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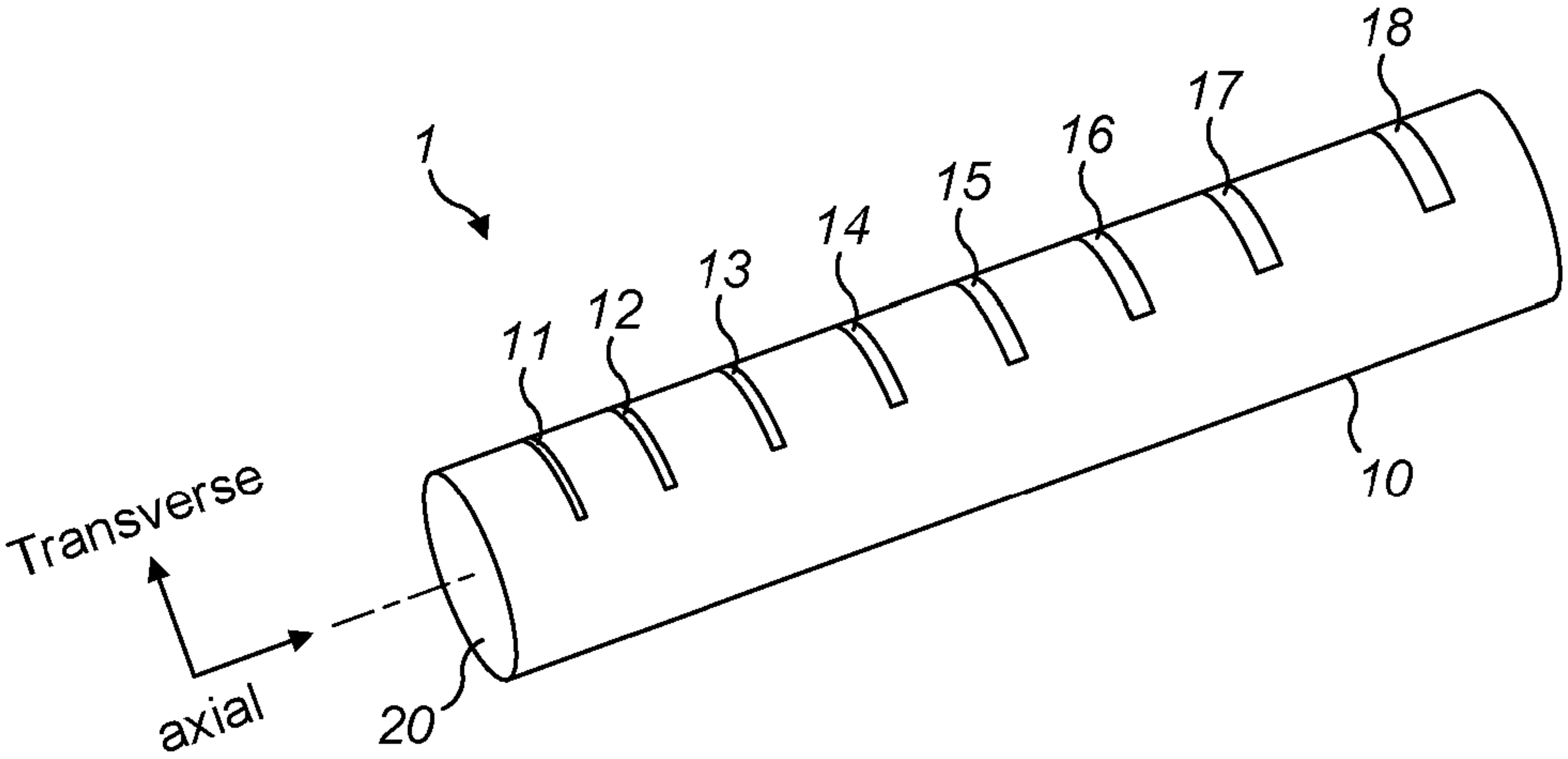

FIG. 1

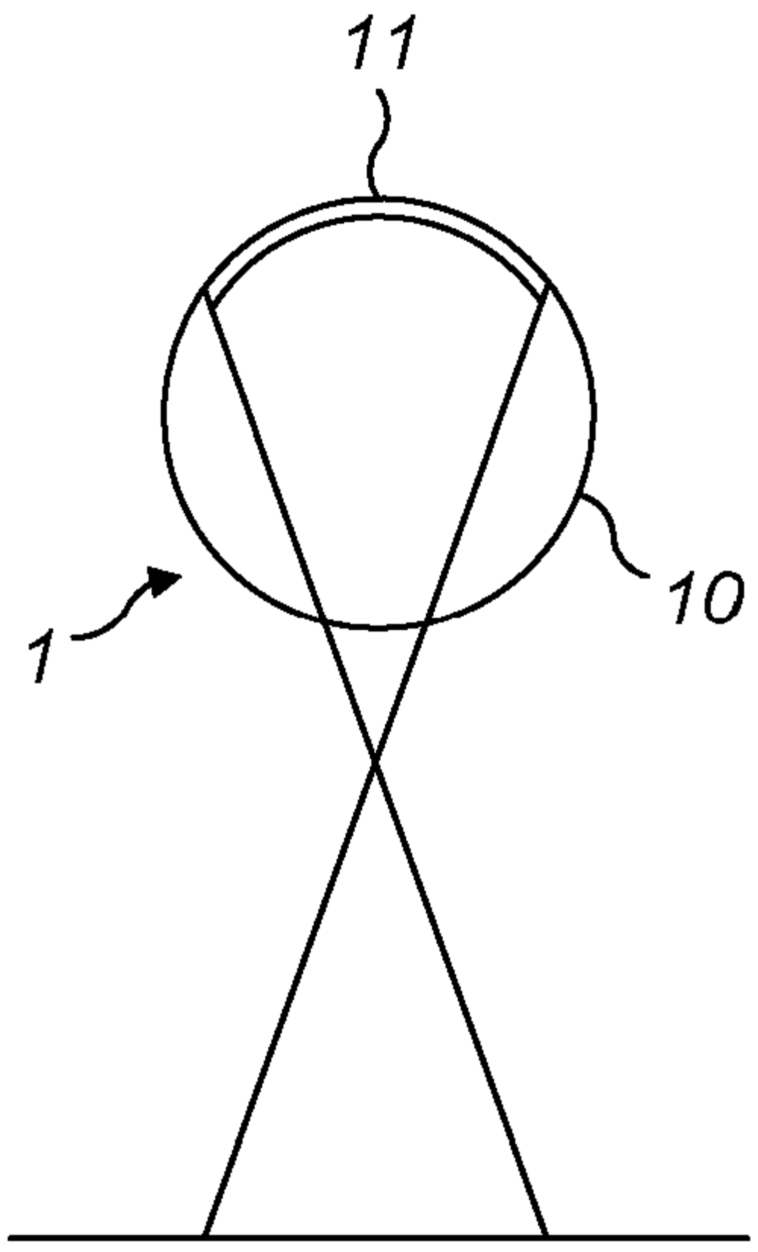

FIG. 2A

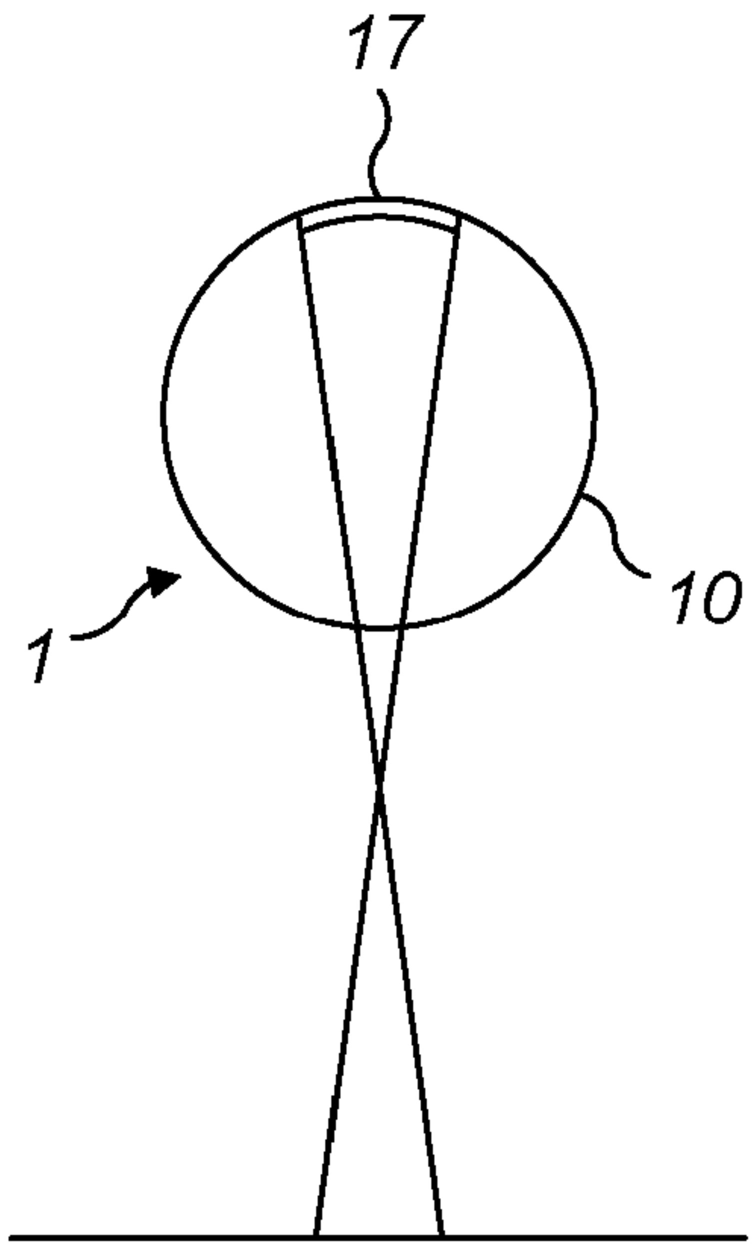

FIG. 2B

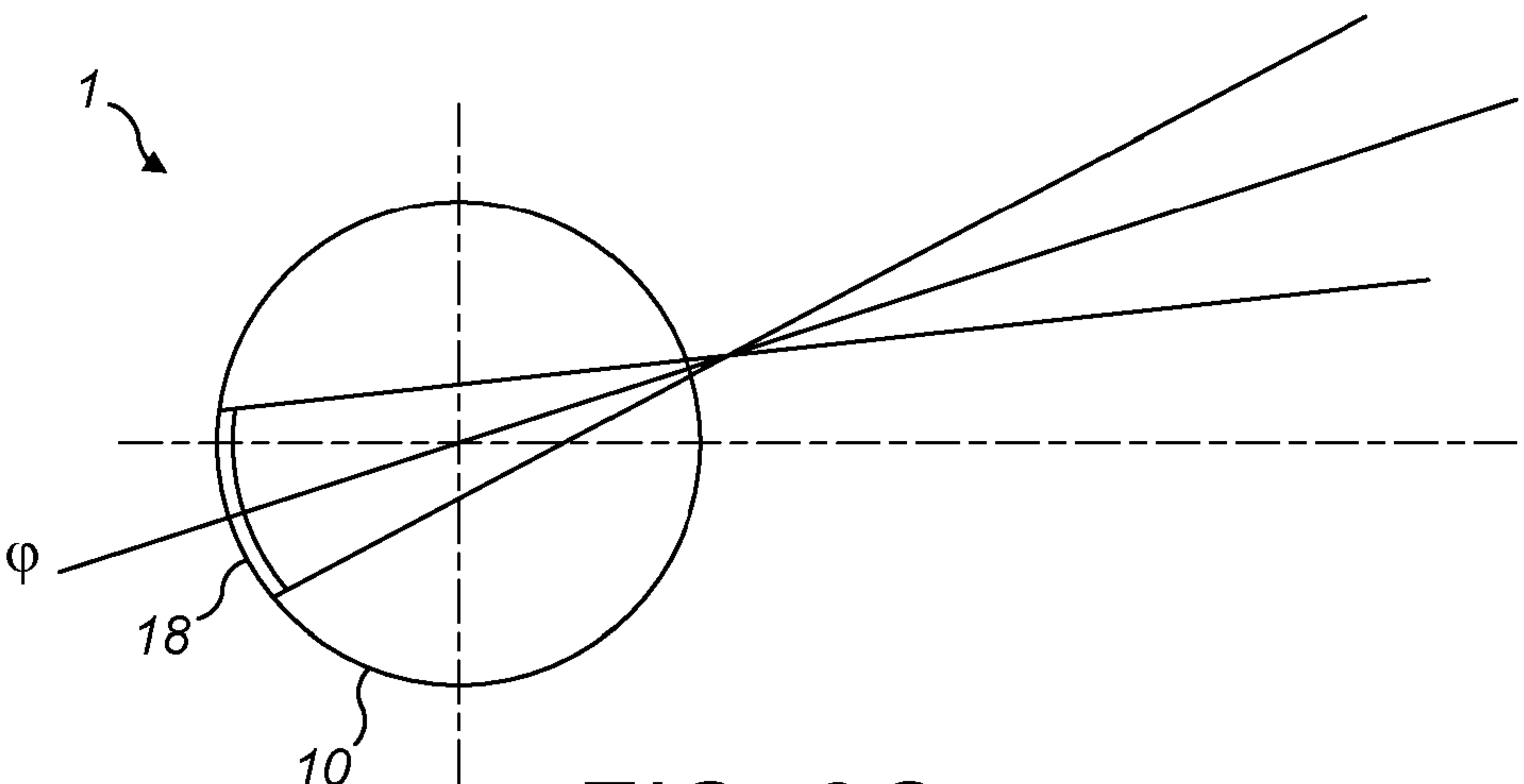

FIG. 2C

FIG. 3

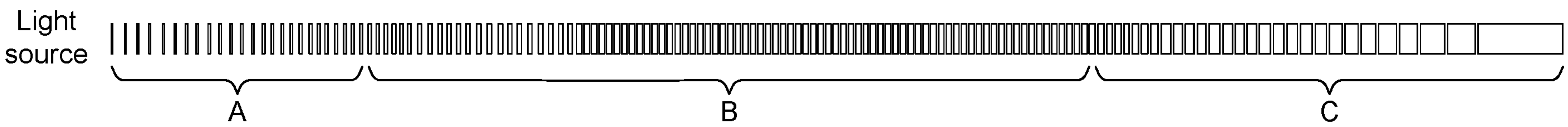

FIG. 4

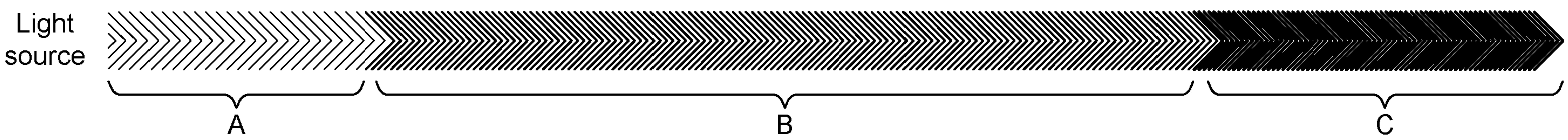

FIG. 5

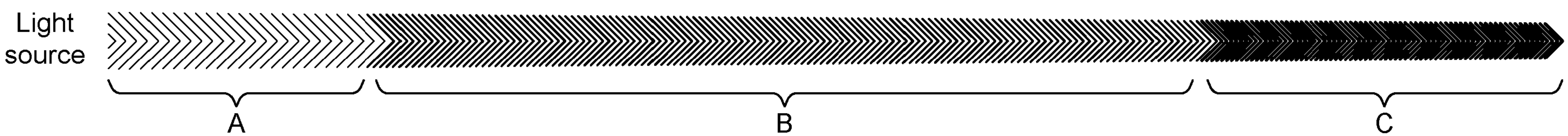

FIG. 6

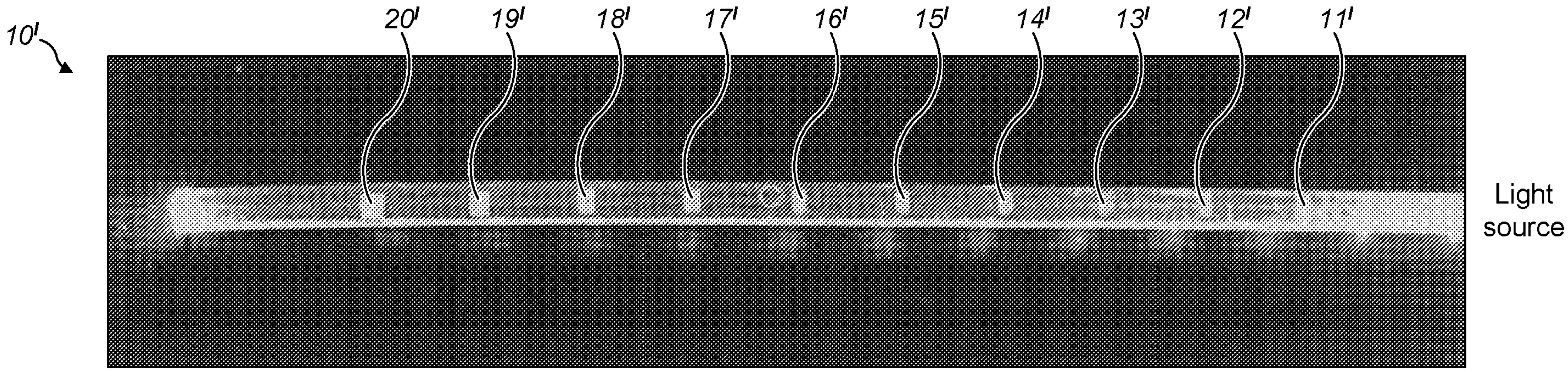

FIG. 7

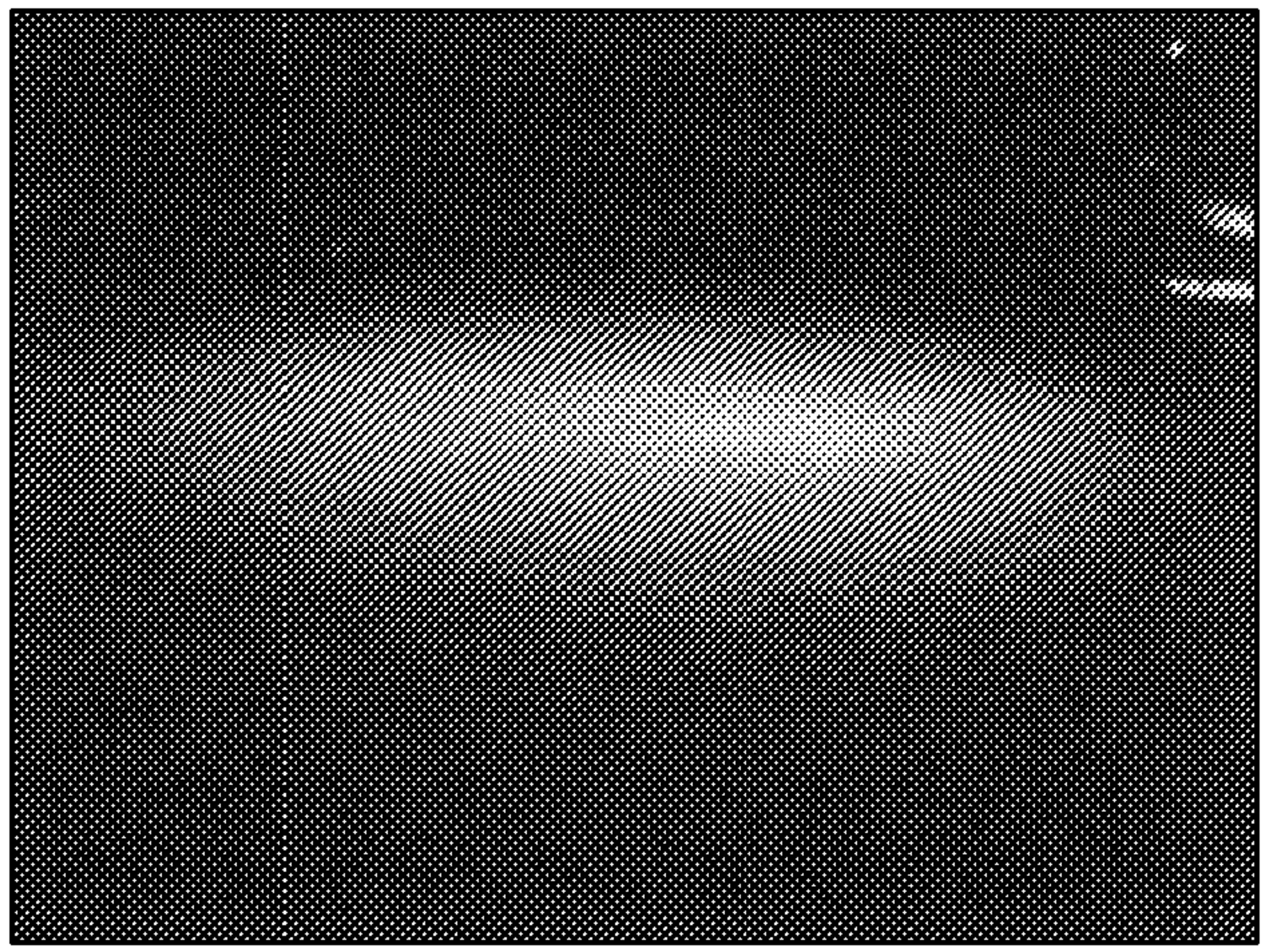

FIG. 8

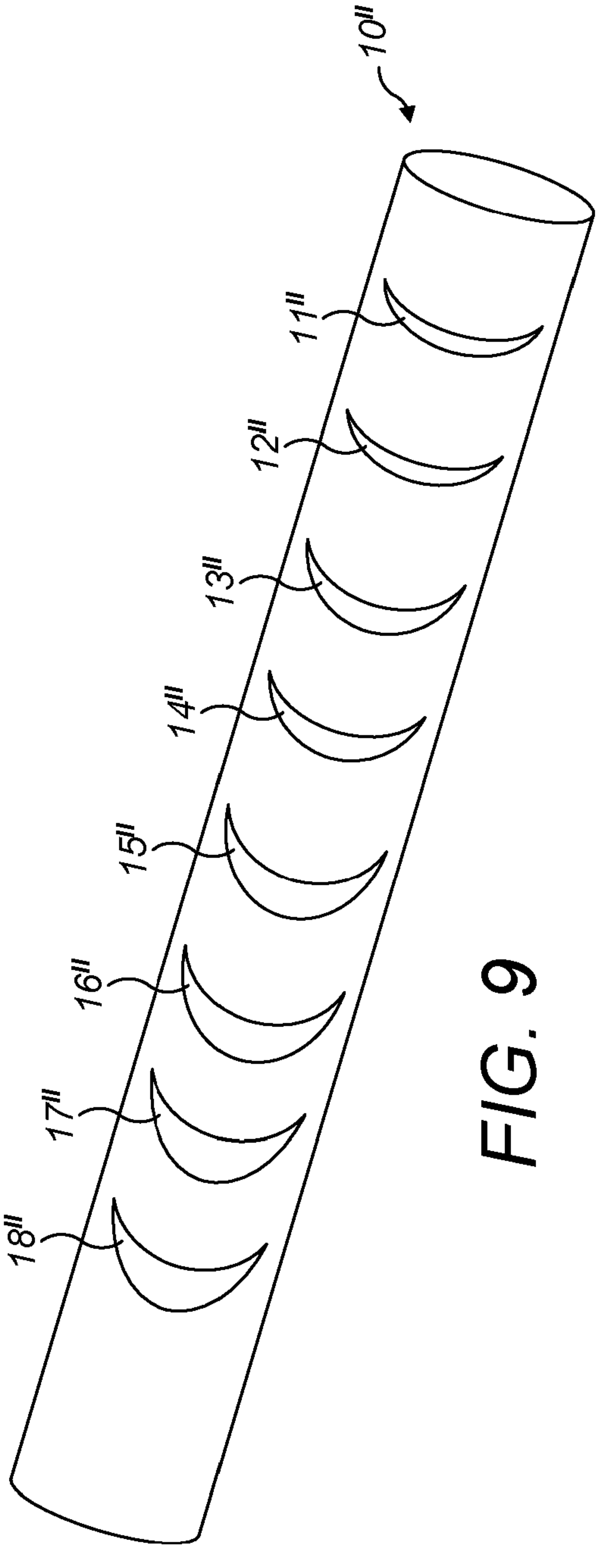

FIG. 9

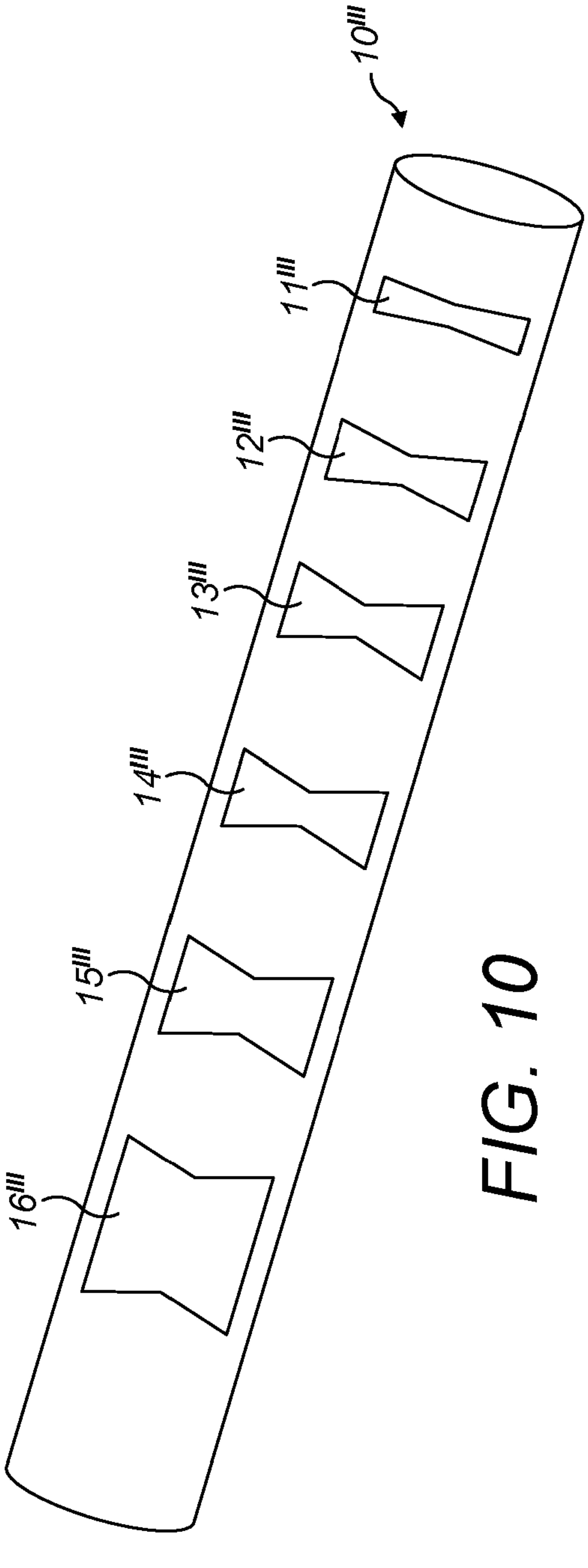

FIG. 10

Optical Element

FIELD

[01] Example embodiments relate to optical elements for directed transmission and emission of light, and associated manufacturing methods.

BACKGROUND

[02] Optical elements for directed transmission and emission of light, often referred to as lightguides, are well known as a way of providing illumination. Light is shone into the lightguide and transmitted along the lightguide by internal reflection. Emission of light from the lightguide is controlled by providing scattering features on the lightguide's surface. The distribution of scattering features along the lightguide is selected at the design stage to achieve a desired illumination profile. Known lightguides comprise point scattering features, meaning that the designer can select the distribution of the centre of the features along the length of the lightguide, referred to as the pitch, and also the distribution of features on the surface at any particular position along the length.

[03] However, point scattering features arranged in this way provide only relatively coarse control over the resultant illumination profile. Although point scattering features can be manufactured to be of small size, for example by laser etching, they are essentially discrete in nature and each one has a significant scattering effect on light passing along the lightguide.

[04] Example embodiments of the present invention aim to address at least one disadvantage of the background art, whether identified herein, or otherwise.

SUMMARY

[05] According to one example embodiment there is provided an optical element for directed transmission and emission of light, comprising a light extraction feature in the form of a line scattering feature.

[06] In one example embodiment the optical element comprises a lightguide, arranged to transmit light that is shone into a first end thereof in an axial direction, away from the first end so that it can be emitted from the lightguide by scattering at a line scattering feature positioned away from the first end. In one example embodiment the lightguide body comprises a curved outer surface, for example, the lightguide comprises a generally cylindrical form.

[07] In one example embodiment the line scattering feature extends across the lightguide, transverse to the axial direction of the lightguide.

[08] In one example embodiment the line scattering feature is arranged on the surface of the lightguide.

[09] In one example embodiment the line scattering feature comprises a laser etched feature on the surface of the lightguide. In one example embodiment the line scattering feature comprises a laser etched feature formed below the surface of the lightguide.

[10] In one example embodiment the line scattering feature comprises a moulded feature on the surface of the lightguide.

[11] In one example embodiment the line scattering feature comprises a chemical etched feature on the surface of the lightguide.

[12] In one example embodiment the line scattering feature comprises a mechanically machined feature on the surface of the lightguide.

[13] In one example embodiment the line scattering feature is characterised by a length characteristic dimension. For example, the line scattering feature has negligible width, e.g. a width of 0.1mm, or less than 0.1mm.

[14] In one example embodiment the length characteristic dimension of the line scattering feature is greater than 0.5mm.

[15] In one example embodiment the length characteristic dimension of the line scattering feature is less than 3mm.

[16] In one example embodiment the length characteristic dimension of the line scattering feature comprises more than 10 percent of the transverse dimension of the lightguide.

[17] In one example embodiment the length characteristic dimension of the line scattering feature comprises up to 100 percent of the transverse dimension of the lightguide.

[18] In one example embodiment the line scattering feature is aligned transverse to the lightguide, such that the length characteristic dimension of the line scattering feature corresponds to a distance across the light guide in a transverse direction, i.e.in a direction perpendicular to the axial direction of the lightguide. In one example embodiment the line scattering feature is aligned transverse to the light guide and runs generally circumferentially around the surface of the lightguide.

[19] In another example embodiment the line scattering feature is arranged skew to the axial direction of the lightguide, and the length characteristic dimension of the line scattering feature comprises the length of the line scattering feature projected onto a cross section of the lightguide transverse to the axial direction of the lightguide.

[20] In one example embodiment the line scattering feature has a length characteristic dimension that comprises the distance around the lightguide in a generally circumferential direction. In one example embodiment the line scattering feature has a length characteristic dimension that comprises a distance on the surface of the lightguide, transverse to the axial direction of the lightguide.

[21] In one example embodiment the line scattering feature is a straight line segment. In one example embodiment the line scattering feature comprises two straight line segments. In one example embodiment the line scattering feature comprises a plurality of line segments arranged to intersect at an angle to one another. In one example embodiment the line scattering feature comprises a curved line, for example a curved line with a single radius of curvature, or with multiple radii of curvature along its length. In one example embodiment the line scattering feature comprises a plurality of curved line segments arranged with a discontinuity in curvature there-between.

[22] In example embodiments having more than one line segment, two or more of the line segments may have corresponding dimensions to one another, for example corresponding characteristic length. In one example embodiment the line scattering feature comprises two identical line segments arranged at different orientations with respect to the axial direction of the lightguide, for example to form a chevron of line segments.

[23] In one example embodiment, the line scattering feature describes a scattering area. In one example embodiment the scattering area extends along the length of the lightguide and across the width of the lightguide.

[24] In one example embodiment, the line scattering feature comprises a plurality of adjoining line segments that together describe a scattering area.

[25] In one example embodiment the scattering area comprises a textured area. In one example embodiment the scattering area fills the area described by the line scattering feature. In one example embodiment the textured area is homogenous across its whole extent. In one example embodiment the textured area provides uniform scattering properties within the scattering area.

[26] In one example embodiment the scattering area extends across the width of the lightguide.

[27] In one example embodiment the scattering area comprises a laser etched feature on the surface of the lightguide. In one example embodiment the scattering area comprises a laser etched feature formed below the surface of the lightguide.

[28] In one example embodiment the scattering area comprises a moulded feature on the surface of the lightguide.

[29] In one example embodiment the scattering area comprises a chemical etched feature on the surface of the lightguide.

[30] In one example embodiment the scattering area comprises a mechanically machined feature on the surface of the lightguide.

[31] In one example embodiment the scattering area is characterised by a length characteristic dimension and a width characteristic dimension.

[32] In one example embodiment the scattering area is aligned generally transverse to the lightguide, such that the length characteristic dimension corresponds to a distance across the lightguide in a transverse direction, i.e. in a direction perpendicular to the axial direction of the lightguide, and with the width characteristic dimension corresponding to a distance along the lightguide in the axial direction.

[33] In another example embodiment the scattering area is arranged skew to the axial direction of the lightguide, and the length characteristic dimension of the scattering area comprises the length of the scattering area projected onto a cross section of the lightguide transverse to the axial direction of the lightguide.

[34] In one example embodiment the scattering area has a length characteristic dimension that comprises the distance around the lightguide in a generally circumferential direction. In one example embodiment the scattering area has a length characteristic dimension that comprises a distance on the surface of the lightguide , transverse to the axial direction of the lightguide

[35] In one example embodiment the length characteristic dimension of the scattering area is greater than 0.5mm.

[36] In one example embodiment the length characteristic dimension of the scattering area is less than 3mm.

[37] In one example embodiment the length characteristic dimension of the scattering area comprises more than 10 percent of the transverse dimension of the lightguide.

[38] In one example embodiment the length characteristic dimension comprises up to 100 percent of the transverse dimension of the lightguide.

[39] In one example embodiment the width characteristic dimension of the scattering area is greater than 0.1mm.

[40] In one example embodiment the width characteristic dimension of the scattering area is less than 10mm.

[41] In one example embodiment the ratio of the length characteristic dimension of the scattering area to the width characteristic dimension of the scattering area is greater than 0.05.

[42] In one example embodiment the ratio of the length characteristic dimension of the scattering area to the width characteristic dimension of the scattering area is less than 30.

[43] In one example embodiment the scattering area comprises a non-circular area.

[44] In one example embodiment the scattering area comprises a polygonal area, for example a generally rectangular area.

[45] In one example embodiment the scattering area comprises a concave line scattering feature and a convex line scattering feature at two opposed edges. In one example embodiment the scattering area comprises a generally crescent shaped area.

[46] In one example embodiment the scattering area comprises a concave line scattering feature at one or more edge thereof. In one example embodiment the scattering area comprises a concave line scattering feature at two opposed edges thereof. In one example embodiment the scattering area is waisted when viewed in a direction transverse to the axial direction of the lightguide.

[47] In one example embodiment the optical element comprises a plurality of identical line scattering features. In one example embodiment the optical element comprises a plurality of only a single type of line scattering feature.

[48] In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length. In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length, with uniform pitch.

[49] In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length with pitch generally increasing with axial distance. In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length with pitch generally increasing with axial distance, for instance progressively increasing with axial distance.

[50] In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length, wherein the separation of adjacent line scattering features varies from one to the next.

[51] In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length, wherein the separation of adjacent line scattering features generally decreases with axial distance. In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length with separation of adjacent line scattering features generally decreasing with axial distance, for instance progressively decreasing with axial distance.

[52] In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length, wherein the length characteristic dimension of the line scattering features varies for the line scattering features in the plurality of line scattering features.

[53] In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length, wherein the line scattering features comprise different length characteristic dimensions between one another.

[54] In one example embodiment the optical element comprises a plurality of line scattering features distributed axially along its length, wherein the length characteristic dimension of the line scattering features varies according to axial position along the lightguide, for example generally increasing with axial distance, or progressively increasing with axial distance.

[55] In one example embodiment the optical element comprises a plurality of identical scattering areas. In one example embodiment the optical element comprises a plurality of only a single type of scattering area.

[56] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length. In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, with uniform pitch.

[57] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length with pitch generally increasing with axial distance. In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length with pitch generally increasing with axial distance, for instance progressively increasing with axial distance.

[58] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the separation of adjacent scattering areas varies from one to the next.

[59] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the separation of adjacent scattering areas generally decreases with axial distance. In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length with separation of adjacent scattering areas generally decreasing with axial distance, for instance progressively decreasing with axial distance.

[60] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the length characteristic dimension of the scattering areas varies for the scattering areas in the plurality of scattering areas.

[61] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the width characteristic dimension of the scattering areas varies for the scattering areas in the plurality of scattering areas.

[62] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the scattering areas comprise different length characteristic dimensions between one another.

[63] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the length characteristic dimension of the scattering

areas varies according to axial position along the lightguide, for example generally increasing with axial distance, or progressively increasing with axial distance.

[64] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the width characteristic dimension of the scattering areas varies according to axial position along the lightguide, for example generally increasing with axial distance, or progressively increasing with axial distance.

[65] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the length characteristic dimension of the scattering areas varies according to axial position along the lightguide, for example generally increasing with axial distance, or progressively increasing with axial distance.

[66] In one example embodiment the optical element comprises a plurality of scattering areas distributed axially along its length, wherein the size of area of the scattering areas varies according to axial position along the lightguide, for example generally increasing with axial distance, or progressively increasing with axial distance.

[67] In one example embodiment the optical element comprises a plurality of line scattering features arranged into groups, wherein the distribution of the line scattering features in the first group is different to the distribution of the line scattering features in the second group.

[68] In one example embodiment the line scattering features in the first group are distributed axially along the length of the light guide with uniform pitch.

[69] In one example embodiment the line scattering features in the second group are distributed axially along the lightguide such that the separation between adjacent line scattering features generally decreases with axial distance. In one example embodiment the optical element comprises line scattering features in a second group that are distributed axially along the length of the lightguide such that separation of adjacent line scattering features generally decreases with axial distance, for instance progressively decreases with axial distance.

[70] In one example embodiment the optical element comprises a plurality of scattering areas arranged into groups, wherein the distribution of the scattering areas in the first group is different to the distribution of the scattering areas in the second group.

[71] In one example embodiment the distribution of the scattering areas in the first and/or second groups corresponds to those described above in relation to the groups of line scattering features.

[72] In one example embodiment the distribution of the scattering areas in one or both of the first group and the second group is arranged such that although there is a constant pitch, the separation between adjacent scattering areas varies according to variation in characteristic width of the adjacent scattering areas. In one such example embodiment the separation of

adjacent scattering areas in the first and/or second group generally decreases with axial distance, for example, progressively decreasing with axial distance.

[73] In one example embodiment the optical element comprises a plurality of scattering areas arranged into a third group, wherein the scattering areas of the third group have uniform separation between scattering areas, and the width characteristic dimension of the scattering areas varies according to axial position along the lightguide, such as generally increasing with axial distance, or progressively increasing with axial distance

[74] In one example embodiment the lightguide comprises one or two groups of line scattering features as described above, and a group of line scattering features that describe scattering areas as described above.

[75] In one example embodiment the separation between the line scattering features/scattering areas in the first group is greater than the separation between the line scattering features in the second group/third group.

[76] In one example embodiment, between first and second, and/or between second and third groups there is a transition region in which the characteristics of the line scattering features/scattering areas in one group gradually changes to those of the next.

[77] In the aforementioned examples the axial distance is measured along the lightguide from the first end thereof, i.e. the end into which light is shone.

[78] In one example embodiment the optical element comprises a lightguide, arranged to transmit light that is shone into a first end thereof in an axial direction, away from the first end so that it can be emitted from the lightguide by scattering, according to a desired output illumination pattern, and comprising a group of line scattering features distributed with progressively decreasing separation long the length of the lightguide. In one example embodiment the lightguide comprises second group of scattering areas arranged such that although there is a constant pitch, the separation between adjacent scattering areas varies according to variation in characteristic width of the adjacent scattering areas. In one such example embodiment the separation of adjacent scattering areas generally decreases with axial distance, for example, progressively decreasing with axial distance. In one example embodiment the optical element comprises a plurality of scattering areas arranged with uniform separation between scattering areas, and width characteristic dimension that varies according to axial position along the lightguide, such as generally increasing with axial distance, or progressively increasing with axial distance. In one example embodiment the two or three arrangements of line scattering features and scattering areas as described are provided, in groups, along the lightguide.

[79] Suitably, the desired output illumination pattern comprises a generally even distribution intensity along the length of the lightguide.

[80] According to another example embodiment there is provided a method of manufacturing an optical element for directed transmission and emission of light, the method comprising forming a line scattering feature in the lightguide.

[81] In one example embodiment the method comprises laser etching the line scattering feature on or below the surface of the lightguide.

[82] In one example embodiment the method comprises forming a line scattering feature that describes a scattering area that extends along the length of the lightguide and across the width of the lightguide.

[83] In one example embodiment the method comprises forming a line scattering feature comprising a plurality of adjoining line segments that together describe a scattering area.

[84] In one example embodiment the method comprises forming a textured scattering area.

[85] In one example embodiment the method comprises moulding the line scattering feature and/or the scattering area on the surface of the lightguide.

[86] In one example embodiment the method comprises chemically etching the line scattering feature and/or the scattering area on the surface of the lightguide.

[87] In one example embodiment the method comprises mechanically machining the line scattering feature and/or the scattering area on the surface of the lightguide.

[88] In one example embodiment the method comprises forming a plurality of line scattering features in the lightguide.

[89] In one example embodiment the method comprises forming a plurality of line scattering features, the line scattering features arranged into groups. In one example embodiment the method comprises forming a first group and a second group, wherein the distribution of the line scattering features in the first group is different to the distribution of the line scattering features in the second group.

[90] In one example embodiment the method comprises forming a plurality of scattering areas, the scattering areas arranged into groups. In one example embodiment the method comprises forming a first group and a second group, wherein the distribution of the scattering areas in the first group is different to the distribution of the line scattering features in the second group, and/or the characteristic width of the scattering areas is different as between the first and second groups.

[91] In one example embodiment, line scattering features/scattering areas in the second and/or third group are formed to comprise a minimum separation possible using the applicable forming technique.

BRIEF DESCRIPTION OF DRAWINGS

[92] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

[93] Figure 1 shows a perspective view of an optical element according to a first example embodiment of the invention;

[94] Figures 2A, 2B and 2C show transverse cross sectional views of the optical element of Figure 1 illustrating light emission patterns from different line scattering features;

[95] Figures 3 to 6 show example distributions of line scattering features for use in example embodiments;

[96] Figure 7 shows a plan view of an optical element according to a second example embodiment;

[97] Figure 8 shows the pattern of emitted light produced by the example embodiment of Figure 7;

[98] Figure 9 shows a perspective view of an optical element according to a third example embodiment; and

[99] Figure 10 shows a perspective view of an optical element according to a fourth example embodiment.

DESCRIPTION OF EMBODIMENTS

[100] Referring now to Figure 1 there is shown a perspective view of an optical element according to a first example embodiment of the invention. The optical element 1 comprises a lightguide 10 for directed transmission and emission of light, and comprises line scattering features 11-18.

[101] The lightguide 10 is arranged to transmit light that is shone into its first end 20 in an axial direction, away from the first end 20 so that it can be emitted from the lightguide 10 by scattering at the line scattering features 11-18 that are positioned away from the first end 20. As will be explained in more detail later with reference to Figure 2, the lightguide 10 comprises a curved outer surface on which the line scattering features 11-18 are formed, and is of generally cylindrical form.

[102] The line scattering features 11-18 extend transversely with their length across the width of the lightguide 10. By varying one or more of the length of the line scattering features, their width, their orientation and their distribution along the axial length of the lightguide 10, fine control over light transmission, and emission from the lightguide 10 can be achieved.

[103] The line scattering features 11-18 are characterised by a length characteristic dimension and a width characteristic dimension. The length characteristic dimension in this example embodiment is the distance that the line scattering feature extends around the surface of the

lightguide 10 and the width characteristic dimension is the distance that the line scattering feature extends in the axial direction along the length of the lightguide, transverse to the length characteristic dimension. In this embodiment the line scattering features are generally rectangular with line scattering taking place as light is incident on the line scattering feature where it runs round the surface of lightguide.

[104] Figures 2A, 2B and 2C show transverse cross sectional views of the optical element of Figure 1 illustrating light emission patterns from line scattering features of different lengths. By arranging the position and length of the line scattering features, different emitted light patterns are produced, so that the viewing angle and position may be controlled. By changing the length of the line scattering feature the viewing angle is controlled, with longer features causing more scattering and therefore a wider viewing angle. By changing the angular position of the line scattering feature as shown relative to a nominal perpendicular light output direction the degree of angular skew is controlled, therefore changing the angle of the viewing position.

[105] Figures 3 to 6 show example distributions of line scattering features for use in example embodiments.

[106] In Figure 3 shows a distribution in which a plurality of line scattering features that define rectangular scattering areas are distributed axially to be applied along the length of a lightguide. The distribution of Figure 3 has uniform pitch, but the characteristic width of the scattering areas is increased with axial distance from the light source. In this way the distribution of Figure 3 is useful in producing a lightguide that has a generally even emission profile along its length, as the increase in ratio of scattering area to the gap there-between increases the proportion of light that is emitted the further from the light source that is considered. The relatively large distance between the scattering areas means that the effect of the uniform pitch reducing the amount of gap between the individual line scattering areas is not significant in determining the emission profile in this case.

[107] In Figure 4 the distribution of scattering features is in a number of distinct parts, with the aim to illustrate an effective way to use scattering features as described herein to produce an even emission profile along the length of the lightguide by varying the separation and characteristic dimensions of the features.

[108] At the end of the lightguide closest to the light source, a relatively low density of line scattering features is provided. The line scattering features in this part are of constant pitch relative to one another. Constant spacing of this nature is relatively easy to manufacture, and the relatively large spacing between the line scattering features means that a relatively high proportion of light is transmitted along the lightguide. This is illustrated as region A in Figure 4. The line scattering features are formed to have negligible width, such as the minimum achievable width according to the manufacturing technique that is used for forming the line scattering features.

[109] Toward the centre of the distribution of Figure 4 the line scattering features define scattering areas, and the gap between the scattering areas decreases with axial distance along the length of the lightguide in order to increase the proportion of light that is emitted, while the characteristic width of the scattering areas remains unchanged. This is illustrated as region B in Figure 4. At some point the minimum achievable gap is reached, according to the manufacturing technique that is used for forming the scattering areas.

[110] At the end of the light guide that is at the furthest axial distance from the light source the proportion of light that needs to be emitted to maintain an even emission profile increases still further. In region C of Figure 4 the gap between the individual scattering areas is reduced, and the characteristic width of the line scattering areas is increased with distance along the distribution. Here it may still be useful to provide the scattering areas separated by the minimum achievable gap, according to the manufacturing technique that is used for forming the scattering areas.

[111] In the embodiment of Figure 5 the line scattering features each comprise two straight line segments in region A that intersect at an angle to one another so as to form a chevron shape, with regions A, B and C also arranged in a distribution comprising regions of line scattering features, scattering areas of fixed characteristic width and increasing characteristic width as described in relation to Figure 4.

[112] In the embodiment of Figure 6 the individual line scattering features are distributed in the same way as those of Figure 5, and the same sort of variation in characteristic width/spacing is also provided in regions A, B and C. However, in this example embodiment of the optical element the scattering areas have length characteristic dimensions which reduce as distance along the light guide increases to thus reduce the effective illumination angle with distance along the lightguide.

[113] Figure 7 shows a plan view of an optical element 10' according to a second example embodiment in the form of lightguide 10' and Figure 8 shows the pattern of emitted light produced by the example embodiment of Figure 7. The scattering areas 11'-20' are formed with regular pitch between centres, with characteristic width that increases along the lightguide from right to left as illustrated in order to increase the proportion of light scattered at each element, thereby evening out the amount of emitted light so that the end of the lightguide away from the light source appears just as bright as the end of the lightguide at which the light is introduced. Note that the light source in this Figure is at the other end of the lightguide to the earlier examples of Figures 3-6.

[114] Figures 9 and 10 show perspective views of optical elements in the form of lightguides 10" and 10''' respectively. In these embodiments scattering areas of crescent and waisted shapes 11" – 18" and 11''' – 16''' respectively are shown.

[115] As will be appreciated, various methods of forming line scattering features may be employed, according to the quantities to be produced, and the desired characteristics of the individual features themselves. For example, laser etching on or below the surface of the lightguide offers good control over the positioning and alignment of the light extraction features, but moulding may be more suitable for mass production. Other techniques can also be used such as mechanical machining or chemical etching. Furthermore, the surface finish at the line scattering features, and in between the line scattering features can be modified, for example by polishing the lightguide in areas where no scattering is intended, and by roughening or back-filling the surface at the light extraction features for more effective scattering/more even emission.

[116] Although the example embodiments herein have been described as having a generally circular cross section, it is to be understood that line scattering features are useful in lightguides with other characteristic shapes according to the particular emitted illumination pattern or application.

[117] As described above, by providing line scattering features, whereby the designer has control over not just the pitch distribution along the axial length of the light guide, a fine degree of control in emission pattern is achievable. In particular, a relatively high density of scattering features is possible to produce effective scattering, while at the same time to avoid the sorts of bright spots or shadows that are typically present in related lightguides.

CLAIMS

1. An optical element for directed transmission and emission of light, comprising a light extraction feature in the form of a scattering feature arranged to scatter light transmitted through the optical element,

wherein the scattering feature describes a scattering area, and

wherein the scattering area is waisted, as hereinbefore defined, when viewed in a direction transverse to an axial direction of the optical element.

2. The optical element of claim 1, comprising a lightguide, the lightguide arranged to transmit light that is shone into a first end thereof in the axial direction, away from the first end so that it can be emitted from the lightguide by scattering at a scattering feature positioned away from the first end.

3. The optical element of claim 1 or 2, wherein the scattering feature is characterised by a length characteristic dimension.

4. The optical element of claim 3, wherein the scattering feature is aligned transverse to the lightguide, such that the length characteristic dimension of the scattering feature corresponds to a distance across the light guide in a transverse direction.

5. The optical element of claim 3, wherein the scattering feature is arranged skew to the axial direction of the lightguide, and the length characteristic dimension of the scattering feature comprises the length of the scattering feature projected onto a cross section of the lightguide transverse to the axial direction of the lightguide.

6. The optical element of any of claims 1 to 5, wherein the scattering feature comprises a plurality of line segments arranged to intersect at an angle to one another.

7. The optical element of any preceding claim, wherein the scattering feature comprises a plurality of adjoining line segments that together describe the scattering area.

8. The optical element of any preceding claim, wherein the scatting area comprises a textured area.

9. The optical element of any of claims 7 to 8, wherein the scattering area comprises a concave scattering feature at two opposed edges thereof.

10. The optical element of any preceding claim, wherein the scattering feature comprises a laser etched feature on the surface of the lightguide.

11. The optical element of any of claims 1 to 9, wherein the scattering feature comprises a laser etched feature formed below the surface of the lightguide.

12. The optical element of any of claims 1 to 9, wherein the scattering feature comprises a moulded feature on the surface of the lightguide.

13. The optical element of any of claims 1 to 9, the scattering feature comprises a chemical etched feature on the surface of the lightguide.

14. The optical element of any of claims 1 to 9, the scattering feature comprises a mechanically machined feature on the surface of the lightguide.

15. The optical element of any of claims 2 to 14, comprising a plurality of scattering features distributed axially along its length.

16. The optical element of claim 15, wherein the plurality of scattering features is distributed axially along the length of the optical element with uniform pitch.

17. The optical element of claim 15 wherein the plurality of scattering features is distributed along the length of the optical element with pitch progressively increasing with axial distance.

18. The optical element of any of claims 15 to 17 when dependent on claim 3, wherein the length characteristic dimension of the scattering features progressively increases with axial distance along the lightguide.

19. The optical element of any of claims 15 to 18 when dependent on any previous claim, wherein the size of area of the scattering areas progressively increases with axial distance along the lightguide.

20. The optical element of any of claims 15 to 19 when dependent on any previous claim, wherein the separation of adjacent scattering areas progressively decreases with axial distance.

21. The optical element of any of claims 2 to 24, comprising a group of scattering features distributed with progressively decreasing separation along the length of the lightguide.

22. The optical element of any of claims 15 to 21, wherein the plurality of scattering features arranged into groups, wherein the distribution of the scattering features in a first group is different to the distribution of the scattering features in a second group.

23. The optical element of claim 22, the scattering features in the first group are distributed axially along the length of the light guide with uniform pitch.

24. The optical element of claim 22 or 23, wherein the scattering features in the second group are distributed axially along the lightguide such that the separation between adjacent scattering features progressively decreases with axial distance

25. A method of manufacturing the optical element of any preceding claim, the method comprising forming the scattering feature in the lightguide.