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(54) **SECTOR BEACON**

SEKTORBAKE

BALISE DE SECTEUR

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Description

[0001] The present invention relates to a sector beacon for use in the control of waterborne traffic. One known solution of a beacon is presented in US 2004/0057234.

[0002] At present, sector beacons based on incandescent light sources, such as incandescent lamps and other corresponding light sources, are used especially in the control of waterborne traffic. Sector beacons based on incandescent lamps and other corresponding light sources involve the problem that, in addition to a high power requirement and a relatively short service life, currently used sector beacons based on incandescent lamps generally involve problems related to the mechanical arrangements of sector plates, which cannot be incorporated in the actual illuminator device if precision is required. Instead, they have to be arranged outside the illuminator device, and therefore in practice the entire beacon is mounted inside the beacon building. The installation and adjustment of sector glasses are precision mechanical tasks. The beacon building is also expensive to construct and maintain.

[0003] In addition, for the sector beacon to be functional and reliable, the ambiguity area should be as small as possible, so that the boundary between sectors at different distances from the sector beacon is precise even when seen from larger distances and determination of location etc. using sector beacons is thus safe and reliable.

[0004] One of the worst deficiencies of sector beacons based on incandescent light sources is additionally a drop in luminous intensity of the colored sectors. In a traditional solution, the colored light sectors are formed by filtering from white light, using colored glass plates as filters. The use of filters reduces the luminous intensity of red and green colors typically to as low a level as 25% as compared to the luminous intensity of white light.

[0005] When conventional and prior-art solutions are used, a further problem results from the rather large size and maintenance need of the beacons, because conventional light sources require space and they also have to be serviced, i.e. they need replacement bulbs or equivalent relatively often.

[0006] Prior-art methods of using LED technology in sector beacons are based on an arrangement where a plurality of low-power LEDs are placed in a circle so that the optical axis of the LEDs is parallel to a horizontal plane. The LEDs are usually mounted inside a drum lens, which allows the vertical angle of the light to be reduced. The sectors are created by placing different colored LEDs on the same circle and mounting opaque partition plates between LED areas of different colors to form sector boundaries, the partition plates being oriented in the direction of the radius starting from the center of the sector beacon. This method, too, is subject to several limitations and problems. Already during manufacture it is necessary to mount different colored LEDs for each sector on a circuit board, so there is no possibility of adjustment in

the field. To achieve even moderate ambiguity areas between different color sectors, partition plates have to be mounted both inside and outside the drum lens of the illuminator device, and the external partition plates as well as the structures supporting them have to be built individually for each sector beacon. Depending on the number of LEDs, the minimum angle of an individual color sector is typically larger than 20° in order that a sufficient luminous efficiency and a sufficient uniformity of luminous efficiency are achieved in the area of the color sector in question. The inaccuracy of the sector boundary is typically of the order of 1° or more, and in addition the luminous intensity of the color area typically falls as the sector boundary is approached.

[0007] It is characteristic for the invention, what is said in the characterizing part of claim 1. Furthermore, the invention is characterised by what is stated in the appended dependent claims 2-9.

[0008] The solution of the invention is intended to eliminate or reduce the problems of prior art, to create a sector beacon that has very exact sector boundaries and is simple and highly reliable in operation, especially designed for use in the control of waterborne traffic. The sector beacon of the invention is based on high-power LEDs. It has one or more LEDs for each color. The sector beacon is constructed vertically, each color being placed on a separate level. For each level (color), the number of sectors and their width are freely selectable, so that, using sector plates mounted around the LEDs, a desired width and position of the sector are obtained by moving the sector plates. The number of sector plates is freely selectable. The sector plates are readily movable, and therefore the sector plates can also be adjusted in the field even in difficult circumstances.

[0009] In addition, as the colors in the solution of the invention are produced directly by LEDs, all color sectors can be of the same level of luminous efficiency or brightness. This is a significant advantage as compared to prior art solutions.

[0010] The high-power LED in the sector beacon, typically having a power rating of 1W or more, is placed on a horizontal plane and directed straight upwards or downwards.

[0011] The LED is used in combination with an optical lens or reflector that deflects the light in the direction of the horizontal plane with a desired vertical distribution of light. The light radiates in the horizontal plane symmetrically over a range of 360°. The lens or reflector can also be used to control the vertical angle of opening of the light. The lens or reflector is either discrete or integrated as part of the high-power LED.

[0012] The performance of the device is based on the shape of the light visible through the lens or via the reflector. As seen through the lens, the light source, i.e. the LED has a vertical narrow shape. The narrower the light source is, the more exact is the sector boundary.

[0013] An individual sector is created by using opaque sector plates placed around the light source, i.e. the LED.

In the direction in which light is to be radiated, sector plates are omitted. In other words, the light of the light source is deflected uniformly to the whole horizontal plane (360°), and only in that sector where light is to be radiated out is an opening left in the sector plates for the light. Each color on its respective level always radiates through 360° inside the illuminator device, but sector plates are used to define the directions where light is needed.

[0014] A guideline by IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities, Guideline to Sector Lights, published in 2004) presents a formula for the calculation of sector ambiguity (as a function of the width of the light source / illuminator device and the distance of the sector plate). If the light of the LED is seen as having a width of 1 mm and the sector plates are placed at a distance of 150mm, then the ambiguity angle is about 0.4°. By moving the sector plates farther away, the ambiguity angle can be reduced. However, according to this calculation model it is clear that even a reasonably small distance allows sufficiently exact sector boundaries to be achieved, which is made possible by the integration of the plates in the mechanical structure of the illuminator device, i.e. sector beacon.

[0015] Even with the luminous efficiency of a single 1W LED and a sufficiently narrow vertical opening angle, it is possible to achieve a visibility range as large as four nautical miles. In the solution of the invention, several LEDs of the same color can be added one above the other on different levels, thus increasing the range of the light.

[0016] Beside other LEDs, e.g. the high-power LED 'Luxeon I Side Emitter' manufactured by Lumileds and provided with optics for lateral deflection of the light, can even be used directly as a part in the solution of the invention.

[0017] The invention makes it possible to achieve a sector beacon that has very exact sector boundaries and is simple and highly reliable in operation and that is especially applicable for use in the control of waterborne traffic.

[0018] The details of the features of the apparatus of the invention are presented in the claims below.

[0019] In the following, the invention will be described in detail with reference to an example and the attached drawings, wherein

Fig. 1 presents a sector beacon in top view.

Fig. 2 presents a cross-section of the sector beacon.

Fig. 3 presents a side view of a sector beacon with three levels and one color for each level.

[0020] According to Fig. 1, the sector beacon has at least one level for each color, and each level contains one or more vertically radiating and high-power LEDs 10 having a power of at least 1 W, the light of which is deflected by a lens or mirror so that at least the main part of it is directed horizontally, and each level is provided

with at least one opaque black-out wall (1, 2), which serves to conceal part of the horizontal light so as to leave the desired sector or sectors, i.e. light openings (3, 4) free, through which the light is visible in the desired direction on each level.

[0021] The position and number of the black-out walls 1, 2 in the sector beacon are adjustable, allowing the width and direction of the light opening 3, 4 to be varied, and the minimum width of the light opening is about 1°.

[0022] The LED 10, whose radiation beam is symmetrical with respect to the optical axis, is so mounted in the sector beacon that its optical axis is vertically oriented, i.e. directed straight upwards or straight downwards.

[0023] The LED 10 is additionally mounted at the middle of the black-out walls and so that the distance of the LED from the black-out walls can vary according to the sector precision required, said distance being typically the same from each black-out wall.

[0024] In the sector beacon it is possible to use additional optics in the area of the light openings 3, 4 located between the black-out walls 1, 2 to allow the width of the vertical light distribution of the light sector radiated through each light opening to be decreased or increased as necessary.

[0025] According to Fig. 2, the LED 10 is so mounted in the sector beacon that its optical axis is vertically oriented, i.e. directed straight upwards or straight downwards. The LED is mounted on a circuit board 5, and the circuit board is mounted on a cooling plate 12. To achieve a good thermal conductivity, the circuit board is often made of aluminum or a ceramic material, but it is also possible to use a conventional glass-fiber circuit board. The LEDs can also be mounted directly on the surface of the cooling plate 12.

[0026] Mounted separately on top of the light source radiating in a vertical main direction of the LED 10 or integrated with the LED is an optical lens or conical mirror 11, which deflects the light to a horizontal plane.

[0027] It is characteristic of the light that it is visible in the vertical direction as a narrow beam through the lens or mirror. The light beam directed towards the observer, said beam being indicated in the figure by the number 13, has a width of "d". Depending on the optics, this width is typically below 2 mm. The narrower the light beam is, the better.

[0028] As illustrated in Fig. 3, the sector beacon comprises three different levels, each of which is provided with black-out walls 6 and 6' with an opening 7, 8 and 9 between them, through which the light is visible. Different colors are visible through the openings at different levels, preferably so that white color is seen through the opening 8 at the middle, green color 7 through the opening on the right and red light through the opening 9 on the left. However, it is also possible to provide other colors besides green, red and white. The openings are usually so arranged that they are in closely staggered positions, but they may also be so arranged that a certain distance exists between the openings, as illustrated in the figure.

There may also be more than one opening for each level.

[0029] The volume of light radiated by each color level can be optically monitored, and if the light production on one color level is found to have fallen in relation to the other color levels, an automatic monitoring system can turn off the light emitting diodes on all levels or alternatively adjust the light production on the other color levels to a volume corresponding to the reduced light production on the deficient color level.

[0030] As the sector boundaries are approached, the luminous intensities of the color sectors are not reduced until the ambiguity area is reached.

[0031] The number or width of the light openings on each level has no effect on the energy consumption of the sector beacon.

[0032] It is obvious to the person skilled in the art that different embodiments of the invention are not limited to the example described above, but that they may be varied within the scope of the claims presented below.

[0033] In the solution disclosed by the invention, it is alternatively also possible to create e.g. a white sector by combining red and green light in the same sector, because if the color coordinates are correctly selected, the combination of the two colors is white.

[0034] Each LED can also be monitored if necessary, and if a fault appears in one LED, then the automatic monitoring system will turn off the other LEDs.

Claims

1. A sector beacon having at least one level for each color, wherein each level contains one or more vertically radiating and high-power LEDs (10) having a power rating of at least 1 W, whose light is deflected by a lens or mirror, accompanied with the LEDs, at least mainly in a horizontal direction, **characterized in that** each level is provided with at least one opaque black-out wall (1, 2) serving to conceal part of the horizontal light so as to leave a desired sector or sectors, i.e. light openings (3, 4) free, through which the light is visible in a desired direction on each level, and that the sector beacon comprises different colors which are visible through the openings at different levels.
2. A sector beacon according to claim 1, **characterized in that** it comprises one or more black-out walls (1, 2), thus having one or more light openings, i.e. sectors on each level.
3. A sector beacon according to claim 1, **characterized in that** the position and number of the black-out walls (1, 2) in the sector beacon are adjustable, allowing the width and direction of the light opening (3, 4) to be varied.
4. A sector beacon according to claim 1, **characterized**

in that the minimum width of the light opening is about 1°, and that the edges of the light opening are preferably vertically oriented.

5. A sector beacon according to claim 1, **characterized in that** the LED (10), whose radiation beam is symmetrical with respect to the optical axis, is so mounted in the sector beacon that its optical axis is vertically oriented, i.e. directed straight upwards or straight downwards.
6. A sector beacon according to claim 1, **characterized in that** it has an optical lens or conical mirror (11) mounted separately on top of the light source radiating in a vertical main direction of the LED (10) or integrated with the LED to deflect the light to a horizontal plane.
7. A sector beacon according to claim 1, **characterized in that** the LED (10) is mounted at the middle of the black-out walls and so that the distance of the LED from the black-out walls can vary according to the sector precision required, said distance being the same from each black-out wall.
8. A sector beacon according to claim 1, **characterized in that** the volume of light radiated by each color level can be optically monitored, and if the light production on one color level is found to have fallen in relation to the other color levels, the automatic monitoring system can turn off the light emitting diodes on all levels or alternatively adjust the light production on the other color levels to a volume corresponding to the reduced light production on the deficient color level.
9. A sector beacon according to claim 1, **characterized in that** it is possible to use additional optics in the sector beacon in the area of the light openings (3, 4) between the black-out walls (1, 2) to allow the width of the vertical light distribution of the light sector radiated through each light opening to be decreased or increased as necessary.
10. A sector beacon according to claim 1, **characterized in that** said different colors are white, green and red.

Patentansprüche

1. Ein Sektorenlichtsignal aufweisend wenigstens eine Ebene für jede Farbe, wobei jede Ebene eine oder mehrere vertikal strahlende Hochleistungs-LEDs (10) aufweist, die eine Leistungsklassifizierung von wenigstens 1 W besitzen, dessen Licht wenigstens hauptsächlich in einer horizontalen Richtung mit einer Linse oder einem Spiegel ausgelenkt wird, die zu den LEDs gehören, **dadurch gekennzeichnet,**

dass jede Ebene mit einer opaken Abdunklungswand (1, 2) ausgestattet ist, die zum Verbergen von Teilen des horizontalen Lichts dient, um den oder die gewünschten Sektor oder Sektoren zu erhalten, das heißt Lichtöffnungen (3, 4) frei, durch die das Licht in einer gewünschten Richtung auf jeder Ebene sichtbar ist, und dass das Sektorenlichtsignal verschiedene Farben umfasst, die durch die Öffnungen auf verschiedenen Ebenen sichtbar sind.

2. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** es eine oder mehrere Abdunklungswände (1, 2) umfasst, und dadurch eine oder mehrere Lichtöffnungen aufweist, das heißt Sektoren auf jeder Ebene.
3. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** die Position und Anzahl von Abdunklungswänden (1, 2) in dem Sektorenlichtsignal anpassbar ist, was erlaubt, die Weite und Richtung der Lichtöffnungen (3, 4) zu variieren.
4. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** die minimale Weite der Lichtöffnung ungefähr 1° ist und dass Kanten der Lichtöffnung vorzugsweise vertikal ausgerichtet sind.
5. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** die LED (10), dessen Strahlung symmetrisch bezüglich der optischen Achse ist, so im Sektorenlichtsignal befestigt ist, dass seine optische Achse vertikal ausgerichtet ist, das heißt gerade aufwärts oder gerade abwärts.
6. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** es eine optische Linse oder einen konischen Spiegel (11) aufweist, der separat auf der Oberseite der Lichtquelle befestigt ist, die in eine vertikale Hauptrichtung der LED (10) strahlt oder mit der LED integriert ist, um das Licht in eine horizontalen Ebene zu lenken.
7. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** die LED (10) in der Mitte der Abdunklungswände befestigt ist, und dass der Abstand der LED von den Abdunklungswänden gemäß der benötigten Sektorengenaugigkeit variiert werden kann, wobei der Abstand von jeder Abdunklungswand gleich ist.
8. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** das Volumen ausgestrahlten Lichts jeder Farbebene optisch überwacht werden kann, und wenn die Lichtproduktion auf einer Farbebene als Absinkend bezüglich der anderen Farbebenen festgestellt wird, das automatische Überwachungssystem die Licht emittierenden Dioden auf

allen Ebenen ausschalten oder alternativ die Lichtproduktion auf den anderen Farbebenen an ein Volumen anpassen kann, das zur verminderten Lichtproduktion auf der fehlerhaften Farbebene passt.

9. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** es möglich ist, zusätzliche Optiken in dem Sektorenlichtsignal im Bereich der Lichtöffnungen (3, 4) zwischen den Abdunklungswänden (1, 2) zu benutzen, um der Breite der vertikalen Lichtverteilung des Lichtsektors, der durch jede Lichtöffnung gestrahlt wird, zu ermöglichen wie benötigt gesenkt oder erhöht zu werden.
10. Ein Sektorenlichtsignal nach Anspruch 1, **dadurch gekennzeichnet, dass** die genannten unterschiedlichen Farben weiss, grau und rot sind.

Revendications

1. Balise sectorielle qui possède au moins un niveau pour chaque couleur, dans laquelle chaque niveau contient une ou plusieurs LED à rayonnement vertical et à forte puissance (10) qui possèdent une puissance nominale d'au moins 1 W, dont la lumière est déviée par une lentille ou un miroir, accompagné(e) des LED, au moins principalement dans une direction horizontale, **caractérisée en ce que** chaque niveau est muni d'au moins une paroi occultante opaque (1, 2) qui sert à dissimuler une partie de la lumière horizontale de façon à laisser un secteur ou des secteurs souhaité(s), c'est-à-dire des ouvertures de lumière (3, 4), libres, par lesquels la lumière est visible dans une direction souhaitée sur chaque niveau, et **en ce que** la balise sectorielle comprend différentes couleurs qui sont visibles à travers les ouvertures aux différents niveaux.
2. Balise sectorielle selon la revendication 1, **caractérisée en ce qu'elle** comprend une ou plusieurs parois occultantes (1, 2), et possède ainsi une ou plusieurs ouvertures de lumière, c'est-à-dire secteurs, sur chaque niveau.
3. Balise sectorielle selon la revendication 1, **caractérisée en ce que** la position et le nombre de parois occultantes (1, 2) dans la balise sectorielle sont ajustables, afin de pouvoir faire varier la largeur et la direction de l'ouverture de lumière (3, 4).
4. Balise sectorielle selon la revendication 1, **caractérisée en ce que** la largeur minimum de l'ouverture de lumière est d'environ 1° , et **en ce que** les bords de l'ouverture de lumière sont de préférence orientés à la verticale.
5. Balise sectorielle selon la revendication 1, **caracté-**

risée en ce que la LED (10), dont le faisceau de rayonnement est symétrique à l'axe optique, est montée dans la balise sectorielle de sorte que son axe optique soit orienté à la verticale, c'est-à-dire qu'il soit dirigé en ligne droite vers le haut ou vers le bas.

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6. Balise sectorielle selon la revendication 1, **caractérisée en ce qu'**elle possède une lentille optique ou un miroir conique (11) montés séparément sur le dessus de la source de lumière qui irradie dans une direction principale verticale de la LED (10), ou intégrés à la LED afin de dévier la lumière vers un plan horizontal.
7. Balise sectorielle selon la revendication 1, **caractérisée en ce que** la LED (10) est montée au milieu des parois occultantes de sorte que la distance de la LED par rapport aux parois occultantes puisse varier selon la précision sectorielle requise, ladite distance étant la même par rapport à chaque paroi occultante.
8. Balise sectorielle selon la revendication 1, **caractérisée en ce que** le volume de lumière irradiée par chaque niveau de couleur peut être optiquement surveillé, et, si la production de lumière sur un niveau de couleur s'est avéré avoir chuté en lien avec les autres niveaux de couleur, le système de surveillance automatique peut désactiver les diodes électroluminescentes sur tous les niveaux, ou, en variante, ajuster la production de lumière sur les autres niveaux de couleur sur un volume qui correspond à la production de lumière réduite sur le niveau de couleur déficient.
9. Balise sectorielle selon la revendication 1, **caractérisée en ce qu'**il est possible d'utiliser des optiques supplémentaires dans la balise sectorielle dans la zone des ouvertures de lumière (3, 4) entre les parois occultantes (1, 2) afin de permettre à la largeur de répartition verticale de la lumière du secteur lumineux irradié à travers chaque ouverture de lumière d'être réduite ou augmentée si nécessaire.
10. Balise sectorielle selon la revendication 1, **caractérisée en ce que** lesdites différentes couleurs sont du blanc, du vert et du rouge.

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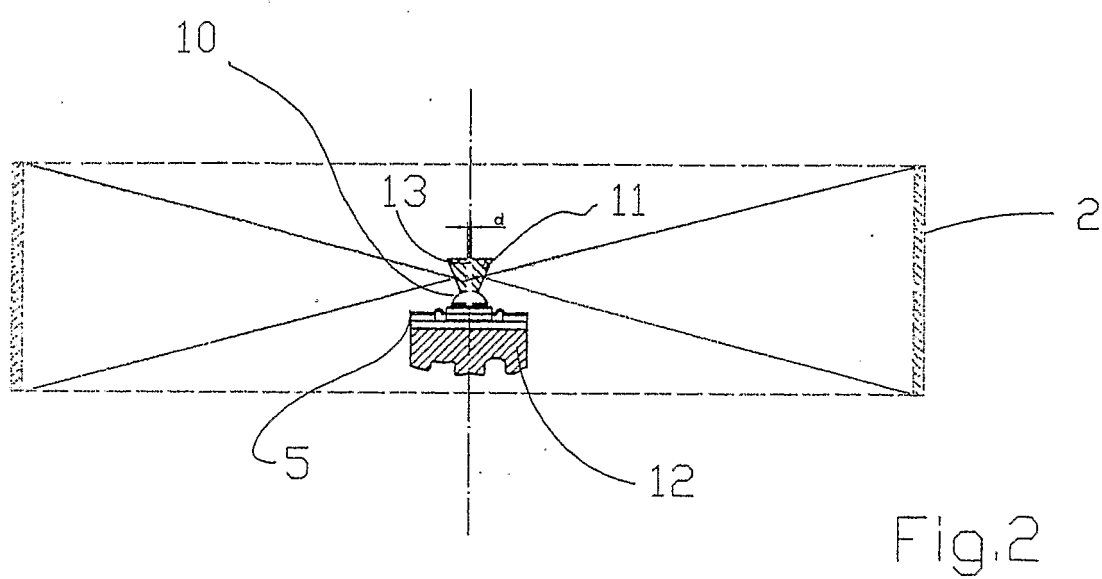
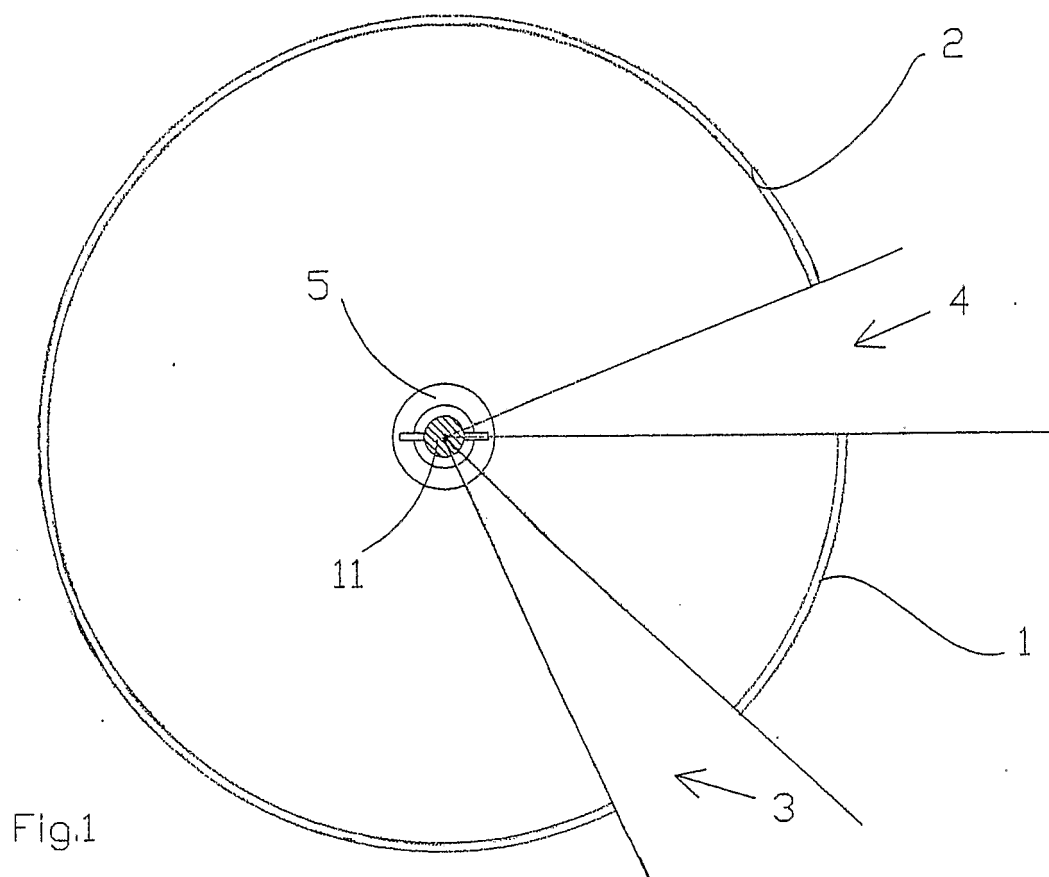
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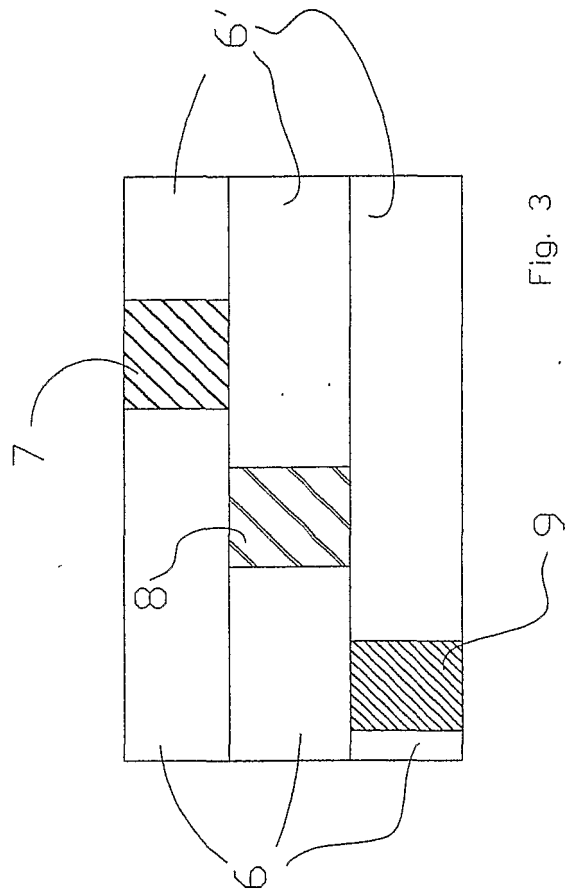
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