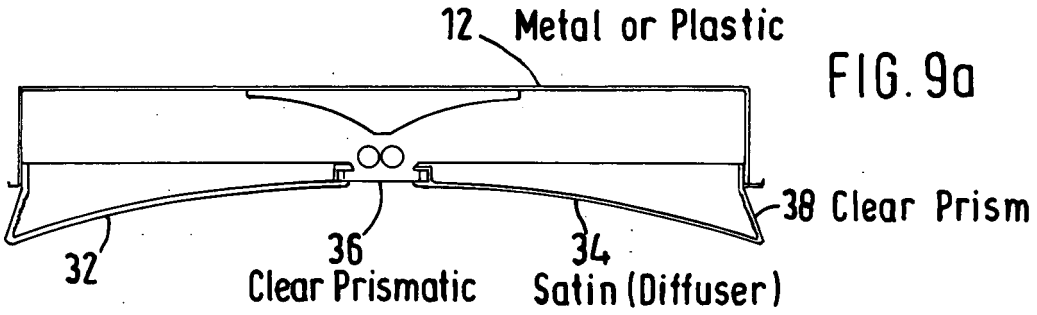


FIG. 9a

Other Possible Variations

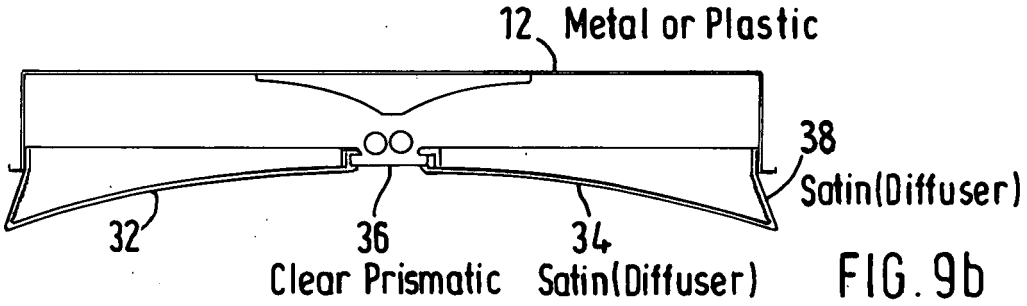


FIG. 9b

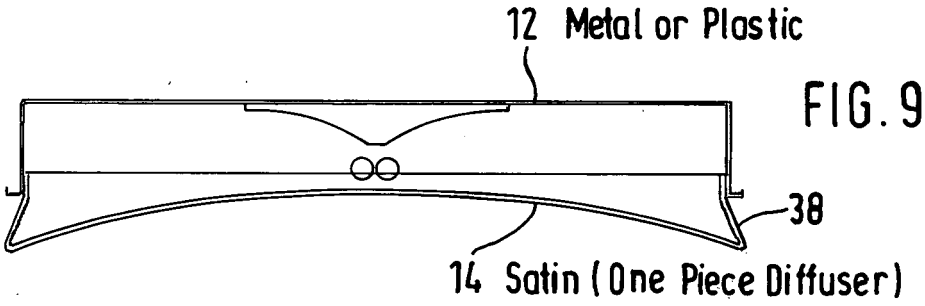


FIG. 9c

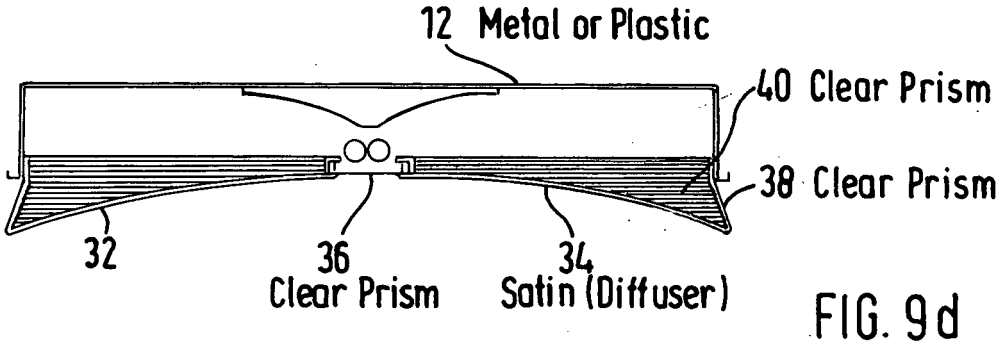


FIG. 9d

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 10 5318

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2005/015078 A (KONINKL PHILIPS ELECTRONICS NV [NL]; WIJBENGA HENDRIK [NL]; ENTROP JEA) 17 February 2005 (2005-02-17) * page 4, line 23 - page 6, line 4; figures 1-3 *	1-4, 14-17, 25,28	INV. F21V7/00 F21S8/04
A		5-13, 18-21, 24,26	

X	DE 203 14 606 U1 (UNGER PATENT UND LIZENZGMBH SE [CH]) 27 November 2003 (2003-11-27) * paragraph [0004] - paragraph [0020]; figures 1-3 *	1-3,22, 25,27	

X	US 3 159 352 A (WAKEFIELD GEORGE P ET AL) 1 December 1964 (1964-12-01) * column 1, line 9 - column 4, line 35; figures 1-8 *	1-3,22, 23,25,27	
	-----		TECHNICAL FIELDS SEARCHED (IPC)
			F21V F21S

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 April 2007	Arboreanu, Antoniu

CATEGORY OF CITED DOCUMENTS

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