(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 September 2007 (20.09.2007)

PCT

(10) International Publication Number
WO 2007/106020 A1

(51) International Patent Classification:
G02B 6/00 (2006.01) *F21V 11/00* (2006.01)
F21V 8/00 (2006.01) *F21V 7/00* (2006.01)

(21) International Application Number:
PCT/SE2007/000245

(22) International Filing Date: 13 March 2007 (13.03.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/781,734 14 March 2006 (14.03.2006) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

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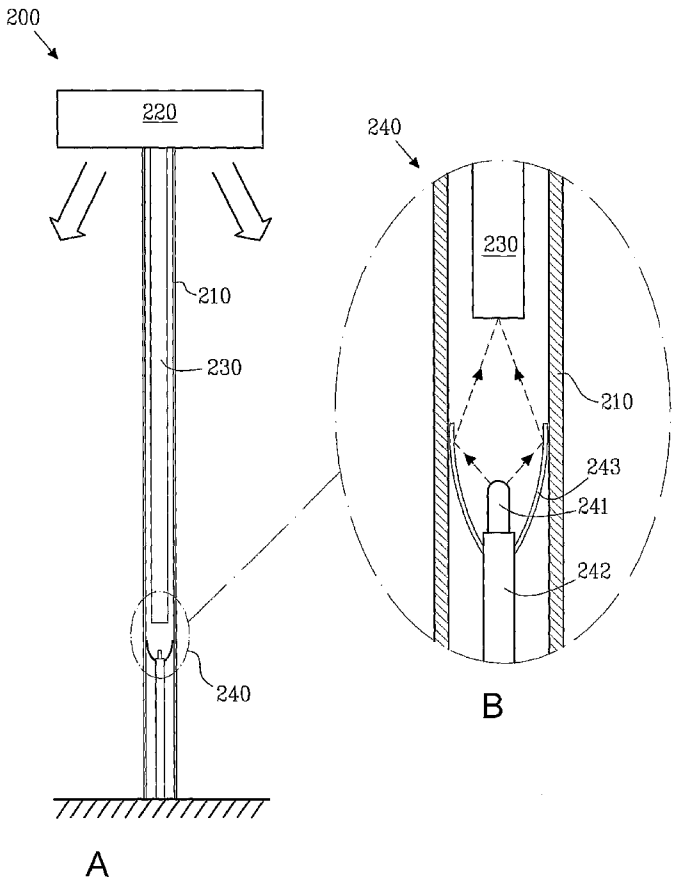
(54) Title: ILLUMINATION ARRANGEMENT



(57) Abstract: The present invention provides an illumination arrangement 100, 200 for illuminating an object, and comprising a column arrangement 100, 110, 200, 210, a light source 240, and a light director 120, 220, 420, 620. The illumination arrangement 100, 200 is characterized in that: the column arrangement 100, 110, 200, 210 comprises a light guide 230, 430, 530, 630; the light source 240 is arranged at or near a first end of the column arrangement 100, 110, 200, 210 so as to emit light into the light guide 230, 430, 530, 630; the light guide 230, 430, 530, 630) is arranged to transport the light from the light source 240 to the light director 120, 220, 420, 620; the light director 120, 220, 420, 620 is arranged at or near a second end of the column arrangement 100, 110, 200, 210 so as to direct the light onto the object to be illuminated.

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TITLE

Illumination arrangement

TECHNICAL FIELD

The present invention relates to illumination arrangements, *e.g.* to indoor and outdoor illumination arrangements.

BACKGROUND OF THE INVENTION

It is well known in the art that a proper illumination of an object often requires a light source that is arranged at some distance from the illuminated object. This is particularly so when it comes to street lights and similar illumination arrangements wherein the light source is usually arranged several meters above the illuminated object, *i.e.* the roadway and the objects thereon. The same or similar situation may occur, *e.g.* in public premises such as assembly-halls and other large indoor localities with high ceilings.

If the light source is arranged at a fairly large distance above the ground or some other object to be illuminated this will typically be a disadvantage when the light source has to be replaced. A replacement may *e.g.* require a ladder, a sky-lift or some other access equipment. Such equipment is often costly and the use of the equipment will typically add time to the replacement.

Besides, a light source arranged at a large distance from the object to be illuminated usually requires some kind of directivity for the light. Today this is typically accomplished by simple reflectors having a limited ability to direct the light in various directions and which usually provides a single substantially continuous cone of light, *i.e.* a rather static and inflexible direction of the light from the light source.

In addition, a light source arranged at a large distance from the object to be illuminated will typically require a cable or similar for transporting electricity to the light source. In many cases the light source is supported by a pole, a column or the like being made of metal (*e.g.* steel or aluminum) or the like, which increases the risk that the column will come into contact with the cable and become current carrying, *e.g.* if the cable and/or the light source support is damaged.

Moreover, for street lights in particular the height *above* the roadway is limited *i.a.* by the allowed operation height for the above mentioned access equipment such as ladders and sky-lifts etc. The distance *from* the roadway is determined *i.a.* by traffic security regulations. The distance *between* two adjacent light poles or light columns is determined by *i.a.* the power of the light source combined with the lowest acceptable luminosity value at the roadway. Taken separately and in particularly taken together this leads to an unfavorable dimensioning and outplacement of the poles or columns, especially with regard to an efficient illumination, an economic operation and an effective installation.

In addition, typical street lights have an unfavorable design in respect of road safety. The poles or columns of the street light have a high dead weight and a high center of gravity, which induces the pole or column to fold when it is hit by a vehicle so as to deform the roof of the vehicle.

Furthermore, the heat from the light source will cause dirt, pollen, bugs etc to burn and stuck to the light source or the transparent protective shield if used, which lowers the efficiency of the light arrangement.

From the above it should be clear that there is a need for an improved light arrangement that exhibits at least one of: improved installation and maintenance properties, improved use and operation properties, more resistant to damages, and/or an improved directivity for the light.

SUMMARY OF THE INVENTION

The invention provides for a light arrangement utilizing optical transportation of light from a light source to a light director for the purpose of illuminating one or several objects.

This is accomplished by a column arrangement for illuminating an object, which column arrangement comprises a light source, a light guide and a light director. The column arrangement is characterized in that:

- the light source is arranged near a first end of the column arrangement so as to emit light into the light guide;

- the light guide is arranged to transport the light from the light source to the light director;
- the light director is arranged at a second end of the column arrangement so as to direct the light onto the object to be illuminated.

The light guide can be arranged inside the column arrangement.

The light source can likewise be arranged inside the column arrangement.

The light guide can be substantially solid and made of a transparent material or a substantially transparent material.

The solid *light guide* can be made of a light weight material such as *e.g.* PMMA, or similar polymer material that can be easily polished to restore edges to substantially full transparency and which can be joined by dissolving and solidifying to form an almost invisible weld.

The *light director* can be made of a light weight material such as *e.g.* PMMA or similar polymer material that can be easily polished to restore edges to substantially full transparency and which can be joined by dissolving and solidifying to form an almost invisible weld.

The light director can have the form of a prism.

The light director can be shaped as at least one of: a reflective prism and a refractive prism. In addition, the light director can be formed so as to guide the light to hit the object to b e illuminated.

The light director can be a reflector.

The light director can be a saddle shaped reflector.

The reflector can be movable so as to assume different distances and angles with respect to the light emitting end of the light guide.

The column arrangement can be arranged as a street light.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1a shows a schematic illustration of a street light 100 according to an embodiment of the present invention.

Fig. 1b shows a schematic illustration of a street light 200 according to another embodiment of the present invention.

Fig. 2a shows the street light 200 in Fig. 1B with the schematic addition of an interior light guide 230 and an interior light source 240.

Fig. 2b shows a schematic and detailed image of the interior of the lower end of the I-shaped column 210 of the street light 200.

Fig. 2c shows another more detailed image of the interior of the lower end of the I-shaped column 210 of the street light 200.

Fig. 3a shows the interior as is shown in Fig. 2b, however with the addition of two section lines A–A and B–B.

Fig. 3b shows a cross-section of the column 210 and the light guide 230 in Fig. 3a.

Fig. 3c shows the same cross-section as in Fig. 3b, however with another light guide.

Fig. 3d shows a cross-section of the column 210, the reflector 243 and the light emitter 241.

Fig. 4a shows a schematic side view of a light director 420 according to an embodiment of the invention.

Fig. 4b shows a schematic top view of the light director 420 in Fig. 4a.

Fig. 4c shows details of an exemplifying path for the light traveling in the light director 420.

Fig. 5a shows two light directors 420 of the kind shown in Fig. 4a–4c.

Fig. 5b shows a top view of the two light directors 420 in Fig. 5a.

Fig. 6a shows a view from the side of a light director 620 shaped as an essentially circular disk.

Fig. 6b shows a top view of the two light director 620 in Fig. 6a.

Fig. 7a shows an embodiment with a saddle shaped reflector for a rectangular illumination profile.

Fig. 7b shows an example of a rectangular illumination profile from the saddle shaped reflector.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Fig. 1a shows a schematic illustration of a street light 100 according to an embodiment of the present invention. The street light 100 has an L-shaped column 110 arranged on the ground in an upside down position. At the top of the column there is a light director 120 attached to the "toe" of the L-shape so as to enable an illuminating of the ground below. The light leaving the light director 120 is indicated by two arrows, which illustrate that an embodiment of the light director 120 can be designed to accomplish two or more separate light beams pointing at slightly different angles toward the objects to be illuminated.

Fig. 1b shows a schematic illustration of a street light 200 according to another embodiment of the present invention. The street light 200 has a straight I-shaped column 210 arranged on the ground. At the top of the I-shaped column there is a light director 220 attached to enable an illuminating of the ground below. The light leaving the light director 220 is indicated by two arrows illustrating that an embodiment of the light director 220 can accomplish two or more separate light beams pointing at slightly different angles toward the objects to be illuminated.

As will be further explained below the light is transported to the light director 120, 220 from a light source (not shown in Fig. 1a-1b) arranged at the bottom end of the column 110, 210. A transportation of light from the light source to the light director 120, 220 is accomplished by one or several light guiding channels (not shown in Fig. 1a-1b), which are preferably arranged inside the column 110, 210. Hence, there are preferably no electrical cables arranged within the column 110, 210 for transporting electricity to a light source arranged at the top of the column. Rather, it is light that is transported, not electricity.

Fig. 2a shows the street light 200 in Fig. 1B with the addition of an interior light guide 230 arranged along the inside of the I-shaped column 210, and a light source 240 arranged at the lower end of the I-shaped column 210. The light guide 230 is indicated by dashed lines to show that it is preferably arranged so as to extend within the column 210. The light source 240 is likewise preferably arranged within the column 210. However, it should be emphasized that other light arrangements may have the light source and the light guide arranged in another way, *e.g.* outside a possible column 210 or other support for the light director 220.

Fig. 2b shows a schematic and expanded image of the interior of the lower end of the I-shaped column 210 of the street light 200 in Fig. 1B. The lower end of the column comprises a light source 240, which in turn comprises a light emitter 241, a light emitter socket 242 and a reflector 243.

It should be emphasized that the I-shaped column is an example of a suitable column provided with a light source according to an embodiment of the present invention. Other columns having other shapes can also be provided with a light source according to an embodiment of the present invention. For example, the L-shaped column 110 of the street light 100 in Fig. 1A may have the same light source 241 arrange at the lower end of the L-shaped column 110. On the whole, embodiments of the present invention can be utilized in a vast number of different column arrangements in a vast variety of different environments – outdoors as well as indoors.

Regarding the light source 240 it is preferred that the light emitter 241 therein has a small light emitting volume and that it has a power of substantially 50–100 W. However, light emitters with lower as well as higher powers are clearly conceivable. A suitable light emitter may *e.g.* be a halogen lamp, a gas discharge lamp containing xenon or krypton, or alternatively one or several high power light emitting diodes (Solid State Lightening Light Emitting Diodes, SSL LEDs). Naturally, the light emitter socket 242 (if needed) is chosen and/or designed so as to fit the light emitter 241 to be used. The reflector 243 is preferably assuming the form of a part of an ellipsoid, *e.g.* half ellipsoid or less. This means that the reflector has the form of an ellipse or a part of an ellipse that is rotated so as to form a shape that is similar to the half or less of an egg. It is preferred that the ellipsoidal reflector comprises two foci. As can be seen in Fig. 2b the light emitter 241 is preferably arranged in or near one focus point of the ellipsoid-shaped reflector 243, whereas the entrance of the light guide 230 is arranged in or near the other focus point or similar of the ellipsoid-shaped reflector 243. The light from the light emitter 241 is reflected in the reflector 243 so as to enter an entrance end of the light guide 230. This has been schematically indicated in Fig. 2b by two dashed lines pointing at the entrance end of the light guide 230 and each comprising an arrow head.

Fig. 2c shows another expanded more detailed image of the interior of the lower end of the I-shaped column 210 of the street light 200. According to strictly exemplifying

dimensions the light guide 230 shaped as a substantially circular rod may *e.g.* have a diameter of approximately 30 millimeters. The light emitter 241 may *e.g.* be a lamp shaped as a circular pipe or a finger with a diameter of approximately 14 millimeters and which extends approximately 52 millimeter from the emitter socket 242. The reflector 243 forming a part of an ellipsoidal shape may *e.g.* have a maximum diameter of approximately 96 millimeters and a depth of approximately 52 millimeters. However, it should be strongly emphasized that the dimensions in Fig. 2c are examples and that other dimensions are clearly conceivable for other embodiments of the invention.

There are several advantages with having the light source 240 arranged at a distance from the light director 220, as illustrated in Fig. 2a–2b. It will *e.g.* be much easier and less risky to replace the light emitter 241. It is especially so if the illuminating light comes from a *high position*, *e.g.* as in the case with ordinary street lights. It is also an advantage if the *illuminating environment* makes a replacement risky, *e.g.* as the case may be in road tunnels where the replacement operation may have to be performed from the roadway. In this and other situations the light source 240 can be arranged in a safe environment and/or at a low height easily reachable by a service person of average height standing on the ground, whereas the light director can be arranged where the light is needed.

The efficiency of the light source 240 is also increased by the use of an advantageous reflector 243 for an improved focusing of the light from the light emitter 241 into the light guide 230.

The light guide 230 will now be described in more detail. It is preferred that the light guide 230 is shaped as a solid elongated rod. However, other shapes and forms are clearly conceivable, as will be discussed below. As can be seen in Fig. 2a the light guide 230 starts at the light source 240 – more precisely substantially in a foci point or similar of the reflector 243 as explained above – and it ends at the light director 220 of the street light 200. The termination of the light guide 230 at the light director 220 will be discussed in more detail below.

It is preferred that the light guide 230 is made of polymethylmethacrylate (PMMA). However, it should be emphasised that the invention is not limited to a use of PMMA. On the contrary, other suitable transparent or at least semitransparent materials can be used, which are preferably light weight.

Regarding polymethylmethacrylate (PMMA) or poly(methyl 2-methylpropanoate), with the chemical formula: (C5O2H8)*n*), it can be mentioned that PMMA is the synthetic polymer of methyl methacrylate. This thermoplastic and transparent plastic is sold by the tradenames Plexiglas, Perspex, Acrylite, Acrylplast, and Lucite and is commonly called acrylic glass or simply acrylic. PMMA has about half the density of glass and it can be joined by using cyanoacrylate cement (so-called "Superglue") or by using liquid di- or trichloromethane to dissolve the plastic at the joint which then fuses and sets to form an almost invisible weld. PMMA can also be easily polished to restore cut edges to full transparency.

Fig. 3a shows the same interior as is in Fig. 2b, however with the addition of two section lines A–A and B–B. The first section line A–A cuts the column 210 and the light guide 230 in a radial direction. In Fig. 3b the cross-section of the column 210 and the light guide 230 are illustrated seen in the direction of the two arrows A in Fig. 3a. It can be clearly seen from Fig. 3b that the exemplifying light guide 230 has a substantially circular shape and that it is substantially solid. However, other embodiments of the invention may use other cross-sections and shapes for the light guide, and the light guide must not necessarily be solid. Another example of a light guide is schematically illustrated in Fig. 3c, which shows the same cross-section as in Fig. 3b. However the light guide 230 in Fig. 3c has an interior that is not solid. Rather, the cross-section in Fig. 3c illustrates that the interior of the light guide 230 can be composed of a bundle of optical light guides 231 with *e.g.* a substantially circular cross-section. This leaves empty spaces within the light guide 230 that are essentially unable to guide any light.

An advantage with a light guide 230 in the form of a solid rod of a suitable cross-section is that the solidness gives a larger area for guiding light compared to *e.g.* bundle of light guides which typically leave empty spaces within the light guide 230. Compared to a bundle of light guides the short end of a single substantially solid rod is also much easier to grind and polish so as to accomplish a flat and smooth surface, which is essential for receiving the light from the light emitter 241 with a minimum of losses. On the other hand, in case optical fibers are used as a plurality of light guides they are typically easier to bend and form, which *e.g.* may be necessary if the distance from the light source to the light director extends along a curved path, *e.g.* if the column 210 of the street lamp 200 is curved.

The second section line B–B in Fig. 3a cuts the column 210, the reflector 243 and the light emitter 241 in a radial direction. In Fig. 3c the cross-section of the column 210, the reflector 243 and the light emitter 241 are illustrated seen in the direction of the two arrows B in Fig. 3a.

The attention is now directed to the light director of an illumination arrangement according to various embodiments of the present invention.

Fig. 4a shows a schematic side view of a light director 420 according to an embodiment of the present invention. The light director 420 is preferably solid and made of the same material as the light guide, *i.e.* preferably PMMA. However, other materials are clearly conceivable, *e.g.* other transparent or at least semitransparent materials preferably of light weight. Even though it is preferred that the light director 420 is solid other embodiments of the light director may have sides made of thin walls or the like leaving the interior of the light director at least partly hollow. However, it is still preferred that at least some of these walls are transparent or at least semi transparent, since this makes it possible to pass at least a part of the light through such walls in one or several directions that are separated from the main direction of the illuminating light, *e.g.* for illumination of the near surroundings of the light director 420 and not only the more distant surroundings.

It is preferred that the light director 420 in Fig. 4a has a shape that is similar to a parallelepiped, *i.e.* a rectangular box that is skewed. Hence, similar to an ordinary box the light director 420 has four long sides that extend essentially parallel to each other. The top and bottom long sides are joined by to two vertical sides opposing each other. However, unlike the sides in an ordinary rectangular box each vertical side of the light director 420 has a first short *end* inclined at an angle of approximately 55° with respect to the bottom long side, and a second short *end* inclined at an angle of approximately 70° angle with respect to the top long side. This means that the first short *side* extends at an angle of approximately 55° with respect to the bottom long side and that the second short *side* extends at an angle of approximately 70° with respect to the top long side.

In Fig. 4a it can also be seen that the light director 420 is attached to a light guide 430. The light guide 430 is essentially the same as the light guide 230. However, it is preferred

that the light guide 430 has a substantially quadratic or rectangular cross-section so as to fit the box shaped light director 420.

Fig. 4b shows a schematic top view of the light director 420 in Fig. 4a.

In Fig. 4a the light from the light guide 430 has been indicated by an arrow and the light leaving the light director 420 for the purpose of illuminating an object has been indicated by an arrow in asimilar way.

Fig. 4c shows details of the traveling path for the light entering the light director 420 from the light guide 430 . The light leaving the light guide 430 is reflected in the first short side of the light director 420 extending at an angle of approximately 55° with respect to the bottom long side as described above. The major part of the light is reflected again in the horizontal top side so as to be directed towards the second short side of the light director 420 that extends at an angle of approximately 70° with respect to the top long side as described above.

In addition, the light guide 430 may be provided with a shade 440 at the outer end where the light is leaving the light guide 430. The exemplifying shade 440 in Fig. 4c is preferably attached to the light guide 430 so as to extend with an angle of approximately 20° with respect to the upper long side of the light guide 430. The shape of the underside of the shade 440 is preferably curved – e.g. a substantially half cylinder – with a metallic luster so as to reflect the incident light.

Moreover, exemplifying dimensions of the light director 420 in Fig. 4c may be a length of the top long side of approximately 115 millimeters, whereas the bottom long side may be approximately 103 millimeters, plus the approximately 30 millimeters that is occupied by the attached light guide 430. The height of the light director 420 may be approximately 54 millimeters.

Naturally the angles and the dimensions of the light director 420 are chosen with respect to the properties of the material (*e.g.* the refraction index for the material) of which the light director is made (*e.g.* PMMA), so that the desired traveling path for the light is achieved for the light inside as well as for the light leaving the light director. It should therefore be emphasized that the dimensions given above is strictly exemplifying. For

example, the indicated angles may be suitable for an illumination from a height of substantially four meters and a distance of up to substantially 30 meters from the column in question. Naturally, other dimension should be chosen for other geometries.

Fig. 5a shows two light directors 420 of the same or similar kind as the one shown in Fig. 4a–4c. The light directors 420 in Fig. 5a are preferably arranged on a rectangular light guide 530 and in opposite directions so as to direct the light in opposite directions. Fig. 5b shows a top view of the two light directors in Fig. 5a.

Fig. 6a shows a view from the side of a light director 620 that is shaped as an essentially circular disk. The center of the disc is provided with a cone-shaped recess wherein the walls of the cone have an angle of approximately 55° with respect to the bottom side of the light director 620, *i.e.* the bottom side of the disc. From the side the light director 620 resembles the light directors 420 as described above with reference to Fig. 4a–4c. The disc shaped light director 620 is preferably attached to a light guide 630 having a substantially circular cross-section. Fig. 6b shows a top view of the light director in Fig. 6a.

In optics the light directors 420, 520 and 620 in Fig. 4a–6b falls in the category called prism. A prism is a device used to refract light, reflect it or break it up (to disperse it) into its constituent spectral colors (e.g. the colors of the rainbow). The traditional geometrical shape is that of a triangular prism, with a triangular base and rectangular sides. However, a prism can assume many other shapes and some types of optical prisms are not in fact in the shape of geometric prisms. The light directors 420 and 520 in Fig. 4a–5b may be perceived as an ordinary prism, whereas the light director 620 may perhaps be perceived as a more unusual prism. However, the common feature is that the prisms that are used as light directors in embodiments of the present invention are preferably refracting and reflecting prisms, wherein the reflection may be a total internal reflection as illustrated in Fig. 4c or a partial reflection, which admits some of the incident light to pass through the reflecting side of the prism.

Fig. 7a discloses an embodiment with a light director in the form of a saddle shaped reflector 710 for a substantially rectangular illumination profile on the ground. The light is emanating from a light source 740 being the same or at least similar to the light source 240 as described above with reference to Fig. 2a–2c. The light is transported in a light

guide 730 comprising a plurality of light guides, *i.e.* a light guide being the same or at least similar to the light guide 230 comprising a bundle of optical light guides 231 as described above with reference to Fig. 3a and 3c. The light emitting ends of the optical light guides are bent and grouped so as to direct light into the underside of the saddle shaped reflector 710 at two different points. The light is thereby reflected in the saddle shaped reflector 710, which creates a substantially rectangular illumination profile 750 on the ground below the reflector. This is schematically illustrated in Fig. 7b.

It should be added that the saddle shaped reflector is preferably movable so as to assume different distances and angles with respect to the light emitting fiber ends. The movability of the reflector can be used to create other illumination profiles on the ground below the reflector.

The present invention has now been described with reference to exemplifying embodiments. However, the invention is not limited to the embodiments described above. On the contrary, the full extent of the invention is determined by the scope of the appended claims.

Reference signs

100	Street Light
110	L-shaped Column
120	Light Director / Reflector
200	Street Light
210	I-shaped Column
220	Light Director / Reflector
230	Light Guide
231	Bundle of Light Guides
240	Light Source
241	Light Emitter
242	Light Emitter Socket
243	Reflector
420	Light Director (e.g. Prism)
430	Light Guide (e.g. quadratic)
440	Shade
530	Light Guide (e.g. rectangular)
620	Light director (e.g. circular)
630	Light Guide
710	Reflector
730	Light Guide
740	Light Source
750	Illumination Profile

CLAIMS

1. A illumination arrangement (100, 200) for illuminating an object, and comprising a column arrangement (100, 110, 200, 210), a light source (240), and a light director (120, 220, 420, 620),
characterized in that:
   - the column arrangement (100, 110, 200, 210) comprises a light guide (230, 430, 530, 630);
   - the light source (240) is arranged at or near a first end of the column arrangement (100, 110, 200, 210) so as to emit light into the light guide (230, 430, 530, 630);
   - the light guide (230, 430, 530, 630) is arranged to transport the light from the light source (240) to the light director (120, 220, 420, 620);
   - the light director (120, 220, 420, 620) is arranged at or near a second end of the column arrangement (100, 110, 200, 210) so as to direct the light onto the object to be illuminated.

2. Illumination arrangement (100, 200) according to claim 1,
characterized in that:
the light guide (230, 430, 530, 630) is arranged inside the column arrangement (100, 110, 200, 210).

3. Illumination arrangement (100, 200) according to claim 1 or 2,
characterized in that:
the light source (240) is arranged inside the column arrangement (100, 110, 200, 210).

4. Illumination arrangement (100, 200) according to claim 1 or 2,
characterized in that:
the light guide (230, 430, 530, 630) is substantially solid and made of a transparent material or a substantially transparent material.

5. Illumination arrangement (100, 200) according to claim 1, 2 or 4,
characterized in that:
the light guide (230, 430, 530, 630) is made of a light weight material that can be easily polished to restore edges to substantially full transparency and which can be joined by dissolving and solidifying to form an almost invisible weld.

6. Illumination arrangement (100, 200) according to any of claim 1–5, characterized in that:
the light director (120, 220, 420, 620) is made of a light weight material that can be easily polished to restore edges to substantially full transparency and which can be joined by dissolving and solidifying to form an almost invisible weld.

7. Illumination arrangement (100, 200) according to any of claim 1–6, characterized in that:
the light director (120, 220, 420, 620) have the form of a prism.

8. Illumination arrangement (100, 200) according to claim 7, characterized in that:
the light director (120, 220, 420, 620) is shaped as at least one of: a reflective prism or a refractive prism; formed so as to guide the light to hit the object to be illuminated.

9. Illumination arrangement (100, 200) according to any of claim 1–5, characterized in that:
the light director is a reflector.

10. Illumination arrangement (100, 200) according to any of claim 9, characterized in that:
the light director is a saddle shaped reflector.

11. Illumination arrangement (100, 200) according to any of claim 9–10, characterized in that:
the reflector is movable so as to assume different distances and angles with respect to the light emitting end of the light guide (230, 430, 530, 630).

12. Illumination arrangement (100, 200) according to any of claim 1–6, characterized in that:
the Illumination arrangement (100, 200) is arranged as a street light.

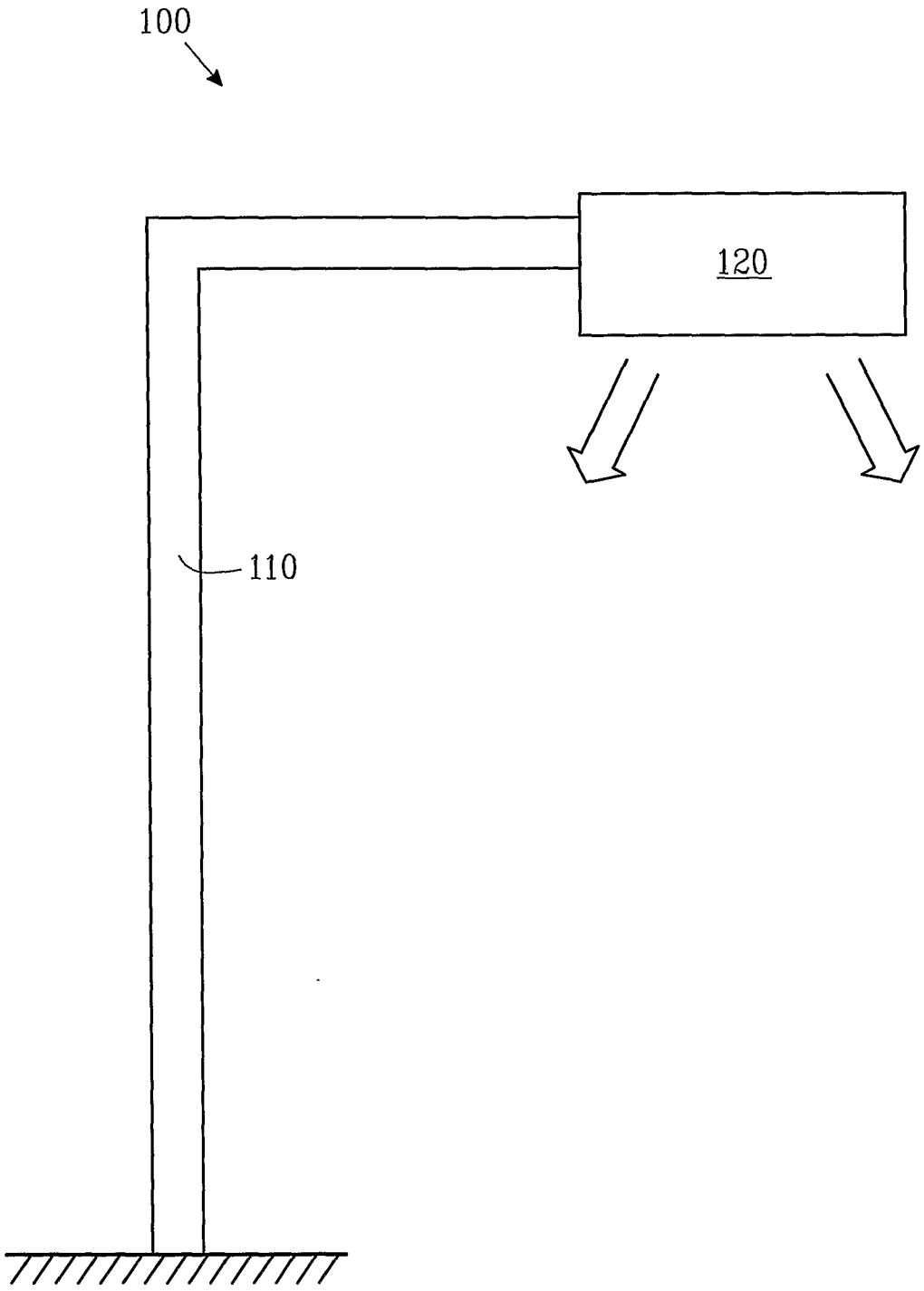

Fig. 1a

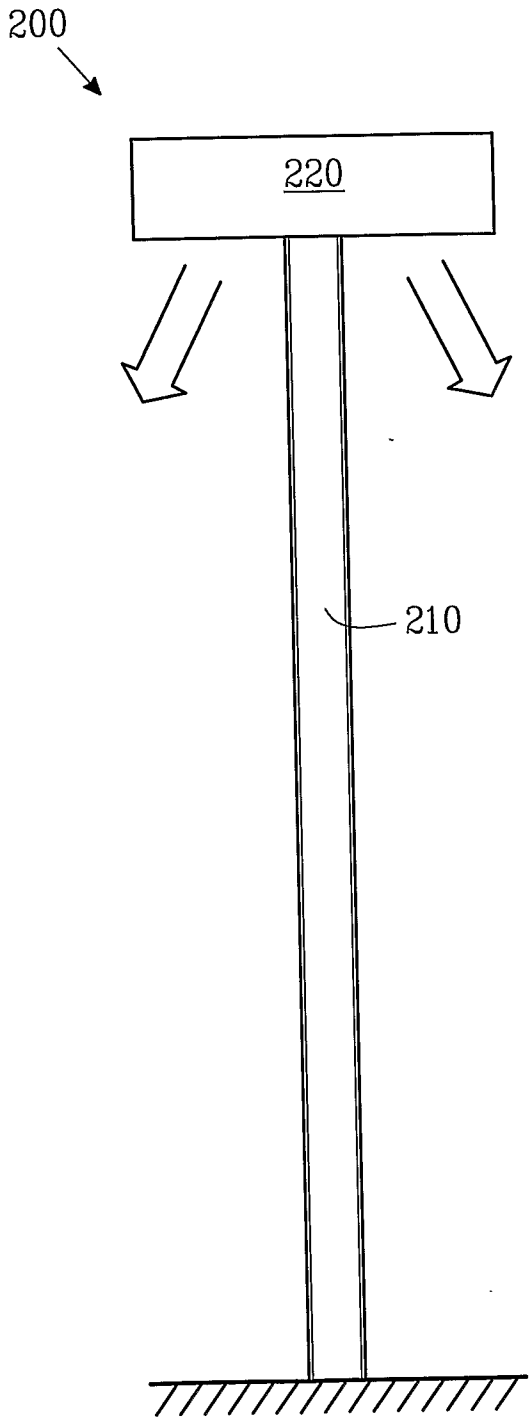

Fig. 1b

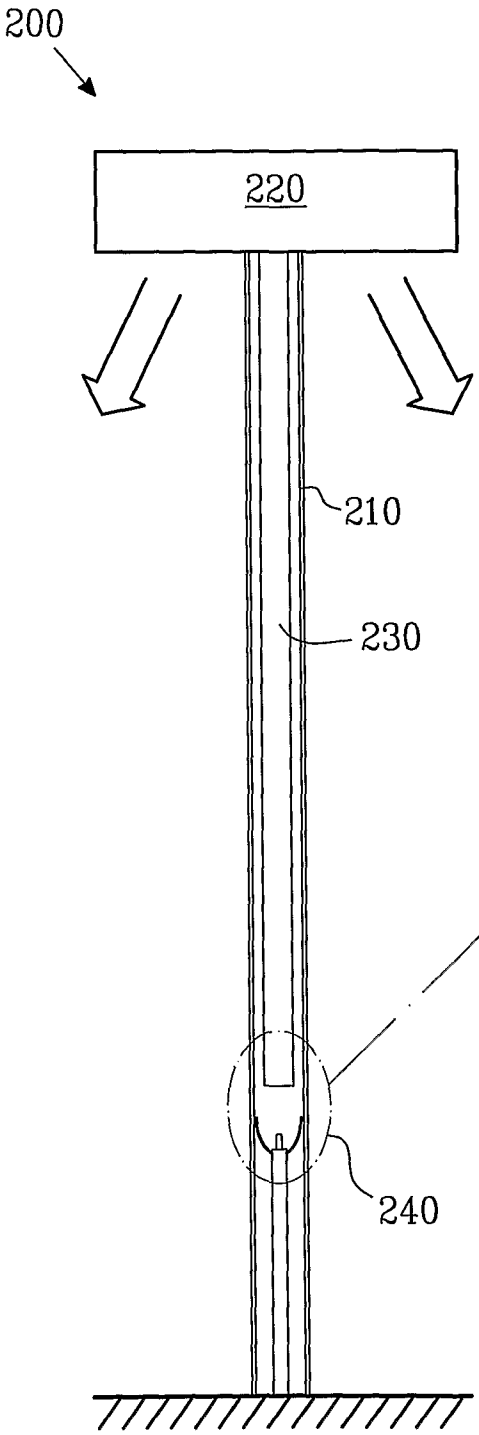

Fig.2a

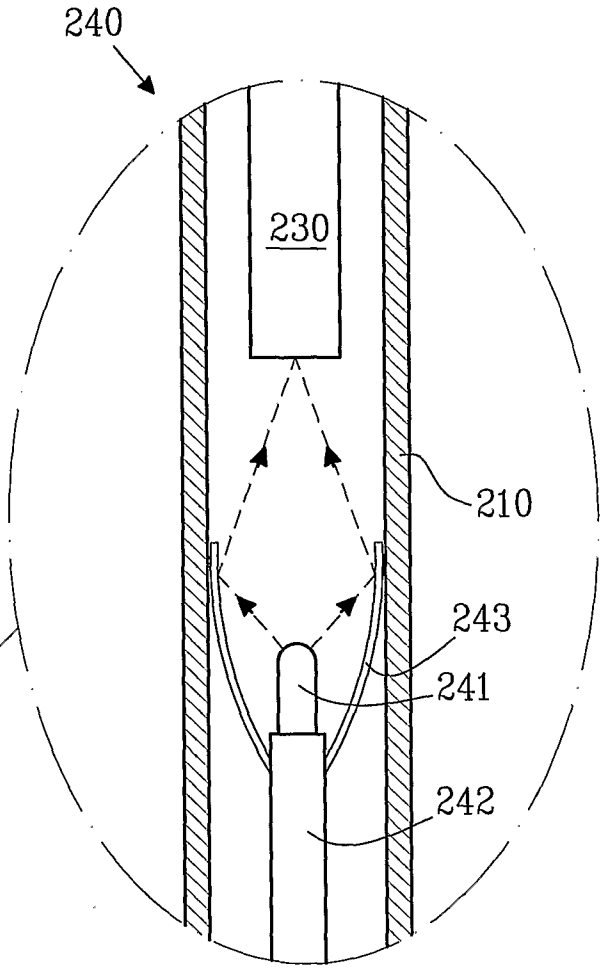

Fig.2b

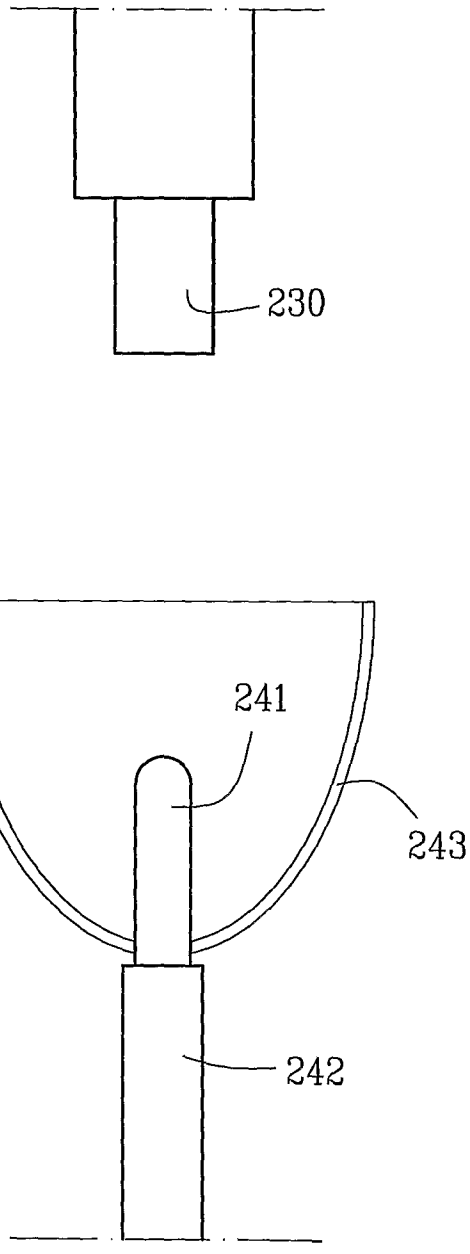

Fig.2c

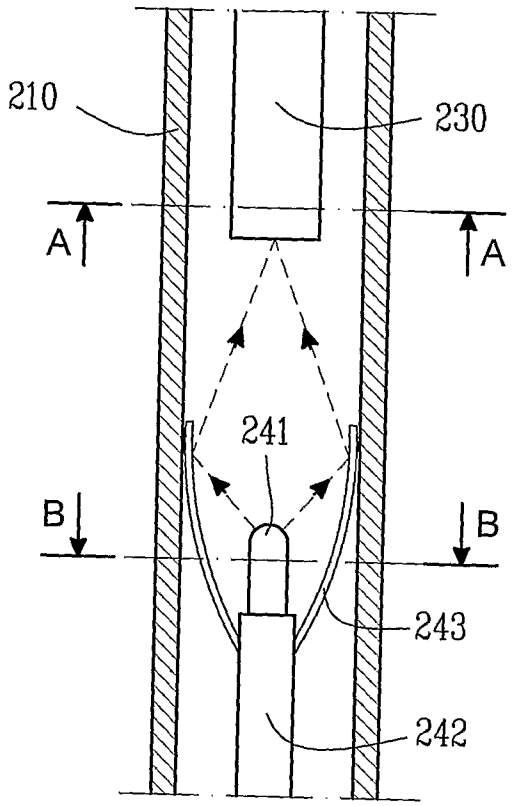

Fig.3a

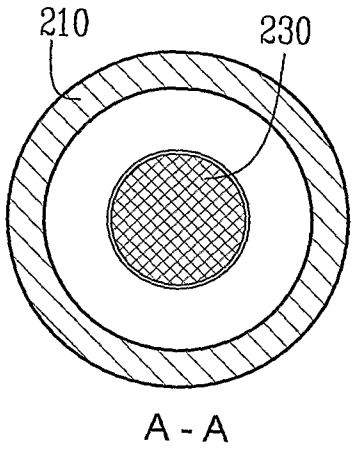

Fig.3b

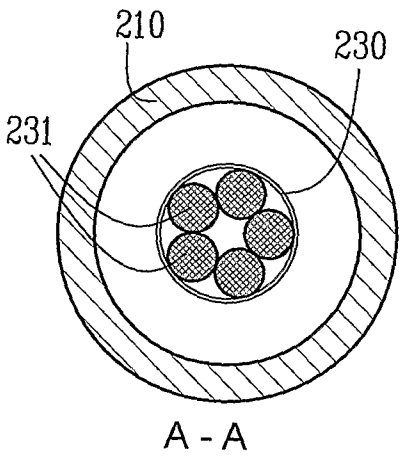

Fig.3c

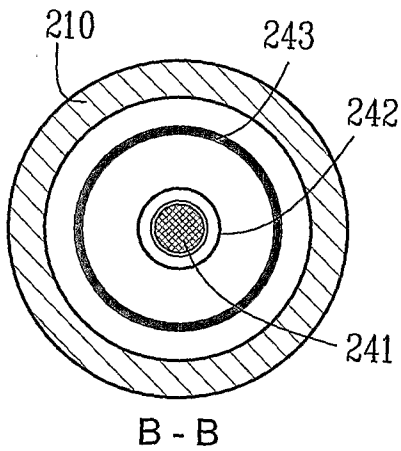

Fig.3d

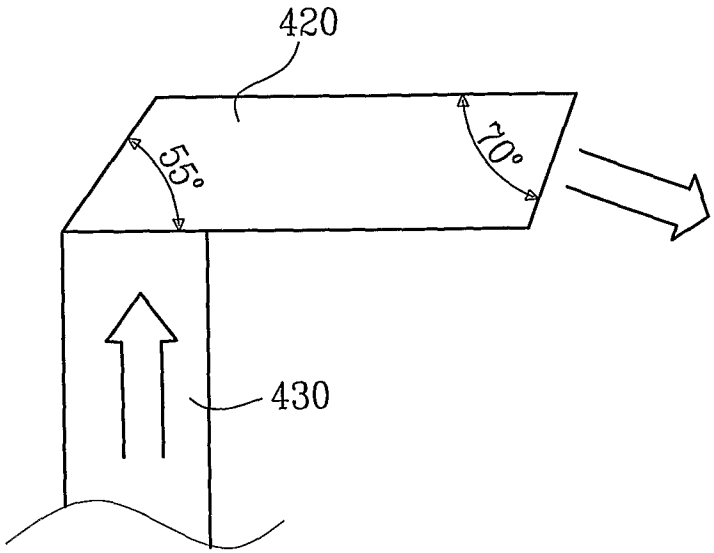

Fig. 4a

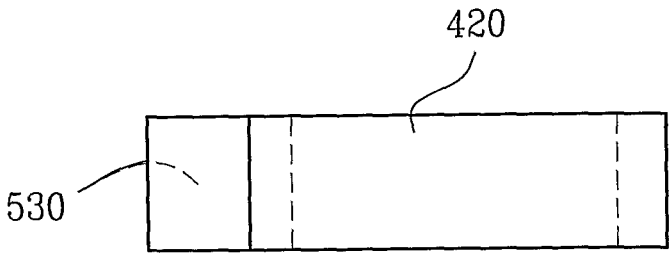

Fig. 4b

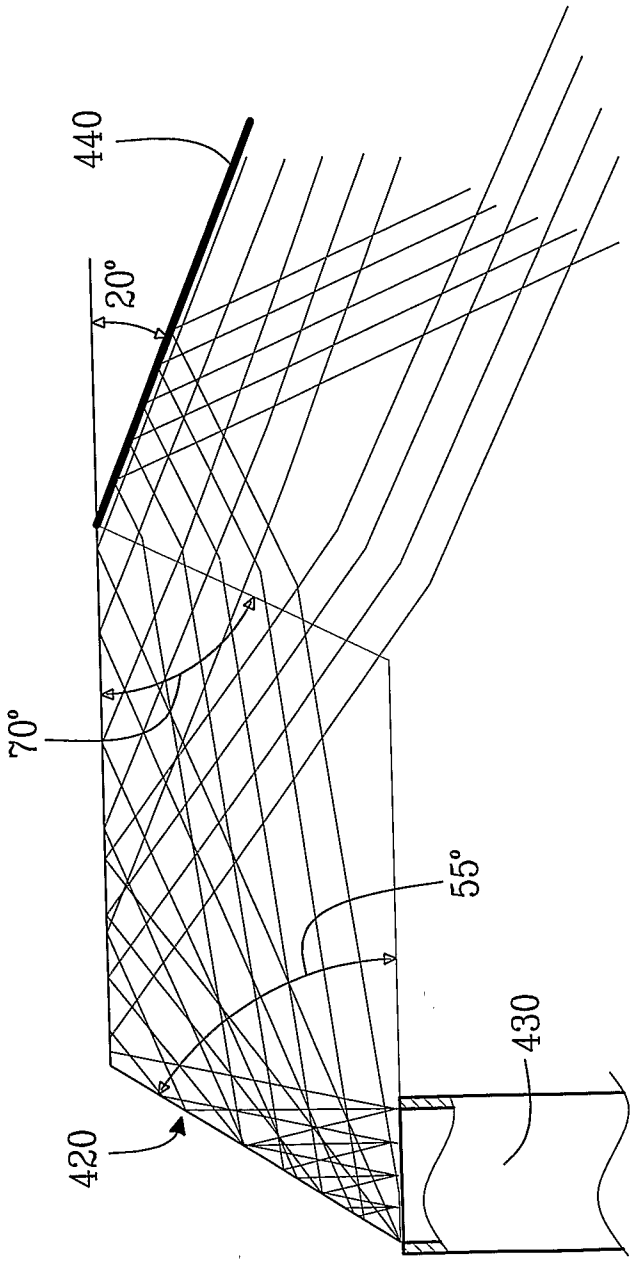

Fig. 4c

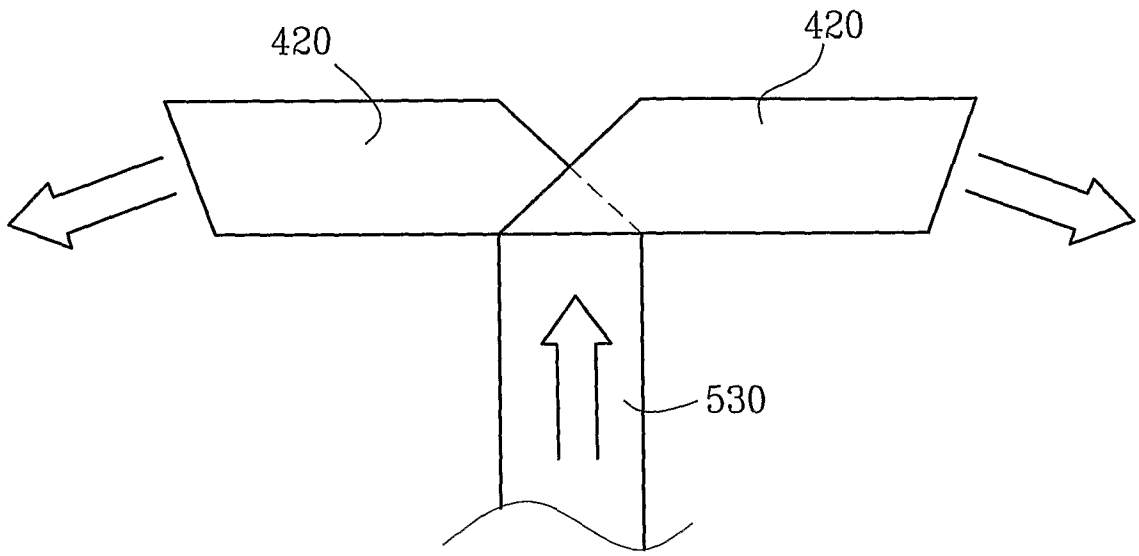

Fig.5a

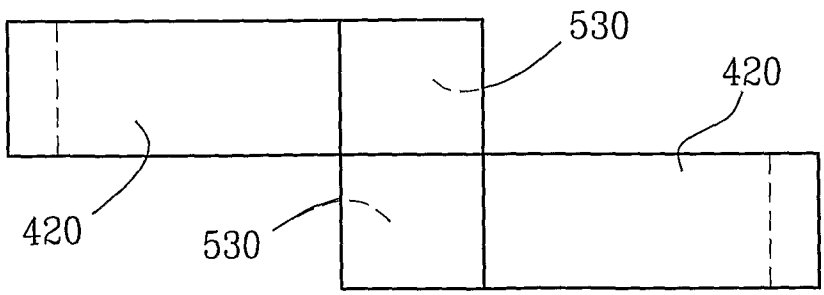

Fig.5b

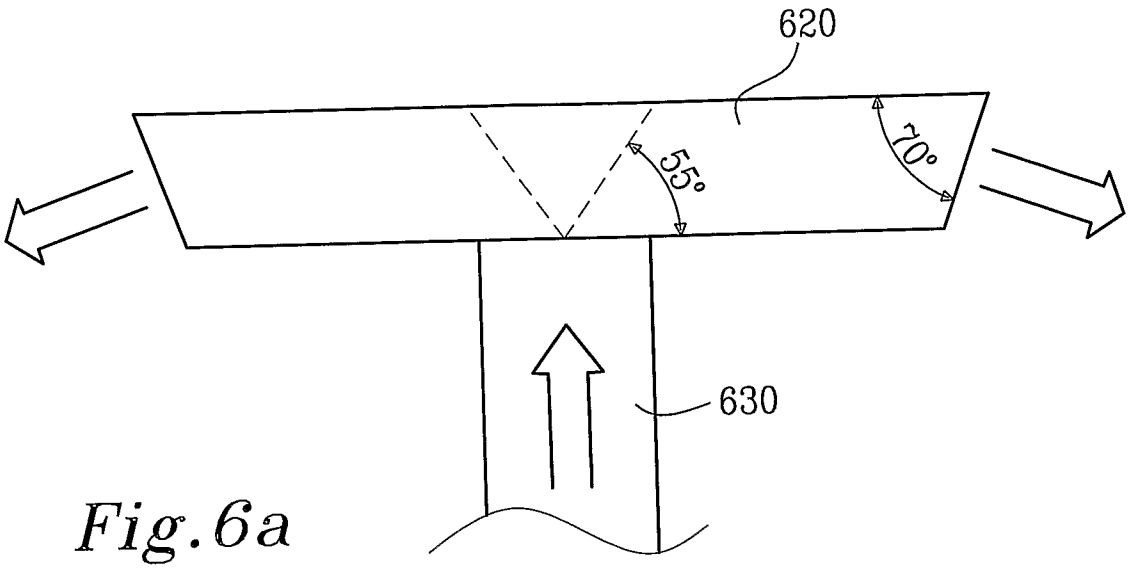

Fig.6a

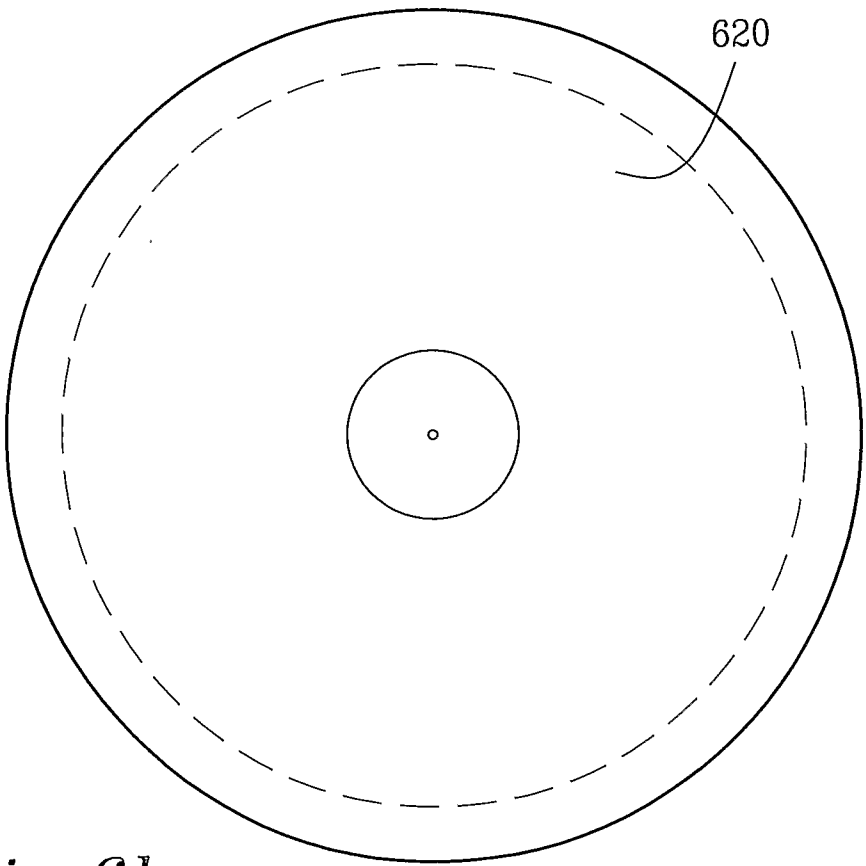

Fig.6b

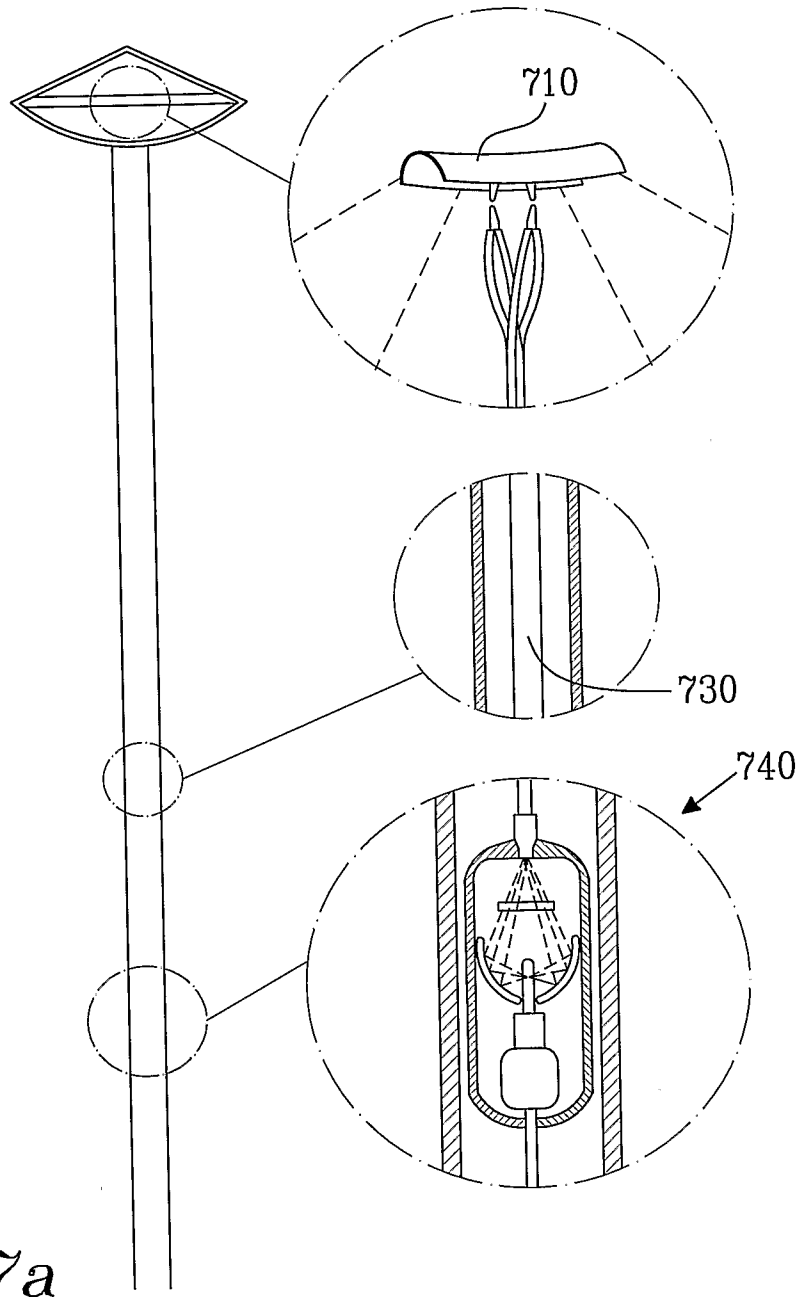

Fig. 7a

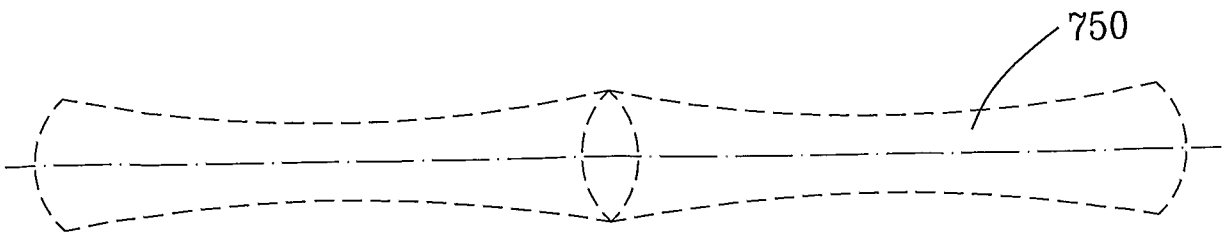

Fig. 7b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2007/000245

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: G02B, F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	SE 523500 C2 (ÅKE JOHANSSON), 19 June 2003 (19.06.2003), figure 1, claim 1, abstract	7-8
X	--	1-3,12
Y	US 6971781 B2 (J.K.GUY), 6 December 2005 (06.12.2005), column 3, line 40 - line 44, figure 2, abstract	7-8
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A	SE 524492 C2 (ÅKE JOHANSSON), 17 August 2004 (17.08.2004), figure 1, claims 1-2, abstract	3
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 July 2007	05 -07- 2007
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Tomas Erlandsson /ITW Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2007/000245

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0678704 A1 (INFODIA S.A.S.DI PICCIAFOCO ROBERTO & CO.), 25 October 1995 (25.10.1995), page 2, column 1, line 31 - column 1, line 40; page 2, column 2, line 10 - column 2, line 14, figure 1, abstract --	1
X	WO 9007677 A1 (DAVID,HILARY,CHARLES), 12 July 1990 (12.07.1990), page 3; page 6, figures 1,4 -- --------	1

International patent classification (IPC)
G02B 6/00 (2006.01)
F21V 8/00 (2006.01)
F21V 11/00 (2006.01)
F21V 7/00 (2006.01)

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Cited literature, if any, will be enclosed in paper form.

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