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(54) AN LED ILLUMINATED LAMP ASSEMBLY

LEUCHTE MIT LED-BELEUCHTUNG

ENSEMBLE LAMPE A ECLAIRAGE PAR DEL

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an LED (light emitting diode) illuminated lamp assembly which can be utilized in overhead signaling or lighting applications such as in traffic signal lamps or overhead illuminated road signs. The assembly is designed to work in combination with an optically powered lens to efficiently redirect light emitted from an LED or a collection of LEDs to specific angles.

Discussion of the Related Art

[0002] Conventional traffic signal lamps or illuminated overhead road signs which utilize incandescent lamps have drawbacks which are related to the use of incandescent lamps. Conventional traffic signal lamps are also equipped with lenses which are generally designed to accept essentially parallel rays of light from a parabolic reflector. Generally, incandescent lamps require much greater power and burn out more frequently than LEDs. Thus, incandescent lamps require more frequent replacement. LEDs offer a desirable reduction in operation and maintenance costs when compared to incandescent lamps.

[0003] With recent advances in LED efficiency, it has become practical to offer exterior lighting products which employ LEDs. However, there are different issues to consider when using LEDs where incandescent lamps have historically been used. First, conventional LEDs emit light in a relatively tight radiation pattern that requires the redistribution of that light in order to attain spatial distributions in compliance with, for example, Institute of Transportation Engineers (ITE) requirements or other regulations. Also, LEDs are heat-sensitive devices and, therefore, heat generated during operation of the LEDs and associated components must be low enough (or dissipated adequately) to assure a reliable operation over extreme temperature ranges.

[0004] A first related LED assembly is disclosed in U. S. Patent 5,174,649 which describes a lamp assembly that utilizes a two-surface lens (with an incident surface having hyperboloids and an exit surface having facets). The hyperboloids of this arrangement translate the LED rays to substantially parallel beams and the facets spread the light out to a desired pattern. However, this design has drawbacks in that it includes a proclivity toward the collection of dirt, oil, ice and other debris which interfere with the light output when used in exterior lighting applications.

[0005] A second related assembly involves a lamp which employs LEDs arranged in concentric circles with a nonpowered lens (i.e., having no lens details). Light emitted from this arrangement produces a symmetrical light distribution. When used in traffic signal applications (where light is only of value below a horizontal axis), this approach is not as efficient as that used in the lamp assembly of the present invention.

[0006] A third product is disclosed in U.S. Patent No. 5,343,330. In this arrangement, the assembly is comprised of a lens containing individual "pockets" into which LEDs are inserted. Because these LEDs are inserted into a curved lens, use of a printed wiring board is neither practical nor used. In this product, the LEDs are wired to each other, complicating the assembly or repair methods. The lens features of this product are all on the internal surface.

[0007] A further known product is an Electrotech product (Model # 33200G2). In this arrangement, the lamp assembly employs LEDs of distinctly different viewing angles to produce symmetrical light. Also, a non-powered lens is utilized with this product. This approach has disadvantages with respect to symmetrical light used in an application where symmetry is not useful. It also provides non-uniform lighting, to give it the appearance of only partial illumination when viewed from different angles.

[0008] An LED illuminated lamp assembly according to the preamble of claim 1 and claim 6 respectively is disclosed in US-A-4729076.

SUMMARY OF THE INVENTION

[0009] Accordingly, an object of the present invention is to provide for an LED illuminated lamp assembly which overcomes the drawbacks of the related products noted above.

[0010] The lens of the present invention is designed to work in combination with specified LEDs to efficiently redirect light emitted from each LED (or collection of LEDs) to specific angles. This provides for a uniformly-illuminated lens in which light emitted through the lens provides for an appearance of full illumination.

[0011] A further object of the present invention is to provide for a lens which can redirect non-parallel rays from multiple LEDs.

[0012] A further object of the present invention is to provide for a lamp assembly which incorporates a flat printed wiring board which is suitable for LED insertion with generally-available electronic assembly methods.

[0013] A further object of the present invention is to provide for a lens with a smooth exterior surface which minimizes the collection of dirt and debris when used in an exterior lighting application.

[0014] A further object of the present invention is to provide for a lens assembly which maximizes light efficiency emitted by a minimal amount of LEDs to meet ITE specifications or other regulations.

[0015] Accordingly, the present invention provides for an LED illuminated lamp assembly which comprises a circuit board assembly having a plurality of rows of LEDs; and a lens having an interior surface and an exterior surface. The interior surface of the lens comprises a plurality of horizontal bands with a single band being

associated with a row of the LEDs. Each of the bands has an upper region and a lower region serving to redirect certain light rays and allow other rays to travel uninterrupted.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Figure 1A shows a front view of the lens of the present invention;
Figure 1B shows a side view of the lens assembly of Figure 1A;
Figure 2A illustrates detail B-B of the lens feature of Figure 1B;
Figure 2B illustrates the redirection of light from multiple LEDs utilizing the lens of the present invention.
Figure 3 illustrates section 3-3 of the lens feature of Figure 2A;
Figure 4A illustrates a circuit board assembly which can be utilized with the lens of the present invention;
Figure 4B is a side view of Figure 4A;
Figure 5 illustrates a circuit diagram which can be utilized for the lens of the present invention;
Figure 6 is a front view of a lens of a further embodiment in which the lens is a dome shaped lens;
Figure 7 is a side view of the lens of Figure 6;
Figure 8 shows detail C of Figure 7;
Figure 9 is a perspective of the lens detail of Figure 7;
Figure 10 illustrates a further modification for detail C of the lens feature of Figure 7; and
Figure 11 shows section 11-11 from Figure 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to Figures 1A and 1B, in these figures a front view and side view of the lens 1 are respectively shown. As illustrated in Figures 1A and 1B, the lens 1 includes a plurality of horizontal bands 3 which extend along the width of the lens 1.

[0018] As illustrated in Figure 1B, the lens 1 can include an interior surface 5 which includes the horizontal bands 3, and a smooth exterior surface 7. The smooth exterior surface 7 minimizes the collection of dirt and debris on the lens when the lens is used in an overhead exterior lighting or signaling application such as in a traffic signal lamp or an overhead illuminated road sign. Only the interior surface 5 includes the optical details of the horizontal bands 3.

[0019] The lens 1 of the present invention can be mounted over a circuit board assembly 9 as illustrated in Figures 4A and 4B. As shown in Figures 4A and 4B, the circuit board assembly 9 includes a plurality of longitudinal rows of LEDs 11 which are spatially positioned on the circuit board assembly 9.

[0020] Referring now to the horizontal bands 3 of the lens 1, each of the horizontal bands 3 includes an upper region 3a and a lower region 3b (see Figure 2A). Details of the upper region and lower region 3a, 3b of the horizontal band 3 can be seen in Figure 2A which shows detail B-B of Figure 1B.

[0021] As illustrated in Figure 2A, each of the horizontal bands 3 includes a line 15 between the upper region 3a and the lower region 3b. The line 15 can be on an optical axis of an associated LED 11, or the LEDs 11 can be located behind the horizontal bands 3 but not centered behind the horizontal bands 3.

[0022] Further with respect to Figure 2A, the upper region 3a of the horizontal band 3 includes a complex surface 17 which can include a first substantially linear surface 17a and a curved surface 17b. Thus, the upper region 3a including the complex surface 17 having the linear surface 17a and the curved surface 17b tends to refract light rays that are headed upward, downward, in precise desirable directions which are preferable for traffic signal lamps in which lighting below the horizontal axis is desired. Thus, there is only vertical optical power created from this region of the band.

[0023] The lower region 3b of the band 3 is comprised of two parts (19a, 19b). The first part 19a is adjacent to the line 15. This first part 19a is a planar or substantially planar window that permits light from the LEDs to pass through as emitted from the LED. The second part 19b is positioned between the first part 19a and an upper half of an adjacent horizontal band. The second part 19b defines an array of precisely designed vertical grooves 21 which extend from the first part 19a in a linear manner and span along the entire width of each band. The vertical grooves 21 refract light to a desirable horizontal direction and can be seen in detail in Figure 3.

[0024] The lens 1 of Figure 1 can have a flat configuration as shown in Figure 1B. It is also recognized that the lens can be a dome shaped lens having a curvature as illustrated in Figures 6 and 7. As illustrated in Figure 6, in the same manner as Figure 1, the lens 100 of Figure 6 can include a plurality of horizontal bands 300 which extend along the width of the lens 100. As shown in Figure 7, the lens 100 can be a dome shaped lens having a curvature and can include an interior surface 500 which includes the horizontal bands 300, and a smooth exterior dome surface 700. As in the previous embodiment, the smooth exterior dome surface 700 minimizes the collection of dirt and debris on the lens when the lens 100 is used in an overhead exterior lighting or a signalling application such as in a traffic signal lamp or an

overhead illuminated road sign. Only the interior surface 500 includes the optical details of the horizontal bands 300.

[0025] The lens 100 of Figures 6 and 7 can be mounted over a circuit board assembly 9 as illustrated in Figures 4A and 4B in the same manner as the first embodiment.

[0026] The details of the horizontal bands 300 of Figures 6 and 7 is illustrated in Figure 8 which shows detail C of Figure 7, as well as Figure 9 which is a perspective view along line 9-9 of Figure 7. Each of the horizontal bands 300 can include an upper region and lower region 300a, 300b as illustrated in Figures 8 and 9. As in the first embodiment, the band 300 can include a line 150 between the upper region 300a and the lower region 300b. The line 150 can be an optical axis of an associated LED 11 or the LED 11 can be located behind the horizontal bands 300 but not centered behind the horizontal bands 300 as in the previous embodiment.

[0027] The upper region 300a of Figures 8 and 9 can include a complex surface 170 which includes a first surface 170a and a generally curved second surface 170b. The lower region 300b can include a first part 190a which can be generally curved and a second part 190b which includes an array of vertical grooves 210 which extend from the first part 190a and expand along the entire width of each band 300. The vertical grooves 210 can refract some light to a desired horizontal direction. Thus, the first part 190a that defines a slightly curved surface permits some light from the LEDs to pass therethrough. The second part 190b which includes the vertical grooves 210 can direct some light from the LEDs in a horizontal direction.

[0028] Figure 10 shows a modification of detail C of Figure 7. As shown in Figure 10, each of the horizontal bands 300' can include an upper region and lower region 300a', 300b'.

[0029] As further illustrated in Figure 10, each of the horizontal bands 300' includes a line 150' between the upper region 300a' and the lower region 300b'. The line 150' can be on an optical axis of an associate LED 11 or the LEDs 11 can be located behind the horizontal bands 300 but not centered behind the horizontal bands 300 as in the previous embodiments.

[0030] Further with respect to Figure 10, the upper region 300a' of the horizontal band 300' can include at least one complex surface 170' in the form of pointed ridges or grooves, and optionally a slightly curved surface 170". Therefore, the upper region 300a' including the at least one complex surface 170' and the sightly curved surface 170" noted above tends to refract light that is headed upward, downward, in precise desirable directions which are preferable for traffic signal lamps in which lighting below the horizontal axis is desired.

[0031] The lower region 300b' of the band 300' can include a first part 190a' which defines a surface which can be a slightly curved surface, and a second part 190b' which defines an array of vertical grooves 210' which extend from the first part 190a' and span along the entire width of each band 300'. The vertical grooves 210' refract light to a desirable horizontal direction.

[0032] Therefore, the first part 190a' that defines a slightly curved surface permits some light from the LEDs to pass therethrough. The second part 190b' which includes the vertical grooves 210' can direct some light from the LEDs in a horizontal direction.

[0033] The vertical grooves 210 or 210' like the grooves 21 of the first embodiment refract light to a desirable horizontal direction and can be seen in detail in Figure 11.

[0034] Accordingly, the lens 1 of the present invention can optimize and redirect LED light in a desirable direction in order to meet, for example, ITE specifications as illustrated in the light ray diagram of Figure 2B. As shown in Figure 2B, the lens 1 of the present invention can redirect non-parallel rays 75 from multiple LEDs. The lens 1 is designed to refract portions of light emitted from an LED while allowing other portions to pass through the lens unchanged. The redirected LED light is optimized for compliance with regulations. The same applies for the lens 100 illustrated in Figures 6 and 10.

[0035] Referring now to Figure 4A, as noted above, the LEDs 11 are arranged in rows so as to correspond with the horizontal bands 3 or 300 of the lens 1 or 100 when the lens 1 or 100 is mounted in front of the circuit board assembly 9. Each of the LEDs 11 has an optical axis which can be on the line 15 between the upper region and the lower region 3a, 3b of the horizontal bands 3. A side view of some LEDs 11 as mounted on the circuit board assembly 9 can be seen in Figure 4B.

[0036] Referring now to Figure 5, the LED control circuit will now be explained. The lamp assembly of the present invention can utilize, for example, AlInGaP LEDs to produce the requisite amount of light. It is recognized that the amount and types of LEDs, utilized can be based on design considerations. As illustrated in Figure 5, the circuit can include eight strings of thirty-six LEDs each. Each string can have cross-linked connections 27 at every sixth LED. Advantages of this arrangement are that if a single LED fails open, the cross-linking will prevent all but six LEDs (2%) from shutting down. The current through each of the remaining seven string segments will increase by only 14%. This value can be sustained indefinitely. Additionally, cross-linking blocks of six LEDs reduces the amount of "current hogging" caused by variation in forward voltage of the LEDs when compared to cross-linking of single LEDs.

[0037] The LEDs can be energized by power from a 120-volt AC line through an 8.2 μF capacitor 29 followed by a full wave bridge rectifier circuit 30 formed by four IN4004 diodes. Current flows bi-directionally through the capacitor at every line cycle but uni-directionally through the LEDs due to the full wave rectifying action of the bridge circuit. The capacitor therefore acts as the series current limiting element, but instead of dissipating power, it temporarily stores it and later returns it to the

line.

[0038] The advantages of this arrangement are that a substantial power can be saved compared to resistive current limiting schemes. This results in the production of less heat. Also, this approach permits the use of more parallel strings of fewer series-connected LEDs. This reduces the intensity variation of the lamp as line voltages varies, without the cost and complexity of a voltage regulator.

[0039] A second capacitor 31 (1.0 μF, 400 VDC) can be placed across the AC line and prevents leakage currents that may be present in solid-state switches, from causing the LEDs to glow in the off-state. This capacitor also prevents conflict monitors from mistaking the LED signal for a burned-out incandescent lamp. Surge protection is provided by a bidirectional 1.5 K Joule transient voltage suppressor diode and a low resistance (2 Ω, 5 watt) resistor. A 2 amp fuse limits power to the assembly in the event of catastrophic failure. As noted above, the values given with respect to Figure 5 are examples and can be based on design considerations.

[0040] Therefore, the lens 1 or 100 and circuit board arrangement 9 of the present invention can provide for a combination in which the lens maximizes light efficiency emitted from a nominal amount of LEDs to meet various regulations. The lens can direct light vertically downward through specific angles and the grooved features of the lens which are placed on specific areas of the lens can collect otherwise extraneous light and redirect this light horizontally. The lens is designed to work in combination with specified LEDs to efficiently redirect light emitted from the LEDs to specific angles. The lamp assembly incorporates a flat wiring board which is suitable for LED insertion and the backlit lens provides an appearance of full illumination. This is advantageous with respect to the use of the lamp assembly as an overhead signaling or lighting assembly such as a traffic signal lamp or an overhead illuminated road sign.

[0041] Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

Claims

1. An LED illuminated lamp assembly comprising:

(a) a circuit board assembly (9) comprising a plurality of rows of LEDs (11); and

(b) a lens (1) having a first surface and a second surface, one (5) of the first and second surfaces of the lens comprising a plurality of horizontal bands (3) with a single band being associated with a row of LEDs **characterised in that**, each of the bands has an upper region (3a) and a lower region (3b), behind which the LEDs (11) are located, wherein:

(c) the upper region (3a) of each of said plurality of horizontal bands comprises at least one complex surface (17) that refracts some light from the LEDs (11) downward;

(d) the lower region (3b) of each of said plurality of horizontal bands comprises:

(i) a first part (19a) adjacent to the upper region (3a) which defines a surface that permits some light from the LEDs (11) to pass therethrough and

(ii) a second part (19b) positioned between the first part (19a) of the lower region and the upper region (3a) of an adjacent horizontal band which defines vertical grooves (21) that extend along a width of each horizontal band; and

(e) said vertical groves (21) direct some light from said LEDs (11) in a horizontal direction.

2. An assembly according to Claim 1, wherein said lens has a flat shape.

3. An assembly according to Claim 1 wherein said lens is a dome shaped lens having a curvature.

4. An assembly according to Claim 1, wherein said one of the first and second surfaces of the lens is an interior surface (5).

5. An assembly according to Claim 4, wherein the other of the first and second surfaces of the lens is an exterior surface (700) which is smooth to reduce collection of dirt and debris on the exterior surface.

6. An LED illuminated lamp assembly comprising:

(a) a circuit board assembly (9) comprising a plurality of rows of LEDs (11);

(b) a lens (1) having a first surface and a second surface, one (5) of the first and second surfaces of the lens comprising a plurality of horizontal bands (3) with a single band being associated with a row of LEDs (11) **characterised in that** each of the bands has an upper region (3a) and a lower region (3b), behind which the LEDs (11) are located; and that

(c) the upper region (3a) of each of said plurality of horizontal bands (3) comprises a substantially linear surface (17a) and a generally curved surface (17b); wherein:

(d) said upper region (3a) directs some upwardly directed light from the LEDs (11) in a downward direction to increase the lighting below a horizontal axis of the lens.

7. An assembly according to claim 6, wherein:

(a) the lower region (3b) of each of said plurality of horizontal bands comprises a surface which is substantially perpendicular to the linear surface (17a) of the upper region (3a); and

(b) a lower part (19b) of the lower region (3b) comprising a vertically grooved surface.

8. An assembly according to Claim 6 wherein said lens has a flat shape.

9. An assembly according to Claim 6, wherein said lens is a dome shaped lens having a curvature.

10. An assembly according to Claim 6, wherein said one (5) of the first and second surfaces of the lens is an interior surface.

11. An assembly according to Claim 6, wherein the other (7) of the first and second surfaces of the lens is an exterior surface which is smooth to reduce collection of dirt and debris on the exterior surface.

Patentansprüche

1. Eine LED-Beleuchtungs-Lampenbaugruppe, die aufweist

(a) eine Leiterplattenbaugruppe (9) mit einer Vielzahl an Reihen von LEDs (11), und
(b) eine Linse (1) mit einer ersten Fläche und einer zweiten Fläche, wobei eine (5) der ersten und zweiten Fläche der Linse eine Vielzahl von horizontalen Bändern (3) aufweist, wobei ein einzelnes Band einer Reihe von LEDs zugeordnet ist,
dadurch gekennzeichnet, dass jedes der Bänder einen oberen Bereich (3a) und einen unteren Bereich (3b), hinter denen sich die LEDs (11) befinden, hat, wobei
(c) der obere Bereich (3a) von jedem der Vielzahl an horizontalen Bändern zumindest eine komplexe Fläche (17) aufweist, die etwas Licht von den LEDs (11) nach unten bricht,
(d) wobei der untere Bereich (3b) von jedem der Vielzahl an horizontalen Bändern aufweist:

(i) einen erste Teil (19a) benachbart zum oberen Bereich (3a), der eine Fläche definiert, die ermöglicht, dass etwas Licht von den LEDs (11) durch diese hindurchtritt, und
(ii) einen zweiten Teil (19b), der zwischen dem ersten Teil (19a) des unteren Bereichs und dem oberen Bereich (3a) eines benachbarten horizontalen Bandes positioniert ist und der vertikale Ausnehmungen (21) definiert, die sich entlang einer Breite von jedem horizontalen Band erstrecken, und

(e) wobei die vertikalen Ausnehmungen (21) etwas Licht von den LEDs (11) in eine horizontale Richtung lenken.

2. Eine Baugruppe nach Anspruch 1, wobei die Linse eine flache Form hat.

3. Eine Baugruppe nach Anspruch 1, wobei die Linse eine haubenförmige Linse mit einer Krümmung ist.

4. Eine Baugruppe nach Anspruch 1, wobei die eine der ersten und zweiten Fläche der Linse eine Innenfläche (5) ist.

5. Eine Baugruppe nach Anspruch 4, wobei die andere der ersten und zweiten Fläche der Linse eine Außenfläche (700) ist, die glatt ist, um die Ansammlung von Schmutz und Bruchstücken an der Außenfläche zu verringern.

6. Eine LED-Beleuchtungs-Lampenbaugruppe, die aufweist:

(a) eine Leiterplatten-Baugruppe (9) mit einer Vielzahl an Reihen von LEDs (11),
(b) eine Linse (1) mit einer ersten Fläche und einer zweiten Fläche, wobei eine (5) der ersten und zweiten Fläche der Linse eine Vielzahl an horizontalen Bändern (3) hat, wobei ein einzelnes Band einer Reihe von LEDs (11) zugeordnet ist,
dadurch gekennzeichnet, dass jedes der Bänder einen oberen Bereich (3a) und einen unteren Bereich (3b) hat, hinter denen sich die LEDs (11) befinden, und dass
(c) der obere Bereich (3a) von jedem der Vielzahl an horizontalen Bändern (3) eine im Wesentlichen lineare Fläche (17a) und eine im Wesentlichen gekrümmte Fläche (17b) aufweist, wobei
(d) der obere Bereich (3a) etwas nach oben gerichtetes Licht von den LEDs (11) in eine ab-

wärts gerichtete Richtung lenkt, um die Beleuchtung unterhalb einer horizontalen Achse der Linse zu erhöhen.

7. Eine Baugruppe nach Anspruch 6, wobei

(a) der untere Bereich (3b) von jedem der Vielzahl an horizontalen Bändern eine Fläche aufweist, die zur linearen Fläche (17a) des oberen Bereichs (3a) im Wesentlichen senkrecht verläuft, und
(b) ein unterer Teil (19b) des unteren Bereichs (3b) eine vertikal genutete Fläche aufweist.

8. Eine Baugruppe nach Anspruch 6, wobei die Linse eine flache Form hat.

9. Eine Baugruppe nach Anspruch 6, wobei die Linse eine haubenförmige Linse mit einer Krümmung ist.

10. Eine Baugruppe nach Anspruch 6, wobei die andere (5) der ersten und zweiten Fläche der Linse eine Innenfläche ist.

11. Eine Baugruppe nach Anspruch 6, wobei die andere (7) der ersten und zweiten Fläche der Linse eine Außenfläche ist, die glatt ist, um die Ansammlung von Schmutz und Bruchstücken auf der Außenfläche zu verringern.

Revendications

1. Ensemble de lampe éclairée par DEL comprenant :

(a) un ensemble de circuit imprimé (9) comprenant une pluralité de rangées de DEL ; et

(b) une lentille (1) ayant une première surface et une seconde surface, une (5) des première et seconde surfaces de la lentille comprenant une pluralité de bandes horizontales (3), une bande unique étant associée à une rangée de DEL, **caractérisé en ce que** chacune des bandes a une région supérieure (3a) et une région inférieure (3b), derrière lesquelles sont situées les DEL, dans lequel :

(c) la région supérieure (3a) de chaque bande de ladite pluralité de bandes horizontales comprend au moins une surface complexe (17) qui réfracte une partie de la lumière venant des DEL vers le bas ;

(d) la région inférieure (3b) de chaque bande de ladite pluralité de bandes horizontales comprend :

(i) une première partie (19a) adjacente à la région supérieure (3a) qui définit une surface qui permet à une partie de la lumière des DEL de passer au travers et

(ii) une seconde partie (19b) positionnée entre la première partie (19a) de la région inférieure et la région supérieure (3a) d'une bande horizontale adjacente qui définit des rainures verticales (21) qui s'étendent le long d'une largeur de chaque bande horizontale ; et

(e) lesdites rainures verticales (21) dirigent une partie de la lumière desdites DEL (11) dans une direction horizontale.

2. Ensemble selon la revendication 1, dans lequel ladite lentille a une forme plate.

3. Ensemble selon la revendication 1, dans lequel ladite lentille est une lentille en forme de dôme ayant une courbure.

4. Ensemble selon la revendication 1, dans lequel ladite surface parmi la première et la seconde surfaces de la lentille est une surface intérieure (5).

5. Ensemble selon la revendication 4 dans lequel l'autre surface parmi la première et la seconde surfaces de la lentille est une surface extérieure (700) qui est lisse pour réduire la collecte de poussière et de débris sur la surface extérieure.

6. Ensemble de lampe éclairée par DEL comprenant :

(a) un ensemble de circuit intégré (9) comprenant une pluralité de rangées de DEL (11) ;

(b) une lentille (1) ayant une première surface et une seconde surface, une (5) surface parmi la première et la seconde surfaces de la lentille comprenant une pluralité de bandes horizontales (3) avec une bande unique associée à une rangée de DEL (11), **caractérisée en ce que** chacune des bandes a une région supérieure (3a) et une région inférieure (3b), derrière lesquelles les DEL (11) sont situées ; et **en ce que**

(c) la région supérieure (3a) de chacune de ladite pluralité de bandes horizontales (3) comprend une surface pour l'essentiel linéaire (17a) et une surface généralement incurvée (17b) ; dans laquelle

(d) ladite région supérieure (3a) dirige une partie de la lumière dirigée vers le haut depuis les DEL (11) dans une direction vers le bas pour

augmenter l'éclairage sous un axe horizontal de la lentille.

7. Ensemble selon la revendication 6, dans lequel :

(a) la région inférieure (3b) de chacune des bandes de ladite pluralité de bandes horizontales comprend une surface qui est pour l'essentiel perpendiculaire à la surface linéaire (17a) de la région supérieure (3a) ; et
(b) une partie inférieure (19b) de la région inférieure (3b) comprenant une surface rainurée verticalement.

8. Ensemble selon la revendication 6 dans lequel ladite lentille a une forme plate.

9. Ensemble selon la revendication 6 dans lequel ladite lentille est une lentille en forme de dôme ayant une courbure.

10. Ensemble selon la revendication 6 dans lequel ladite surface (5) parmi la première et la seconde surfaces de l'objectif est une surface intérieure.

11. Ensemble selon la revendication 6 dans lequel l'autre surface (7) parmi la première et la seconde surfaces de la lentille est une surface extérieure qui est lisse pour réduire la collecte de poussière et de débris sur la surface extérieure.

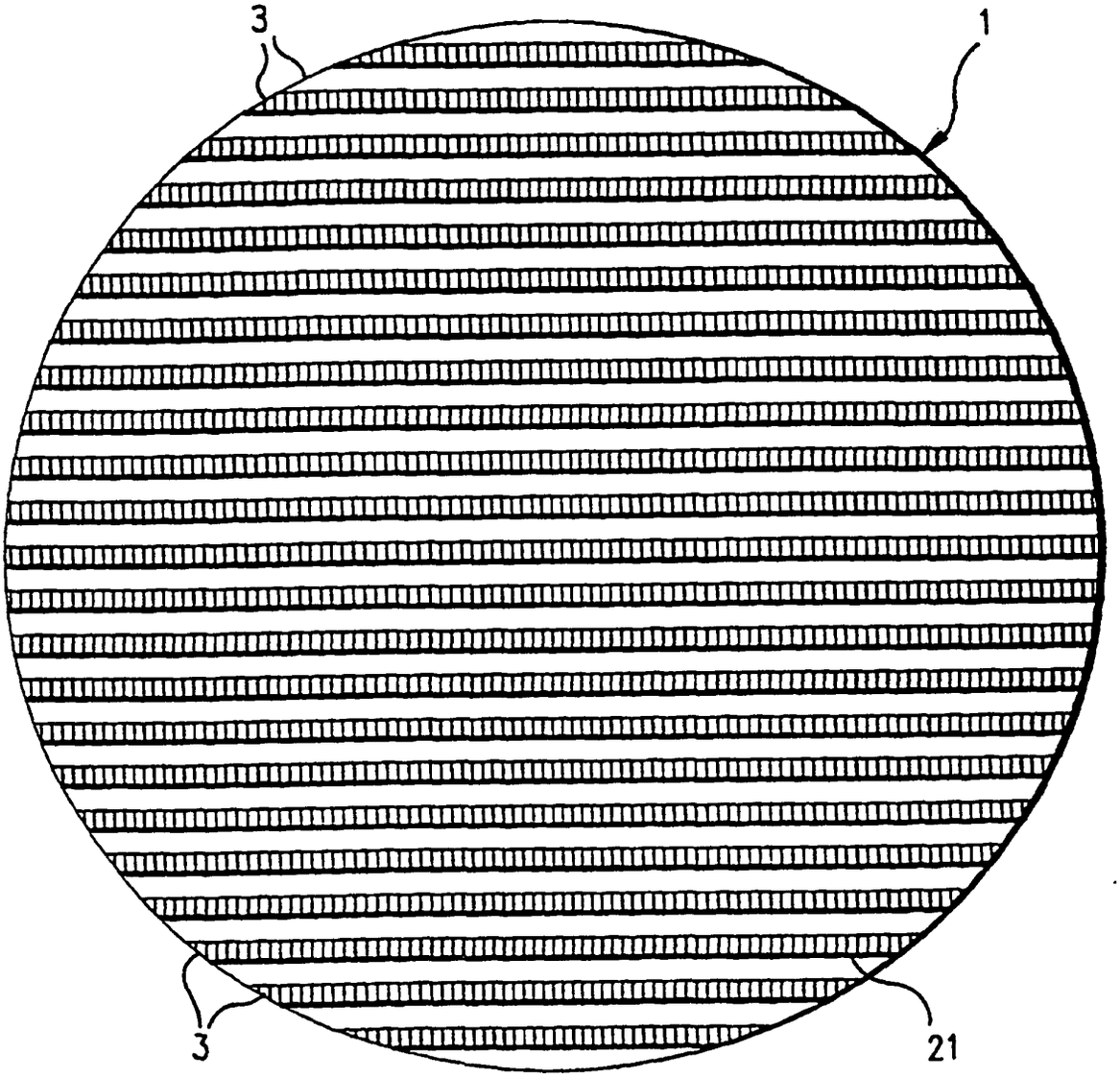

FIG.1A

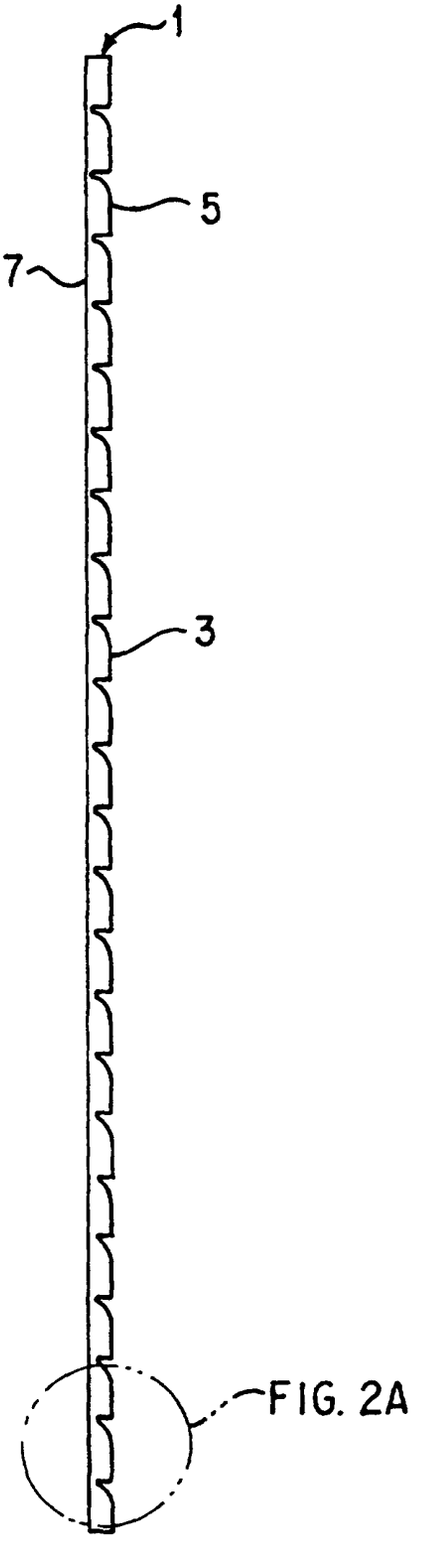

FIG. 1B

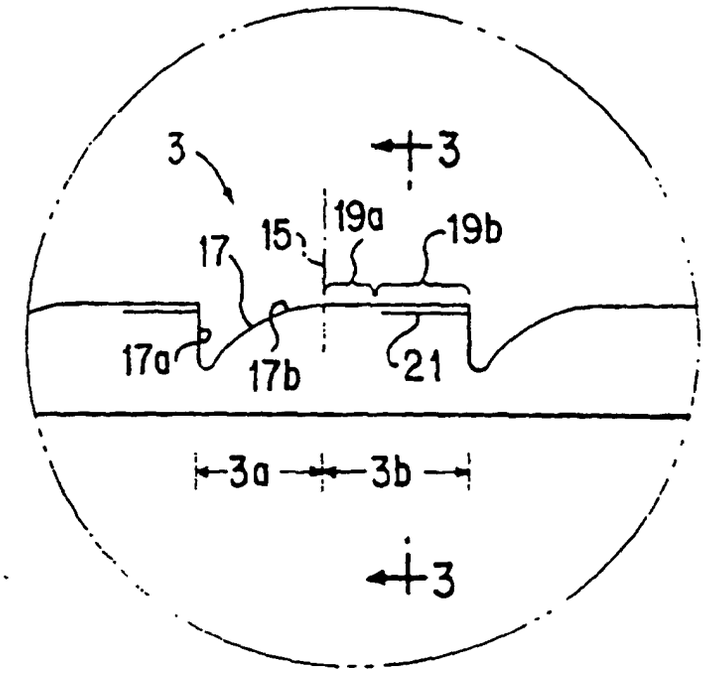

FIG. 2A

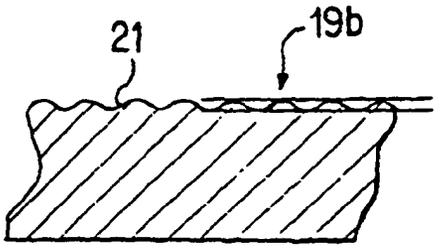

FIG. 3

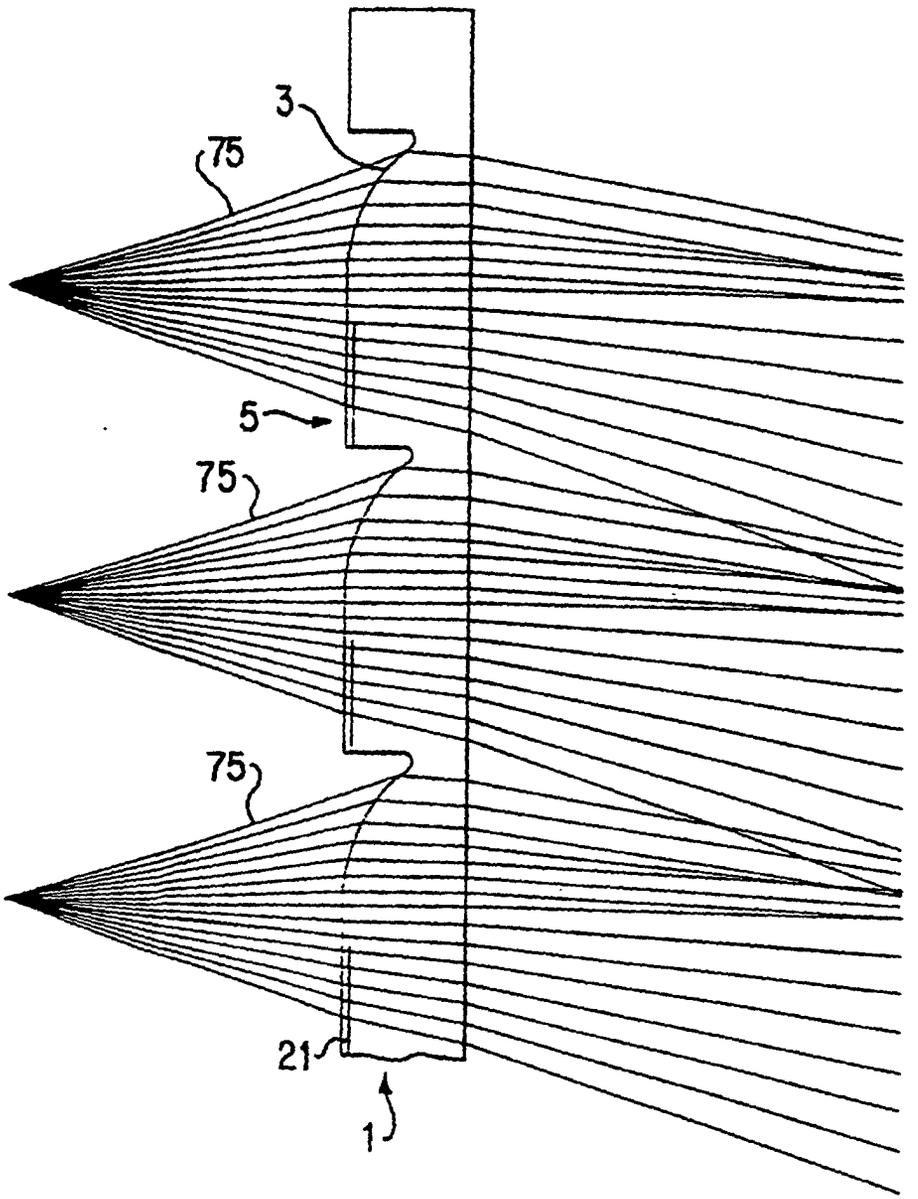

FIG. 2B

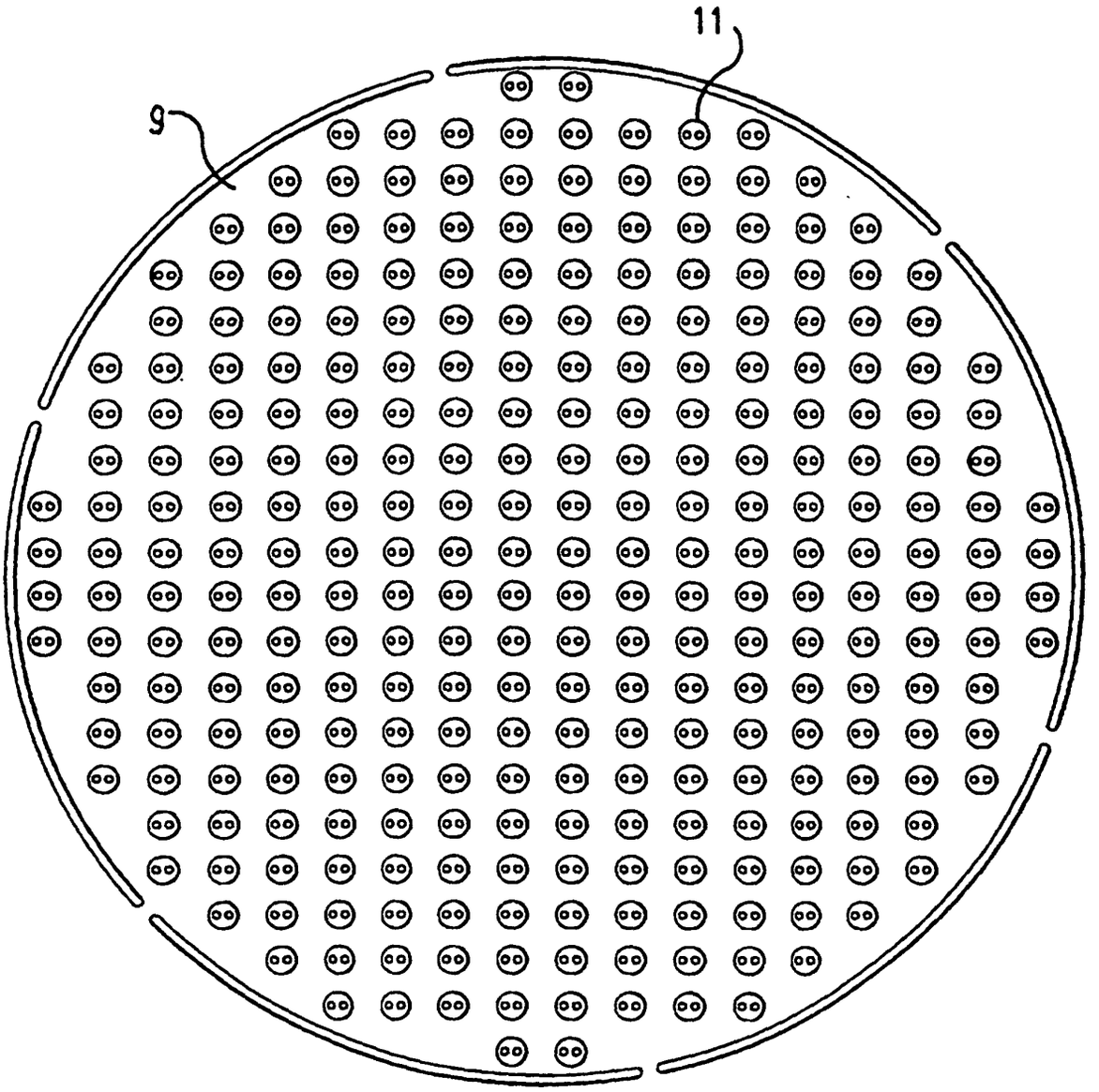

FIG.4A

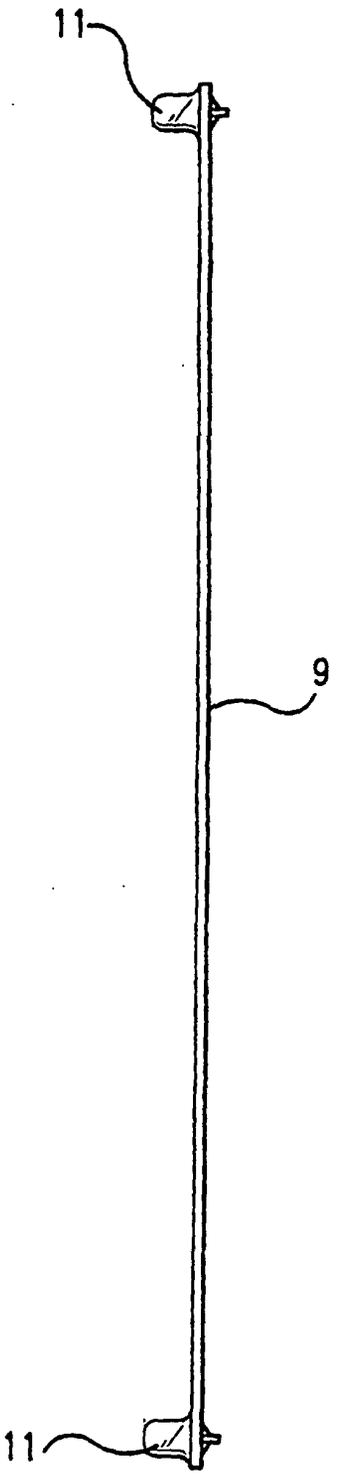

FIG.4B

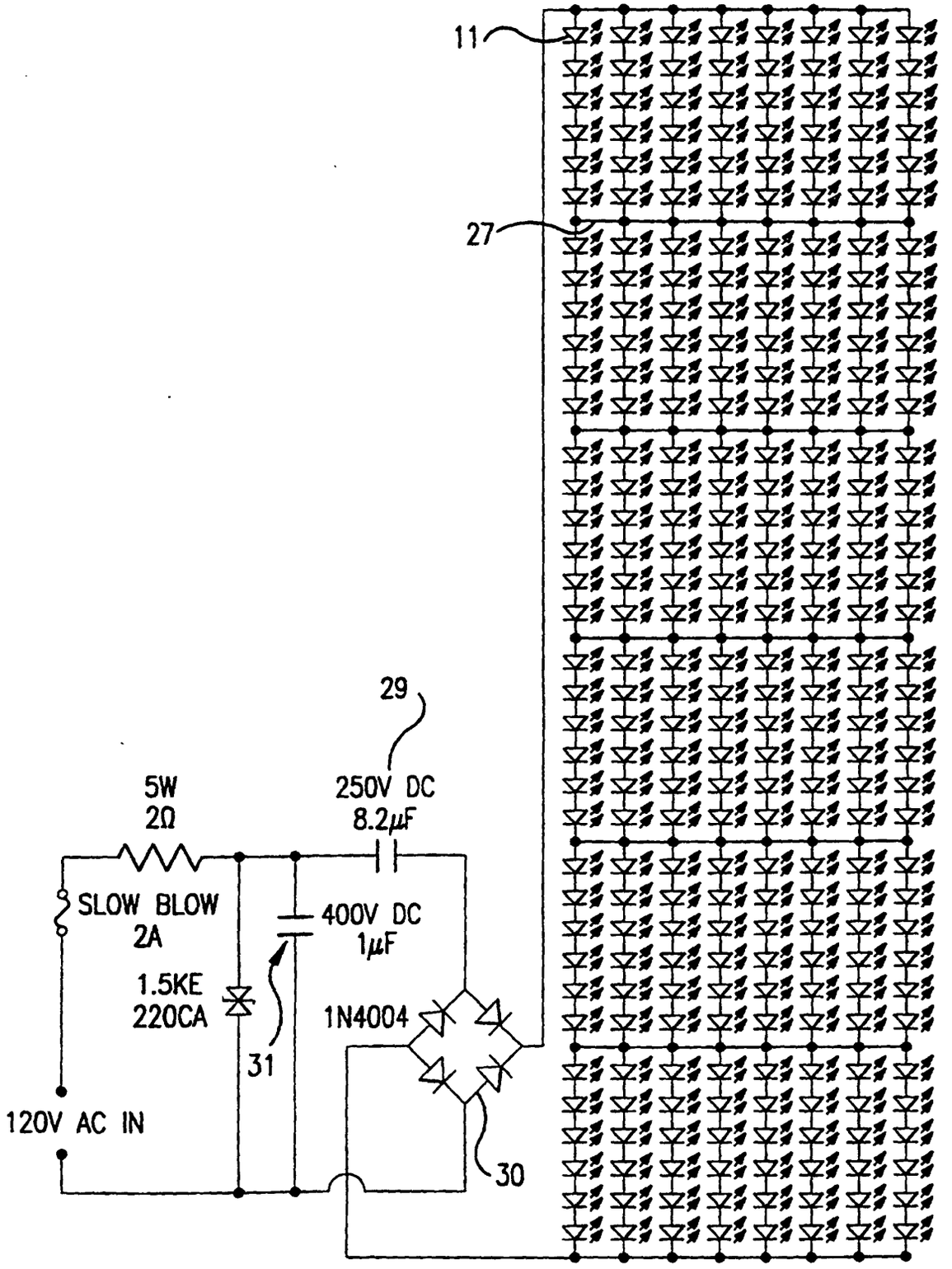
11
27
29
5W
2Ω
250V DC
8.2μF
SLOW BLOW
2A
400V DC
1μF
1.5KE
220CA
1N4004
31
120V AC IN
30

FIG.5

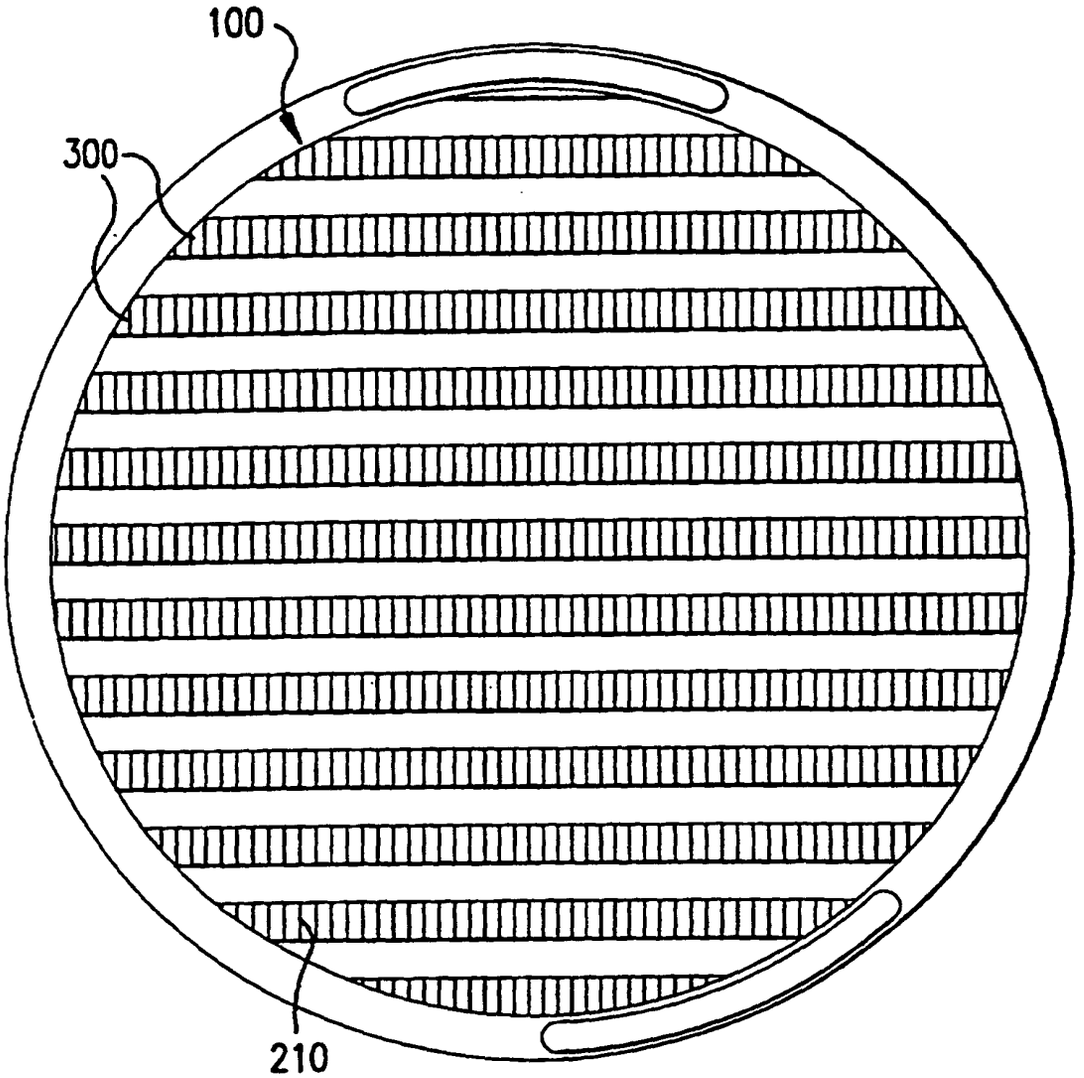

FIG.6

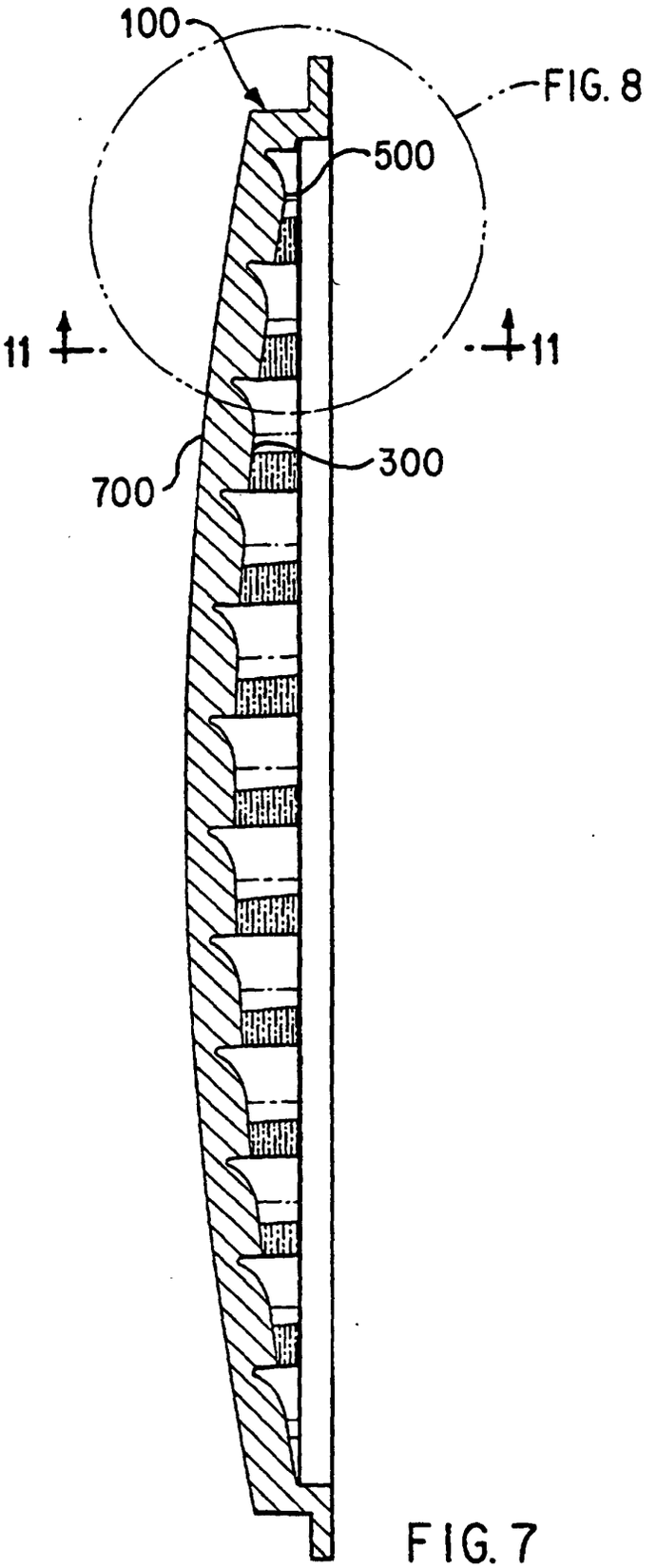

FIG. 7

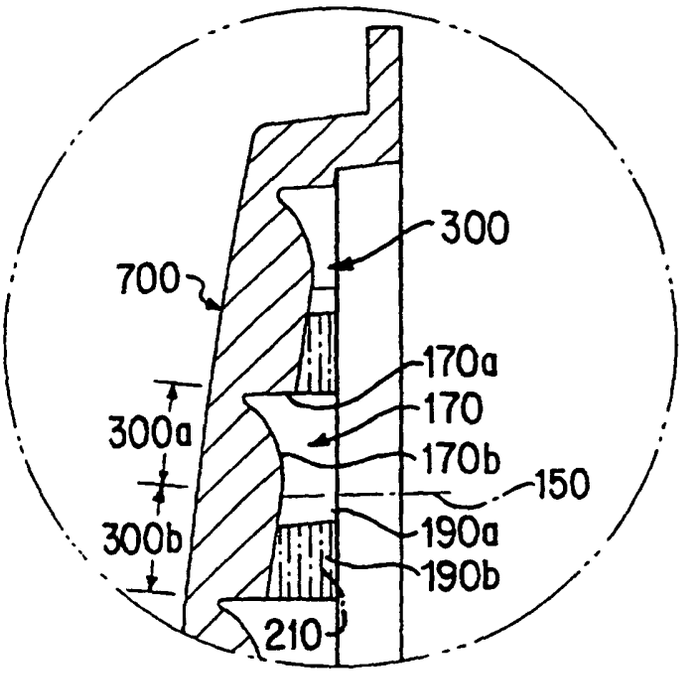
300
700
170a
170
300a
170b
150
300b
190a
190b
210

FIG. 8

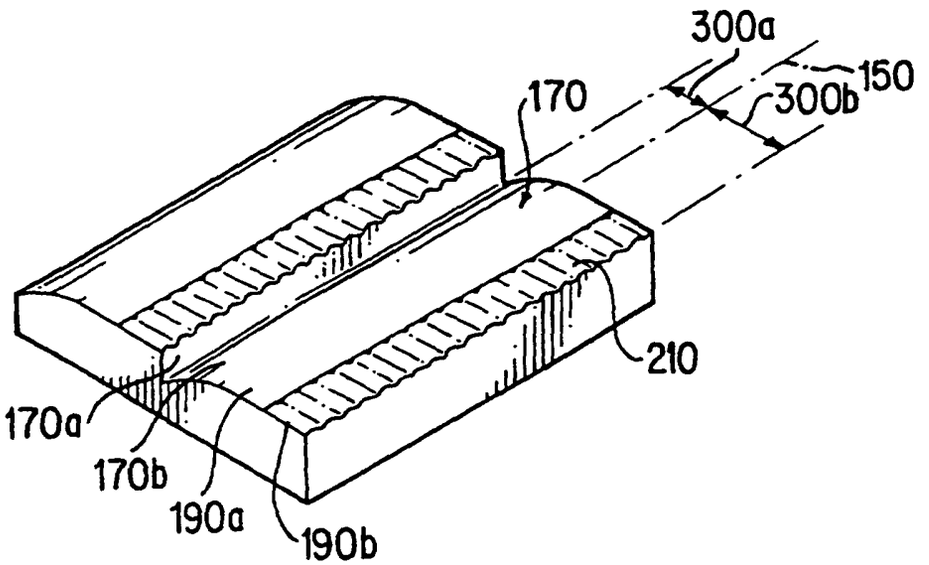
300a
150
170
300b
210
170a
170b
190a
190b

FIG. 9

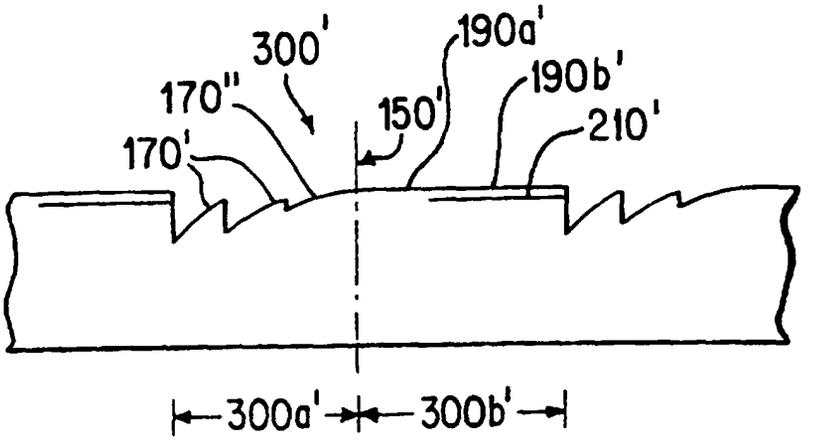

FIG. 10

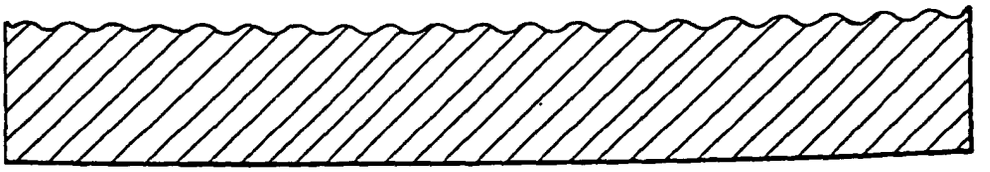

FIG. 11