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(54) VEHICLE PIXELATED LIGHTING DEVICE, VEHICLE LAMP, AND VEHICLE

(57) A vehicle pixelated lighting device, a vehicle lamp, and a vehicle. The vehicle pixelated lighting device comprises a pixel lighting light source (10), a light-transmitting element (30) and a lens assembly (20). The pixel lighting light source (10) is provided with an integral light-emitting surface (11). The light-transmitting element (30) is arranged at the edge of the pixel lighting light source (10) and covers at least a part of the edge of the integral light-emitting surface (11) of the pixel lighting light source (10). The light-transmitting element (30) is used to change the deflection angle of a light ray emitted from the pixel lighting light source (10) into the light-transmitting element (30), and to emit a polarization light ray to the lens assembly (20). The intersection of the reverse extension line of the polarization light ray and the plane of the integral light-emitting surface (11) is located outside of the light-emitting point of an incident light corresponding to the polarization light ray. The part of light entering the light-transmitting element (30) is directed at a point away from the outside of a pixelated light shape center point by means of the light-transmitting element (30), thereby achieving blurring of an pixelated light-shape edge, such that the pixelated light shape has a soft transition at the blurring edge thereof, and finally, after the pixelated light shape and the non-pixelated light shape are superposed, the transition is uniform at the superposition edge, and the connectivity is good..

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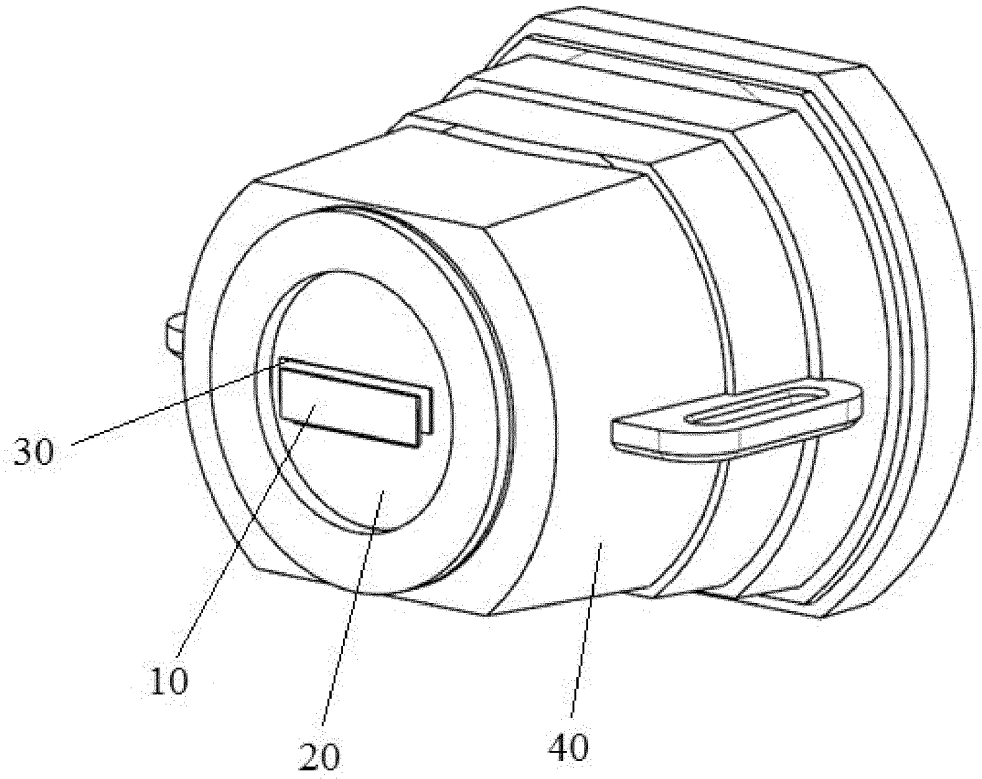

Fig. 8

Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of vehicle lighting, in particular, to a vehicle pixelated lighting device, a vehicle lamp including the vehicle pixelated lighting device, and a vehicle including the vehicle lamp.

BACKGROUND

[0002] In recent years, the application of pixelated lighting devices in the field of vehicle lighting technology has become more and more common. In actual use, pixelated lighting devices used to form pixelated light shapes and lighting devices used to form non-pixelated light shapes (such as matrix lighting devices) are superimposed and used together, that is, pixelated light shapes and non-pixelated light shapes are superimposed and used together, and the two have a certain superimposed area and superimposed boundary.

[0003] Furthermore, a superimposed light shape of a pixelated light shape and a non-pixelated light shape of a vehicle lamp in a high beam illumination mode is shown in Figure 1, and a superimposed light shape of a pixelated light shape and a non-pixelated light shape of a vehicle lamp in a low beam illumination mode is shown in Figure 2. In Figures 1 and 2, region a is a pixelated light shape, region b is a non-pixelated light shape, and c is the superimposed boundary between the pixelated light shape and the non-pixelated light shape. In addition, d is a low beam cutoff line in Figure 2, and is formed by several bright and dark areas of the pixelated light shape area.

[0004] Furthermore, a pixelated light shape is shown in Figure 3. A road simulation light shape formed by superimposing a pixelated light shape and a non-pixelated light shape is shown in Figure 4. In Figures 3 and 4, region a1 is the pixelated light shape, and region c1 is the superimposed boundary between the pixelated light shape and the non-pixelated light shape, that is, region c1 is the lower boundary area of the pixelated light shape. From Figures 3 and 4, it can be seen that the boundary of the pixelated light shape formed by a conventional pixelated lighting device is too sharp, which makes the superimposed shape transitions uneven and has poor continuity at the superimposed boundary after superimposing the pixelated light shape and the non-pixelated light shape, causing visual fatigue for drivers and thus creating driving safety hazards.

SUMMARY

[0005] Given the shortcomings of the prior art mentioned above, the present disclosure provides a vehicle pixelated lighting device that can blur the boundary of pixelated light shape, so that the superimposed shape transitions uniformly and has good continuity at the superimposed boundary after superimposing the pixelated light shape and the non-pixelated light shape.

[0006] Specifically, the present disclosure provides a vehicle pixelated lighting device, including a pixel illumination light source and a lens group arranged along a light-emitting direction. The pixel illumination light source has an overall light-emitting surface facing the lens group. The device further includes a light-transmitting element fixedly arranged between the pixel illumination light source and the lens group. The light-transmitting element is arranged at a boundary of the pixel illumination light source and covers at least a part of a boundary of the overall light-emitting surface of the pixel illumination light source. The light-transmitting element includes a light incident surface facing the pixel illumination light source and a light-emitting surface facing the lens group. The light-transmitting element is used for changing a deflection angle of a light ray from the pixel illumination light source, and emitting a deflected light ray to the lens group. A reverse extension line of the deflected light ray intersects with a plane where the overall light-emitting surface is located at a position outside of a light-emitting point of the incident light ray corresponding to the deflected light ray.

[0007] Further, the light-transmitting element covers only an upper boundary of the overall light-emitting surface of the pixel illumination light source.

[0008] Further, the light-transmitting element covers all boundaries of the overall light-emitting surface of the pixel illumination light source.

[0009] Further, the light-transmitting element is a silicone component.

[0010] Further, the light-emitting surface of the light-transmitting element includes at least one of an arc-shaped surface segment, a vertical plane segment, a horizontal plane segment, and an oblique plane segment.

[0011] Further, the light incident surface of the light-transmitting element includes at least one of an arc-shaped surface segment, a vertical plane segment, a horizontal plane segment, and an oblique plane segment.

[0012] Further, a distance between the pixel illumination light source and the light-transmitting element is less than or equal to 0.5mm.

[0013] Further, the lens group includes a first lens, a second lens, and a third lens sequentially arranged along the light-emitting direction. The first lens is a lens with positive optical power, the second lens is a lens with negative optical power, and the third lens is a lens with positive optical power.

[0014] Further, Abbe numbers of the first lens and the third lens are both greater than an Abbe number of the second lens.

[0015] Further, a material of the first lens is optical glass, a material of the second lens is PC, and a material of the third lens is PMMA.

[0016] Further, the vehicle pixelated lighting device further includes a lens holder, a circuit board, and a heat sink. The first lens, the second lens, and the third lens are all installed in the lens holder. The pixel illumination

light source is installed on the circuit board. The heat sink, the circuit board, and the lens holder are fixedly connected in a sequence along the light-emitting direction. The light-transmitting element is fixed on the lens holder or the circuit board.

[0017] Further, the vehicle pixelated lighting device further includes a first limiting ring and a second limiting ring both arranged inside the lens holder, and a beam limiting element threadedly connected to one end of the lens holder. The other end of the lens holder includes a first limiting portion, and an inner wall of the lens holder includes a second limiting portion and a third limiting portion. Outer peripheral surfaces of the first lens, the second lens and the third lens are all abutted against the inner wall of the lens holder. The first lens is limited between the first limiting portion and the first limiting ring, the second lens is limited between the second limiting portion and the second limiting ring, and the third lens is limited between the third limiting portion and the beam limiting element.

[0018] Further, the beam limiting element is an aperture stop.

[0019] The present disclosure further provides a vehicle lamp. The vehicle lamp is equipped with the above vehicle pixelated lighting device.

[0020] The present disclosure further provides a vehicle. The vehicle is equipped with the above vehicle lamp.

[0021] As described above, the vehicle pixelated lighting device, the vehicle lamp and the vehicle involved in the present disclosure have the following beneficial effects:

[0022] In the present application, a light-transmitting element that covers at least part of the boundary of the pixel illumination light source is set at the boundary of the pixel illumination light source to change the deflection angle of the light entering the light-transmitting element, so that the light is deflected relative to the original propagation direction and forms a deflected light entering the lens group. The intersection point of the reverse extension line of the deflected light and the plane where the overall light-emitting surface is located is located outside the light-emitting point of the incident light corresponding to the deflected light, so that the light-emitting angle of the light after passing through the lens group increases. In this way, the light-transmitting element makes the light entering the light-transmitting element be directed to extend towards the outside away from the center of the pixelated light shape, thus realizing blurring of the boundary of the pixelated light shape, so that the pixelated light shape transitions softly and smoothly at its blurred boundary, and the superimposed shape transitions uniformly and has good continuity at the superimposed boundary after superimposing the pixelated light shape and the non-pixelated light shape. In addition, the boundary of the pixelated light shape is blurred through the light-transmitting element in the present application, and since the light-transmitting element does not block light, light energy will not be lost, and energy utilization is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

Figure 1 is a schematic diagram of a light shape of a vehicle lamp of a vehicle pixelated lighting device in a high beam illumination mode in the prior art.

Figure 2 is a schematic diagram of a light shape of a vehicle lamp of a vehicle pixelated lighting device in a low beam illumination mode in the prior art.

Figure 3 is a schematic diagram of a pixelated light shape with a low beam cut-off line in the prior art.

Figure 4 is a schematic diagram of a simulated road light shape after superimposing a pixelated light shape and a non-pixelated light shape in the prior art.

Figure 5 is a structural schematic diagram of a vehicle pixelated lighting device according to the present application.

Figure 6 is an exploded view of Figure 5, which omits a light-transmitting element.

Figure 7 is a cross-sectional view of Figure 5.

Figure 8 is an assembly schematic diagram of a pixel illumination light source, a lens group, a light-transmitting element, and a lens holder in a vehicle pixelated lighting device according to the present application.

Figure 9 is an assembly schematic diagram of a pixel illumination light source, a lens group, and a light-transmitting element in a vehicle pixelated lighting device according to the present application.

Figure 10 is a structural schematic diagram of a pixel illumination light source according to the present application.

Figure 11 is an assembly schematic diagram of a pixel illumination light source and a light-transmitting element according to the present application.

Figure 12 is a structural schematic diagram of a light-transmitting element according to the present application.

Figures 13a to 13c are cross-sectional views of a light-transmitting element according to different embodiments of the present application.

Figure 14 is a cross-sectional view of Figure 11.

Figure 15 is a schematic diagram of the propagation of light rays at an upper boundary of a pixel illumination light source after deflection by the light-transmitting element.

Figure 16 is an imaging diagram on a distribution screen when a single light-emitting unit is lit and no light-transmitting element is provided.

Figure 17 is an imaging diagram on a distribution screen when a single light-emitting unit is lit and a light-transmitting element is provided according to the present application.

Figure 18 is a schematic diagram of a pixelated light shape formed by a pixelated lighting device without a light-transmitting element.

Figure 19 is a schematic diagram of a pixelated light shape formed by a pixelated lighting device with a light-transmitting element set at a whole circle of boundaries of a pixel illumination light source according to the present application.

Figure 20 is a schematic diagram of a pixelated light shape with a low beam cut-off line according to the present application.

Figure 21 is a schematic diagram of a simulated road light shape after superimposing pixelated and non-pixelated light shapes according to the present application.

Description of Reference Numerals

[0024]

10 Pixel illumination light source
11 Overall light-emitting surface
12 Light-emitting unit
20 Lens group
21 First lens
22 Second lens
23 Third lens
231 Lens flange structure
30 Light-transmitting element
31 Arc surface segment
32 Vertical plane segment
33 Horizontal plane segment
34 Oblique plane segment
40 Lens holder
41 First limiting portion
42 Second limiting portion
43 Third limiting portion
50 Circuit board
60 Heat sink
70 First limiting ring
80 Second limiting ring
90 Beam limiting element

DETAILED DESCRIPTION

[0025] The embodiments of the present disclosure will be described below. Those skilled may easily understand other advantages and effects of the present disclosure according to contents disclosed by the specification.

[0026] It should be understood that the structures, proportions, sizes, and the like, which are illustrated in the drawings of the present specification, are only used to clarify the contents disclosed in the specification for understanding and reading by those skilled, and are not intended to limit the implementation of the present disclosure. Any modification of the structure, change of the scale, or adjustment of the size should still fall within the scope of the technical contents disclosed by the present disclosure without affecting the effects and achievable objectives of the present disclosure. In the meantime, the terms "upper", "lower", "left", "right", "intermediate" and "one" as used in this specification are also for convenience of description, and are not intended to limit the scope of the present disclosure, and the change or adjustment of the relative relationship is considered to be within the scope of the present disclosure without substantial changes in technology.

[0027] In addition, the terms "first," "second," and "third" are used for descriptive purposes and should not be construed as indicating or implying relative importance or implying the number of technical features indicated. Therefore, features described with "first," "second," and "third" may include one or more of the features described either explicitly or implicitly.

[0028] The present application provides a vehicle. The vehicle includes a vehicle lamp that may be a front or rear lamp. Further, the vehicle lamp includes a vehicle pixelated lighting device for forming a pixelated light shape. For ease of description, in the following embodiments, the light-emitting direction of the vehicle pixelated lighting device is defined as a forward direction, that is, the light source in the vehicle pixelated lighting device emits light forward, and the vehicle pixelated lighting device forms a pixelated light shape on its front side.

[0029] In addition, in the following embodiments, "dispersion" refers to the property that the refractive index of a material changes with the frequency of incident light. For example, white light includes seven monochromatic lights: red, orange, yellow, green, blue, indigo and violet, and because the refractive indices of these seven monochromatic lights are different, incident white light will be dispersed into these seven colors after refraction. The degree of dispersion is generally related to the structure and material of the lens. Generally speaking, short-wave inward dispersion and long-wave outward dispersion occur in lenses with positive optical power, while short-wave outward dispersion and long-wave inward dispersion occur in negative optical power lenses. Therefore, combining these two types of lenses can compensate for and

correct dispersion. "Chromatic aberration" refers to the difference in image caused by different monochromatic lights having different refractive indices when imaging with white light, so that different monochromatic lights have different propagation paths, resulting in the difference in optical paths caused by different monochromatic lights.

[0030] As shown in Figures 5-6 and 8-9, the vehicle pixelated lighting device provided in the present application includes a pixel illumination light source 10, a light-transmitting element 30, and a lens group 20 arranged in sequence from rear to front along the light-emitting direction. The light-transmitting element 30 is fixedly arranged between the pixel illumination light source 10 and the lens group 20. The light emitted forward by the pixel illumination light source 10 can form a pixelated light shape after passing through the lens group 20. The light-transmitting element 30 has a light incident surface facing the pixel illumination light source 10 and a light-emitting surface facing the lens group 20. As shown in Figure 10, multiple light-emitting units 12 arranged in a matrix are provided on a front surface of the pixel illumination light source 10. The light-emitting surfaces of the multiple light-emitting units 12 form an overall light-emitting surface 11 of the pixel illumination light source 10. The overall light-emitting surface 11 faces the light incident surface of the lens group 20 and the light incident surface of the light-transmitting element 30. The outer edge of the pixel illumination light source 10 is its boundary. The outer edge of the overall light-emitting surface 11 of the pixel illumination light source 10 is its boundary.

[0031] Specifically, as shown in Figure 11, the light-transmitting element 30 is arranged around the boundary of the pixel illumination light source 10 and covers at least a portion of the boundary of the overall light-emitting surface 11 of the pixel illumination light source 10, that is, corresponding inner edges of the light-transmitting element 30 are located within the portion of the boundary of the overall light-emitting surface 11 covered by the light-transmitting element 30. In this way, the light-transmitting element 30 may cover the lower boundary, upper boundary, left boundary, or right boundary of the overall light-emitting surface 11 of the pixel illumination light source 10; or the light-transmitting element 30 may simultaneously cover both the lower and upper boundaries of the overall light-emitting surface 11 of the pixel illumination light source 10; or the light-transmitting element 30 may simultaneously cover all the boundaries of the overall light-emitting surface 11 of the pixel illumination light source 10. The overall light-emitting surface 11 of the pixel illumination light source 10 emits forward light rays. Some of these light rays enter the light-transmitting element 30 and are herein defined as incident rays P1 as shown in Figure 15. The pixel illumination light source 10 emits forward the incident rays P1 from a certain light-emitting point A, then the light-transmitting element 30 is used to change the deflection angle of the incident rays P1 entering it from the pixel illumination light source 10 and correspondingly emit deflected rays P2 after deflection to lens group 20. The intersection points A1 and A2 between backward extension lines of the deflected rays P2 and a plane where the overall light-emitting surface 11 is located are located on outer sides of the light-emitting point A of the corresponding incident rays P1, i.e., the intersection points A1 and A2 are farther away from the center of the overall light-emitting surface 11 than the light-emitting point A.

[0032] When the light-transmitting element 30 is set only at the upper boundary of the pixel illumination light source 10 and covers only the upper boundary of the overall light-emitting surface 11 of the pixel illumination light source 10, the overall light-emitting surface 11 of the pixel illumination light source 10 emits forward light rays, and the incident rays P1 emitted from the upper boundary portion of the overall light-emitting surface 11 enter the light-transmitting element 30, as shown in Figure 15, the light-transmitting element 30 changes the deflection angle of these incident rays P1 and emits deflected rays P2, and then makes these deflected rays P2 enter the lens group 20. Specifically, in Figure 15, if the light-transmitting element 30 is not set, two incident rays P1 emitted from the light-emitting point A respectively enter the lens group 20 along their original propagation directions S1 and Y1, and the imaging on the illumination screen is shown in Figure 16, where the lower boundary of the illumination area corresponding to the upper boundary of overall light-emitting surface 11 is not blurred. After setting the light-transmitting element 30 according to the present application, two incident rays P1 emitted from the light-emitting point A are deflected into deflected rays P2 after passing through the light-transmitting element 30. Two deflected rays P2 respectively enter the lens group 20 along deflected propagation directions S2 and Y2. From Figure 15, it can be seen that the two incident rays P1 emit forward from the light-emitting point A, A1 is the intersection point of the reverse extension line of a first deflected light ray P2 corresponding to a first incident ray P1 along the S2 direction and the plane where the overall light-emitting surface 11 of the pixel illumination light source 10 is located. A2 is the intersection point of the reverse extension line of a second deflected light ray P2 corresponding to a second incident ray P1 along the Y2 direction and the plane where the overall light-emitting surface 11 of the pixel illumination light source 10 is located. Both the intersection points A1 and A2 are higher than the light-emitting point A, i.e., both the intersection points A1 and A2 are located outside the light-emitting point A and farther away from the center of the overall light-emitting surface 11 than the light-emitting point A. Since the lens group 20 shows inverted images, images of both the intersection points A1 and A2 on the screen are lower than the image of the light-emitting point A, i.e., images of both the intersection points A1 and A2 are located outside the image of the light-emitting point A, so there will be light below the original spot, resulting in a blurring effect. The images

on an illumination screen after setting the light-transmitting element 30 according to the present application are shown in Figure 17, where the lower boundary of the illumination area corresponding to the upper boundary of overall light-emitting surface 11 has a blurring effect, the lower boundary of this part of illumination area extends downward (i.e., outward), equi-illuminance lines are sparser, and light is softer.

[0033] Similarly, when the light-transmitting element 30 is set only at the lower boundary of the pixel illumination light source 10 and covers only the lower boundary of the overall light-emitting surface 11 of the pixel illumination light source 10, the light-transmitting element 30 deflects the light rays upward, causing light to appear above the original light spot of the pixelated light shape and achieving a blurring effect of the upper boundary of the pixelated light shape. When the light-transmitting element 30 is set only at the left boundary of the pixel illumination light source 10 and covers only the left boundary of the overall light-emitting surface 11 of the pixel illumination light source 10, the light-transmitting element 30 deflects the light rays to the right, causing light to appear on the right side of the original light spot of the pixelated light shape and achieving a blurring effect of the right boundary of the pixelated light shape. When the light-transmitting element 30 is set only at the right boundary of the pixel illumination light source 10 and covers only the right boundary of the overall light-emitting surface 11 of the pixel illumination light source 10, the light-transmitting element 30 deflects the light rays to the left, causing light to appear on the left side of the original light spot of the pixelated light shape and achieving a blurring effect of the left boundary of the pixelated light shape.

[0034] Therefore, the present application provides a light-transmitting element 30 that covers at least part of the boundaries of the pixel illumination light source 10 at a boundary of the pixel illumination light source 10 to change the deflection angles of the light rays entering the light-transmitting element 30. This causes these light rays to be deflected and form deflected light rays P2 that enter the lens group 20. The intersection points of the reverse extension lines of the deflected light rays P2 and the plane where the overall light-emitting surface 11 is located are located outside the light-emitting point of the incident light rays P1 corresponding to the deflected light P2. Therefore, after passing through the lens group 20, these light rays have a larger exit angle, which makes it possible for the light rays entering the light-transmitting element 30 to extend directionally toward the outside of the pixelated light shape, thereby achieving a blurring effect of the boundary of the pixelated light shape and makes the pixelated light shape transition softly at its blurred boundary. Finally, it makes it possible for the superimposed shape transitions uneven and has poor continuity at the superimposed boundary c1 after superimposing the pixelated light shape and the non-pixelated light shape, as shown in Figures 20 and 21. In addition, by blurring the boundary of the pixelated light shape through the light-transmitting element 30, the present application does not block the light rays and therefore does not lose energy, thereby increasing light energy utilization efficiency. At the same time, since the illumination range of the blurred pixelated light shape is larger, the blurring effect will also expand the illumination range of the whole light shape. The light-transmitting element 30 is set at the boundary, so imaging light shapes of pixels at central areas will not be blurred. Pixels at the boundary are blurred along the boundary direction without affecting mutual shading between pixels, i.e., the blurred light will not enter adjacent pixel areas.

[0035] Preferably, in the present application, the light-transmitting element 30 covers at least the upper boundary of the pixel illumination light source 10 and at least blurs the lower boundary of the pixelated light shape to make the transition on the road surface smoother and better connected to the auxiliary low beam shape. More preferably, in one embodiment, as shown in Figures 11, 12 and 14, the light-transmitting element 30 is a loop member that covers all the boundaries of the pixel illumination light source 10. When no light-transmitting element 30 is set up, the pixelated light shape formed is as shown in Figure 18, and the boundary of the entire light shape is sharp. After setting up a whole circle of light-transmitting element 30 according to the present application, the pixelated light shape formed is as shown in Figure 19, which blurs the entire circle of boundaries of the pixelated light shape and makes the entire boundary of the pixelated light shape transition softly. Thus, as shown in Figure 20, a pixelated light shape with a low beam cutoff line whose boundary is blurred is formed. The road simulation light shape formed by superimposing a pixelated light shape with a blurred boundary and a non-pixelated light shape is shown in Figure 21. It can be seen from Figures 20 and 21 that there is a uniform transition and good continuity at their superimposed boundary c1.

[0036] Furthermore, in other embodiments, a light-transmitting element 30 that covers only the upper boundary of the overall light-emitting surface 11 may be set at the upper boundary of the pixel illumination light source 10. In this case, light rays emitted from the upper boundary of the overall light-emitting surface 11 will be deflected downward while light rays emitted from the lower boundary and left and right boundaries will still propagate in their original directions without deflection. This will not affect illumination areas on the upper side and left and right sides. A light-transmitting element 30 that covers only the lower boundary of the overall light-emitting surface 11 may also be set at the lower boundary of the pixel illumination light source 10 to blur the upper boundary of the pixelated light shape to avoid discomfort caused by observing sharp boundaries while driving in tunnels. Therefore, depending on specific needs for blurring boundaries of pixelated light shapes, a light-transmitting element 30 can be set at corresponding boundaries of the pixel illumination light source 10.

[0037] Furthermore, the light-transmitting element 30 is a silicone component, that is, the light-transmitting element 30 is made of silicone. While realizing the blurring of the boundary of the pixelated light shape, it can also effectively reduce the manufacturing cost. Preferably, the closer the light-transmitting element 30 is to the pixel illumination light source 10, the better. In one embodiment, the distance between the pixel illumination light source 10 and the light-transmitting element 30 is less than or equal to 0.5mm and preferably 0.5mm to prevent contact or overheating. In other embodiments, the distance between the pixel illumination light source 10 and the light-transmitting element 30 may also be greater than 0.5mm.

[0038] Furthermore, the light-emitting surface of the light-transmitting element 30 may be a flat surface, or a curved surface with patterns. The light incident surface of the light-transmitting element 30 may be a flat surface, or a curved surface with patterns. The light-transmitting elements 30 distributed on upper and lower sides or left and right sides of the pixel illumination light source 10 may be symmetrically arranged or not, as long as the light incident surface and light-emitting surface of the light-transmitting element 30 are matched to adjust the light-emitting angle of the light entering it so that the light is deflected to the desired light-emitting angle. Based on this, there are many specific forms of light-transmitting elements 30. For example, as shown in Figure 13a, the light incident surface on the rear side of the light-transmitting element 30 includes a vertical plane segment 32 extending up and down and an oblique plane segment 34 extending obliquely, and the light-emitting surface on the front side of the light-transmitting element 30 includes multiple oblique plane segments 34. For example, as shown in Figure 13b, the light incident surface on the rear side of the light-transmitting element 30 includes a vertical plane segment 32 extending up and down and being a flat structure, and the light-emitting surface on the front side of the light-transmitting element 30 includes multiple arc-shaped surface segments 31 and multiple horizontally extending horizontal plane segments 33. For example, as shown in Figure 13c, the light incident surface on the rear side of the light-transmitting element 30 includes a vertical plane segment 32 extending up and down and being a flat structure, and the light-emitting surface on the front side of the light-transmitting element 30 includes an oblique plane segment 34 extending obliquely.

[0039] Preferably, the pixel illumination light source 10 is a matrix-type LED light source with tens to hundreds of pixels, which has 100 pixels in one embodiment. The size of the pixel is about 0.5mm in length, which can make the clarity of the formed pixel image higher, and then can realize higher precision control of the light shape formed after the pixel image is projected out. In this case, the boundary of the formed dark part and the change of the dark part position are also more delicate and smooth, which can better avoid dazzling or blindness to pedestrians or drivers. Moreover, the rectangular matrix arrangement of the LEDs provides a wider light shape to illuminate the areas on both sides of the road, which is conducive to drivers' observation of pedestrians and road signs on both sides of the road.

[0040] Furthermore, as shown in Figures 6 to 9, the vehicle pixelated lighting device further includes a lens holder 40, a circuit board 50, and a heat sink 60. The lens group 20 includes a first lens 21, a second lens 22, and a third lens 23 arranged from back to front along the light-emitting direction. The first lens 21 is a lens with positive optical power, the second lens 22 is a lens with negative optical power, and the third lens 23 is a lens with positive optical power. The first lens 21, the second lens 22 and the third lens 23 are all installed in the lens holder 40. The pixel illumination light source 10 is installed on the circuit board 50. The heat sink 60, the circuit board 50, and the lens holder 40 are fixedly connected in a sequence along the light-emitting direction. The light-transmitting element 30 is fixed on the lens holder 40 or the circuit board 50.

[0041] Furthermore, as shown in Figures 6 to 7, the vehicle pixelated lighting device further includes a first limiting ring 70 and a second limiting ring 80, both arranged inside the lens holder 40, and a beam limiting element 90 threadedly connected to the front end of the lens holder 40. The first limiting ring 70 and the second limiting ring 80 are fixedly assembled inside the lens holder 40 in a tight fit. The rear end of the inner wall of the lens holder 40 includes a first limiting portion 41 that bends and extends inwardly. The inner wall of the lens holder 40 includes a second limiting portion 42 and a third limiting portion 43 that protrude inwardly. The first limiting portion 41, the first limiting ring 70, the second limiting portion 42, the second limiting ring 80, the third limiting portion, and the beam limiting element 90 are sequentially distributed from back to front along the light-emitting direction. The outer peripheral surfaces of the first lens 21, the second lens 22 and the third lens 23 are abutted against the inner wall of the lens holder 40. The first lens 21 is limited between the first limiting portion 41 and the first limiting ring 70. The second lens 22 is limited between the second limiting portion 42 and the second limiting ring 80. The third lens 23 is limited between the third limiting portion 43 and the beam limiting element 90. In this way, the first lens 21, the second lens 22 and the third lens 23 are arranged in sequence and fixedly installed inside the lens holder 40. The first lens is pressed into place by means of the first limiting ring 70 and the first limiting portion 41. The second lens is pressed into place by means of the second limiting ring 80 and the second limiting portion 42. The third lens is pressed into place by means of the beam limiting element 90 and third limiting portion 43. Thus, the first lens 21, the second lens 22 and the third lens 23 can be tightly arranged inside the lens holder 40 to effectively reduce the overall volume for miniaturization design. In addition, the present application limits the lens group 20 in the light-emitting direction through the first limiting ring 70, the second limiting ring 80 and the beam limiting element

90 without additional limiting components inside the lens holder 40. It can reduce the production cost to some extent by reducing requirements for the production accuracy on the lens holder 40. The beam limiting element 90 is threadedly connected to the outer periphery at the front end of the lens holder 40, thus the beam limiting element 90 and the lens holder 40 are detachably connected with each other for easy installation of the first lens 21, the first limiting ring 70, the second lens 22, the second limiting ring 80 and the third lens 23 into the lens holder 40 in sequence. The beam limiting element 90 is preferably an aperture stop, which determines the amount of light beams passing through the lens group 20.

[0042] Preferably, the rear end of the outer wall of the lens holder 40 may include a mounting seat that bends and extends outwardly. The circuit board 50 is mounted on the mounting seat, and the heat sink 60 is mounted on the rear side of the circuit board 50 for heat dissipation of the pixel illumination light source 10. An opening may also be provided on the mounting seat for placing connectors to realize power supply to the circuit board 50 and the pixel illumination light source 10, and also play a role in ventilation and heat dissipation to improve the heat dissipation power. In addition, the outer diameter of the first lens 21 is smaller than that of the second lens 22, and the outer diameter of the second lens 22 is smaller than that of the third lens 23, which is in tune with the light-emitting direction to ensure the efficiency of light transmission and improve illumination brightness.

[0043] Furthermore, the Abbe numbers of the materials of the first lens 21 and the third lens 23 are both greater than that of the material of the second lens 22, which can help eliminate chromatic aberration. An Abbe number is a dispersion coefficient, which is used to measure the degree of dispersion of light in a transparent medium. Generally speaking, under the premise of equal optical power, the smaller the Abbe number of a medium, the more severe its chromatic dispersion; conversely, the larger the Abbe number of a medium, the less severe its chromatic dispersion. Preferably, the material of the first lens 21 is optical glass, such as optical glass with grade H-K9L, the material of the second lens 22 is polycarbonate (PC), and the material of the third lens 23 is polymethyl methacrylate (PMMA). Using these materials can better eliminate the chromatic aberration.

[0044] Preferably, as shown in Figure 7, a part or all of the outer peripheral surface of the first lens 21, a part or all of the outer peripheral surface of the second lens 22, and a part or all of the outer peripheral surface of the third lens 23 are respectively abutted and matched with the inner wall of the lens holder 40 to limit the radial movement of the first lens 21, the second lens 22 and the third lens 23. In addition, a lens flange structure 231 is provided on the outer peripheral side of the third lens 23. The outer peripheral surface of the lens flange structure 231 is abutted with the inner wall of the lens holder 40, which can ensure that the part used for light transmission will not be blocked by the connecting structure on the lens holder 40, thereby ensuring the efficiency of light transmission and improving the illumination brightness. Moreover, the lens flange structure 231 is also used to abut with a light beam limiting element 90 and the third limiting portion 43 to fix and limit the third lens 23 between the light beam limiting element 90 and the third limiting portion 43.

[0045] Furthermore, a light incident surface and/or a light-emitting surface of at least one of the first lens 21, the second lens 22, and the third lens 23 is provided with an anti-reflection film, which can improve the transmittance of the light incident surface or the light-emitting surface provided with the anti-reflection film, enhance the transmittance performance and improve the illumination brightness. In addition, a light-shielding layer is provided on an outer peripheral surface of the first lens 21, an outer peripheral surface of the second lens 22, and the lens flange structure 231 of the third lens 23 to reduce light emitted from edges of the first lens 21, the second lens 22, and the third lens 23. The light-shielding layer may be formed by sandblasting black processing to prevent stray light; or alternatively, the light-shielding layer may be formed by plating an anti-reflection film to prevent stray light, so that a light shape formed by projecting a pixel image can be consistent with the pixel image without generating scattered spots.

[0046] As mentioned above, the present disclosure effectively overcomes various shortcomings in the existing technology and has high industrial utilization value.

[0047] The above-mentioned embodiments are just used for exemplarily describing the principle and effects of the present disclosure instead of limiting the present disclosure. Those skilled in the art can make modifications or changes to the above-mentioned embodiments without going against the spirit and the range of the present disclosure. Therefore, all equivalent modifications or changes made by those who have common knowledge in the art without departing from the spirit and technical concept disclosed by the present disclosure shall be still covered by the claims of the present disclosure.

Claims

1. A vehicle pixelated lighting device, comprising a pixel illumination light source (10) and a lens group (20) arranged along a light-emitting direction, the pixel illumination light source (10) having an overall light-emitting surface (11) facing the lens group (20), wherein the device further comprises a light-transmitting element (30) fixedly arranged between the pixel illumination light source (10) and the lens group (20), wherein the light-transmitting element (30) is arranged at a boundary of the pixel illumination light source (10) and covers at least a part of a boundary of the overall light-emitting surface (11) of the pixel illumination light source (10); wherein the light-trans-

mitting element (30) comprises a light incident surface facing the pixel illumination light source (10) and a light-emitting surface facing the lens group (20); wherein the light-transmitting element (30) is used for changing a deflection angle of a light ray from the pixel illumination light source (10), and emitting a deflected light ray to the lens group (20), wherein a reverse extension line of the deflected light ray intersects with a plane where the overall light-emitting surface (11) is located at a position outside of a light-emitting point of the incident light ray corresponding to the deflected light ray.

2. The vehicle pixelated lighting device according to claim 1, wherein the light-transmitting element (30) covers only an upper boundary of the overall light-emitting surface (11) of the pixel illumination light source (10).

3. The vehicle pixelated lighting device according to claim 1, wherein the light-transmitting element (30) covers all boundaries of the overall light-emitting surface (11) of the pixel illumination light source (10).

4. The vehicle pixelated lighting device according to any one of claims 1-3, wherein the light-transmitting element (30) is a silicone component.

5. The vehicle pixelated lighting device according to claim 1, wherein the light-emitting surface of the light-transmitting element (30) comprises at least one of an arc-shaped surface segment (31), a vertical plane segment (32), a horizontal plane segment (33), and an oblique plane segment (34).

6. The vehicle pixelated lighting device according to claim 1, wherein the light incident surface of the light-transmitting element (30) comprises at least one of an arc-shaped surface segment (31), a vertical plane segment (32), a horizontal plane segment (33), and an oblique plane segment (34).

7. The vehicle pixelated lighting device according to claim 1, wherein a distance between the pixel illumination light source (10) and the light-transmitting element (30) is less than or equal to 0.5mm.

8. The vehicle pixelated lighting device according to claim 1, wherein the lens group (20) comprises a first lens (21), a second lens (22), and a third lens (23) sequentially arranged along the light-emitting direction, wherein the first lens (21) is a lens with positive optical power, the second lens (22) is a lens with negative optical power, and the third lens (23) is a lens with positive optical power.

9. The vehicle pixelated lighting device according to claim 8, wherein Abbe numbers of the first lens (21) and the third lens (23) are both greater than an Abbe number of the second lens (22).

10. The vehicle pixelated lighting device according to claim 9, wherein a material of the first lens (21) is optical glass, a material of the second lens (22) is PC, and a material of the third lens (23) is PMMA.

11. The vehicle pixelated lighting device according to claim 8, further comprising: a lens holder (40), a circuit board (50), and a heat sink (60), wherein the first lens (21), the second lens (22), and the third lens (23) are all installed in the lens holder (40); wherein the pixel illumination light source (10) is installed on the circuit board (50); wherein the heat sink (60), the circuit board (50), and the lens holder (40) are fixedly connected in a sequence along the light-emitting direction; wherein the light-transmitting element (30) is fixed on the lens holder (40) or the circuit board (50).

12. The vehicle pixelated lighting device according to claim 11, further comprising: a first limiting ring (70) and a second limiting ring (80) both arranged inside the lens holder (40), and a beam limiting element (90) threadedly connected to one end of the lens holder (40), wherein the other end of the lens holder (40) includes a first limiting portion (41), and an inner wall of the lens holder (40) includes a second limiting portion (42) and a third limiting portion (43), wherein outer peripheral surfaces of the first lens (21), the second lens (22) and the third lens (23) are all abutted against the inner wall of the lens holder (40), wherein the first lens (21) is limited between the first limiting portion (41) and the first limiting ring (70), the second lens (22) is limited between the second limiting portion (42) and the second limiting ring (80), and the third lens (23) is limited between the third limiting portion (43) and the beam limiting element (90).

13. The vehicle pixelated lighting device according to claim 12, wherein the beam limiting element (90) is an aperture stop.

14. A vehicle lamp, comprising the vehicle pixelated lighting device according to any one of claims 1-13.

15. A vehicle, comprising the vehicle lamp according to claim 14.

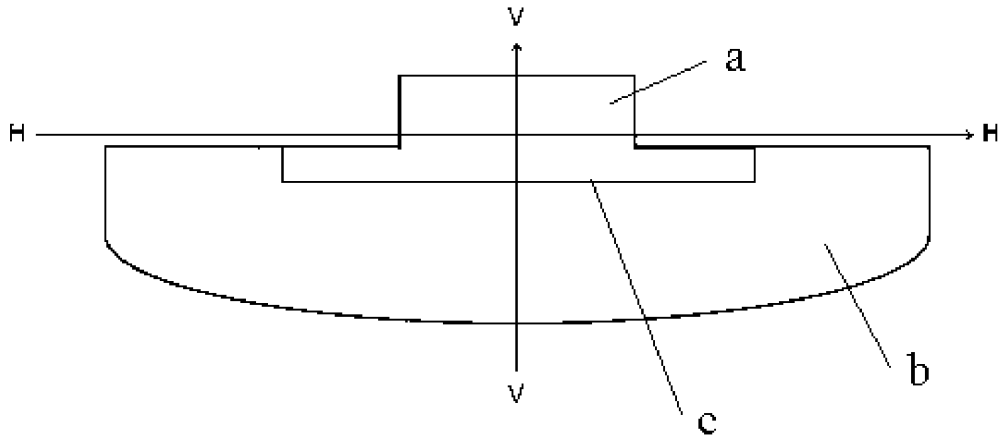

Fig. 1

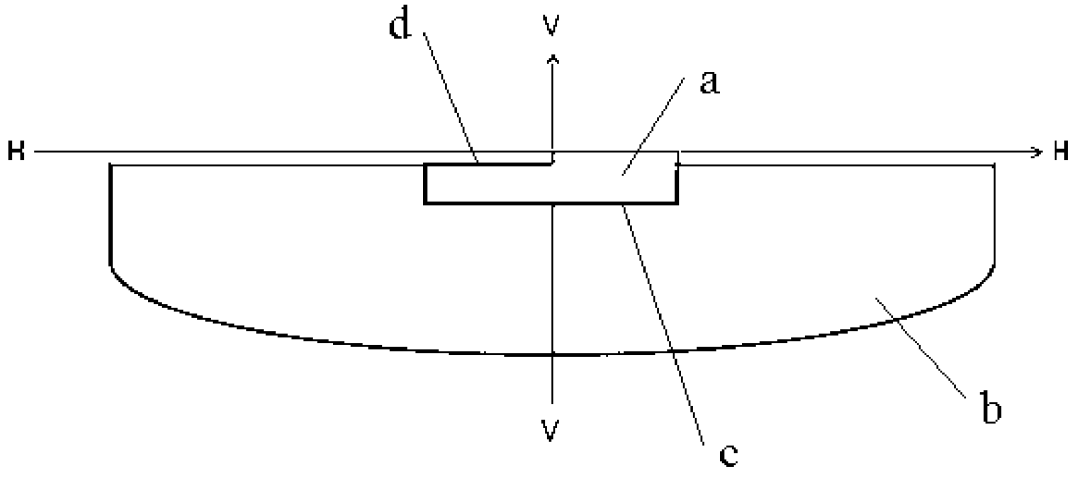

Fig. 2

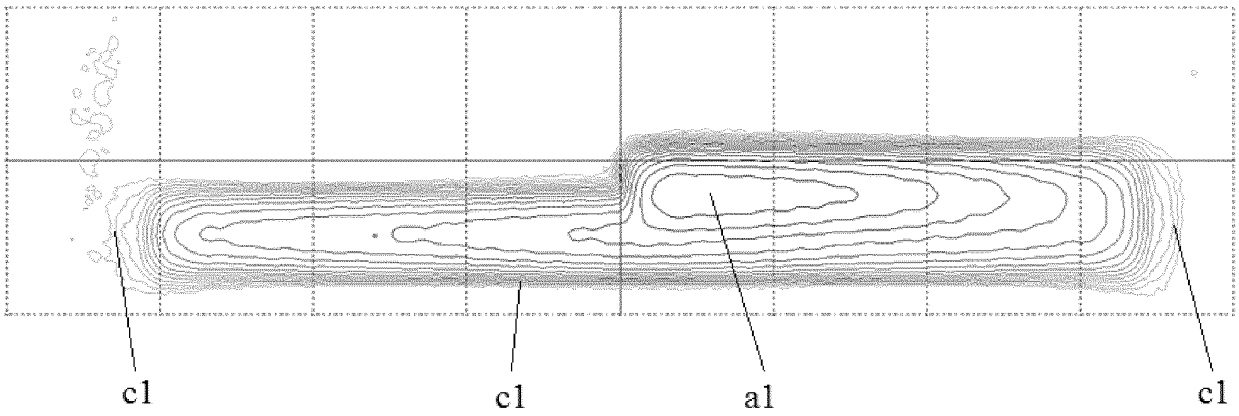

Fig. 3

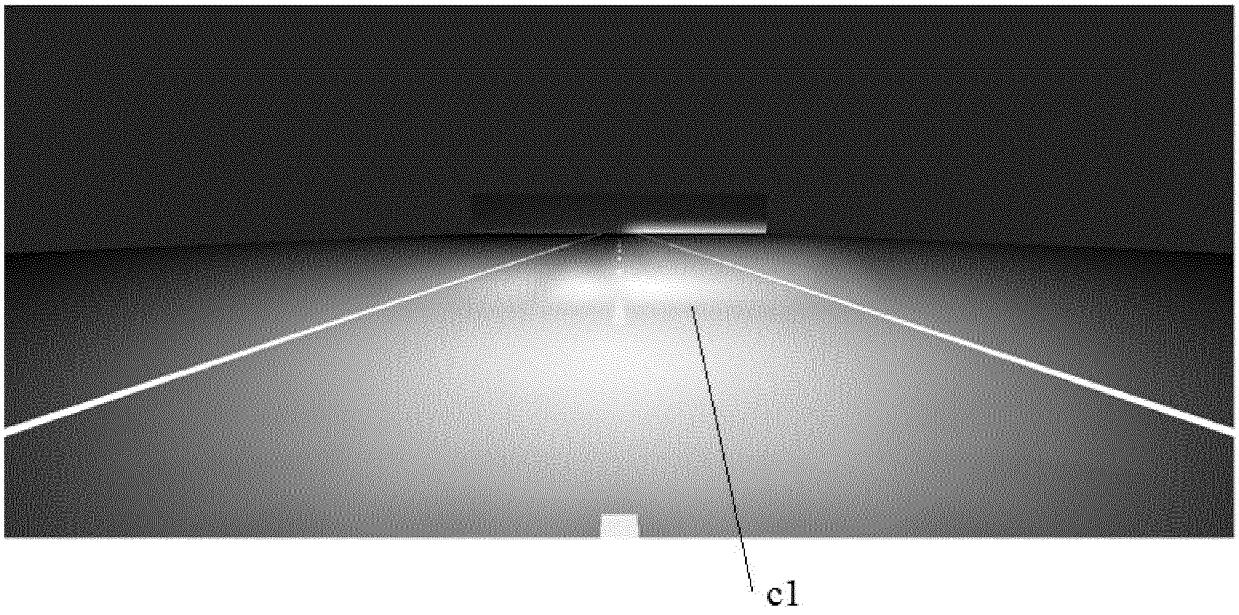

Fig. 4

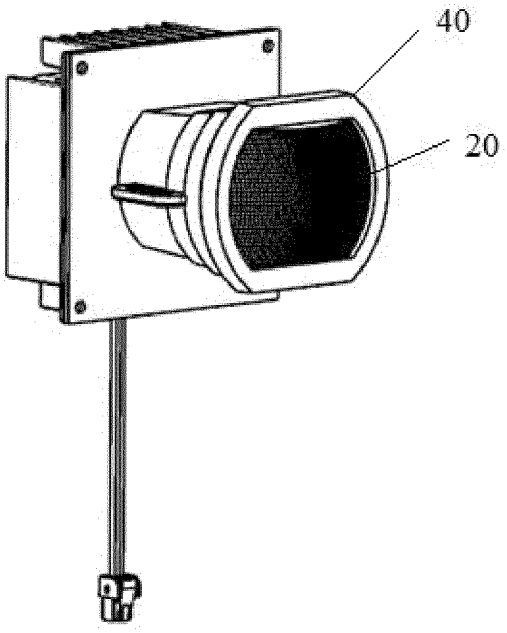

Fig. 5

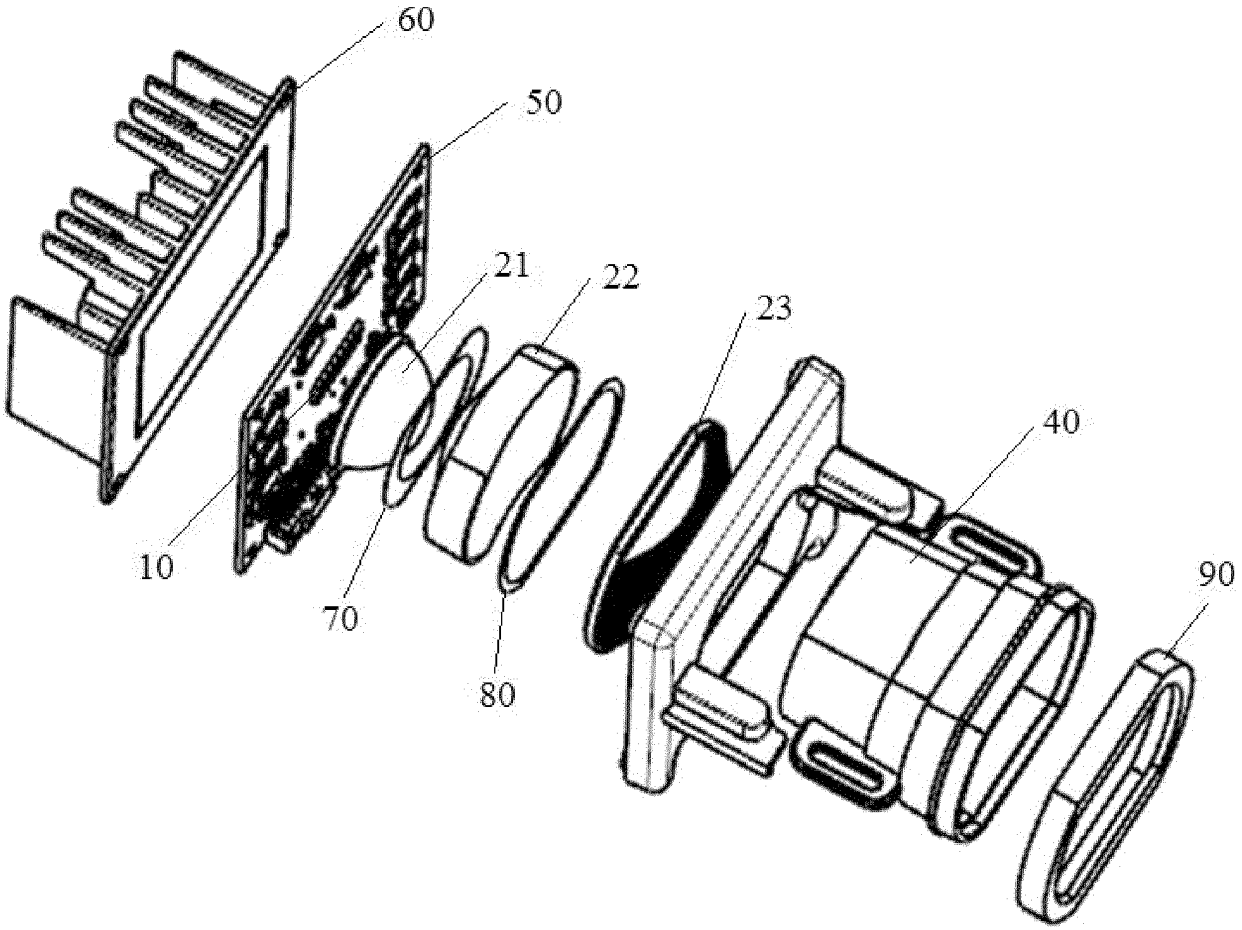

Fig. 6

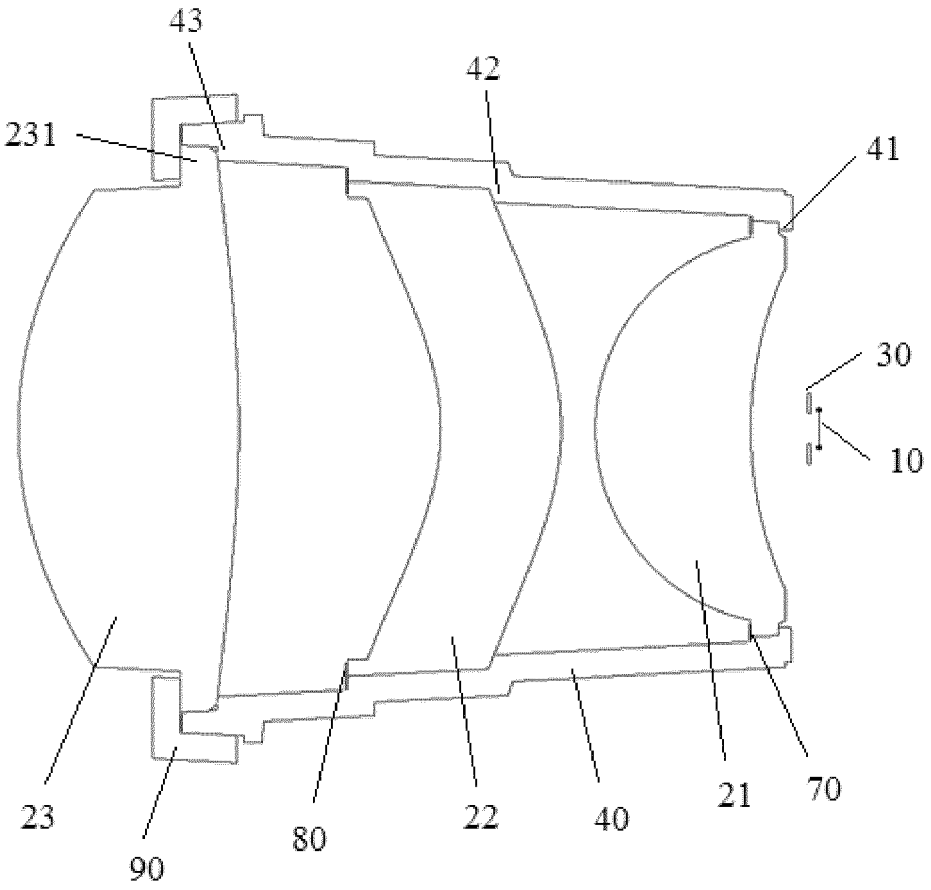

Fig. 7

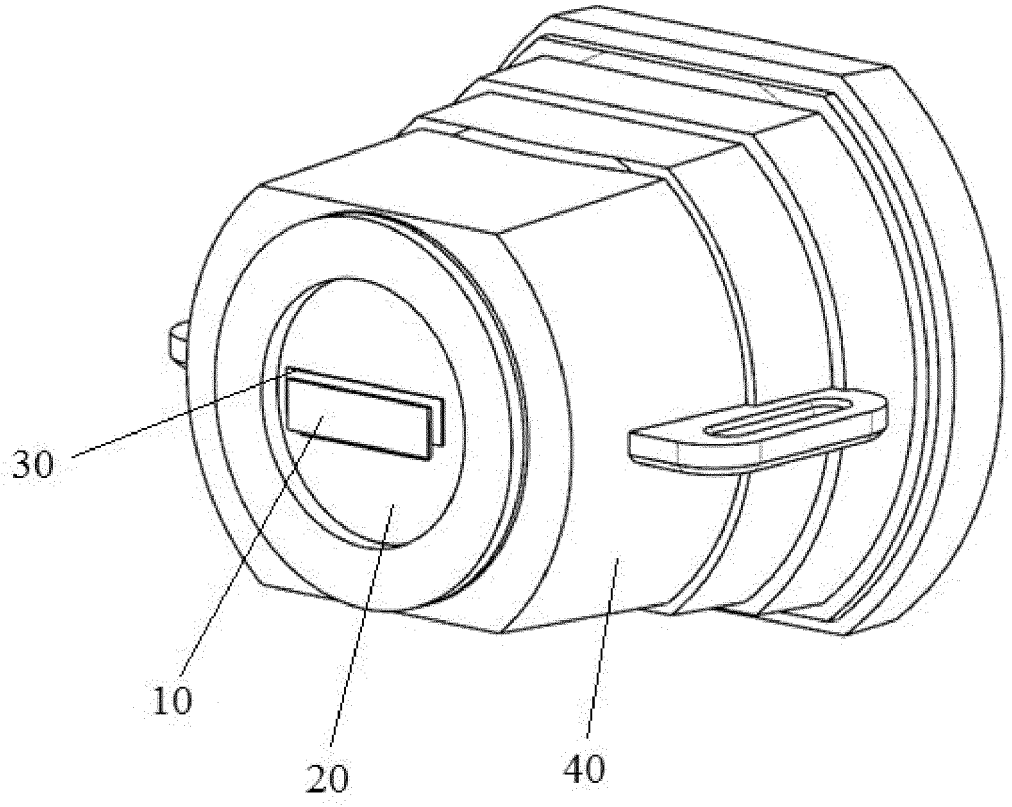

Fig. 8

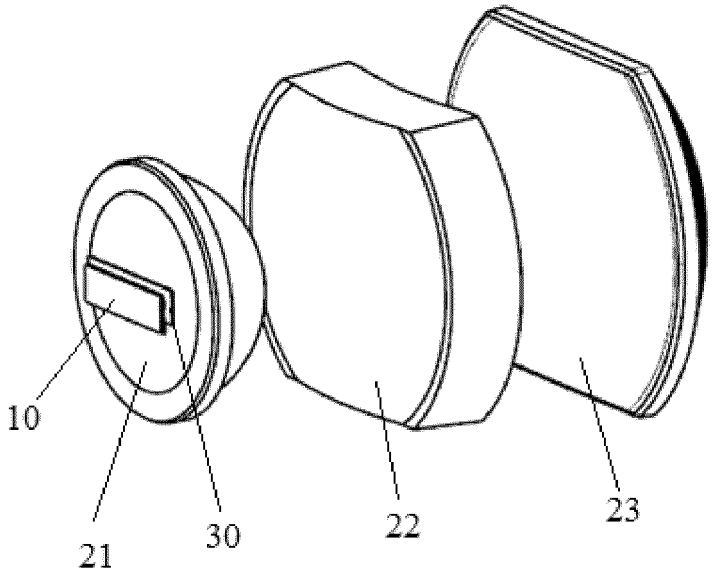

Fig. 9

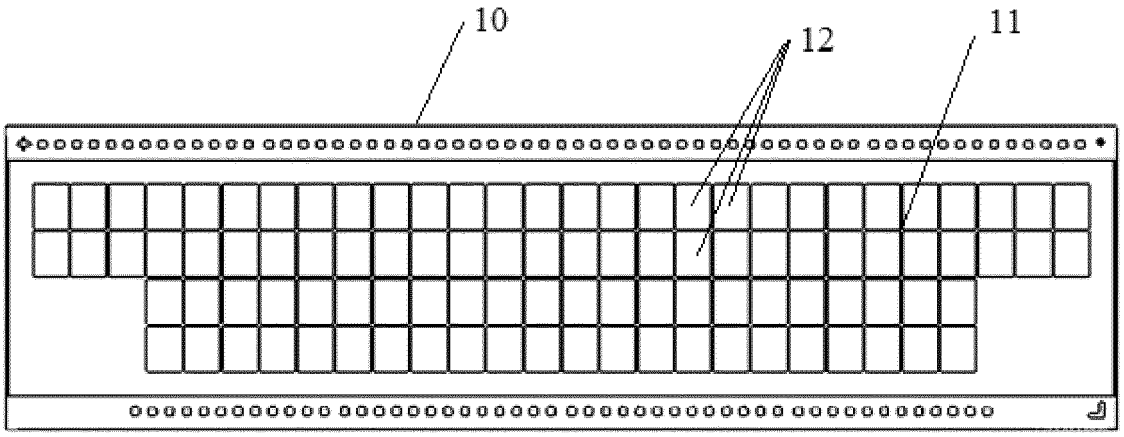

Fig. 10

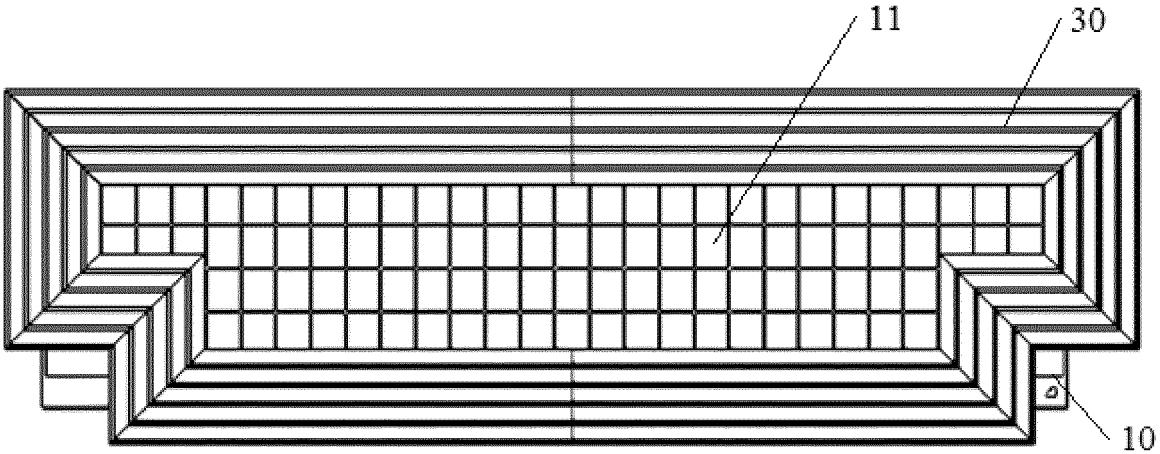

Fig. 11

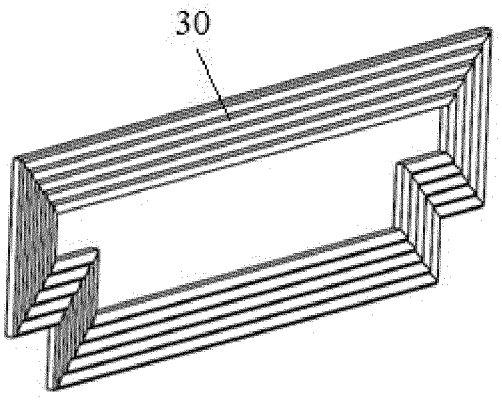

Fig. 12

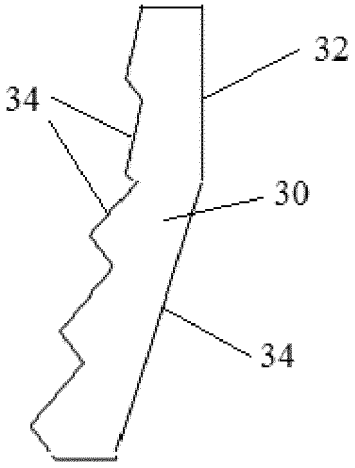

Fig. 13a

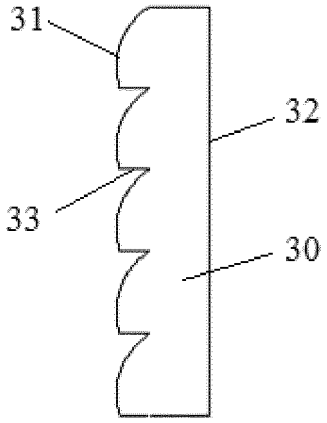

Fig. 13b

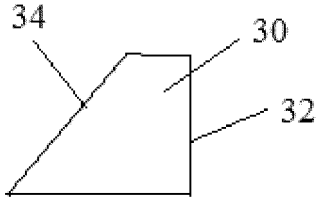

Fig. 13c

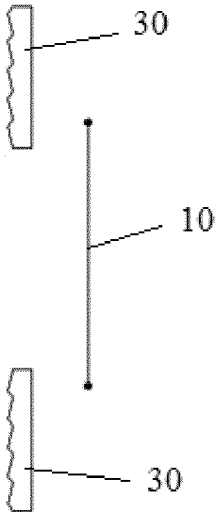

Fig. 14

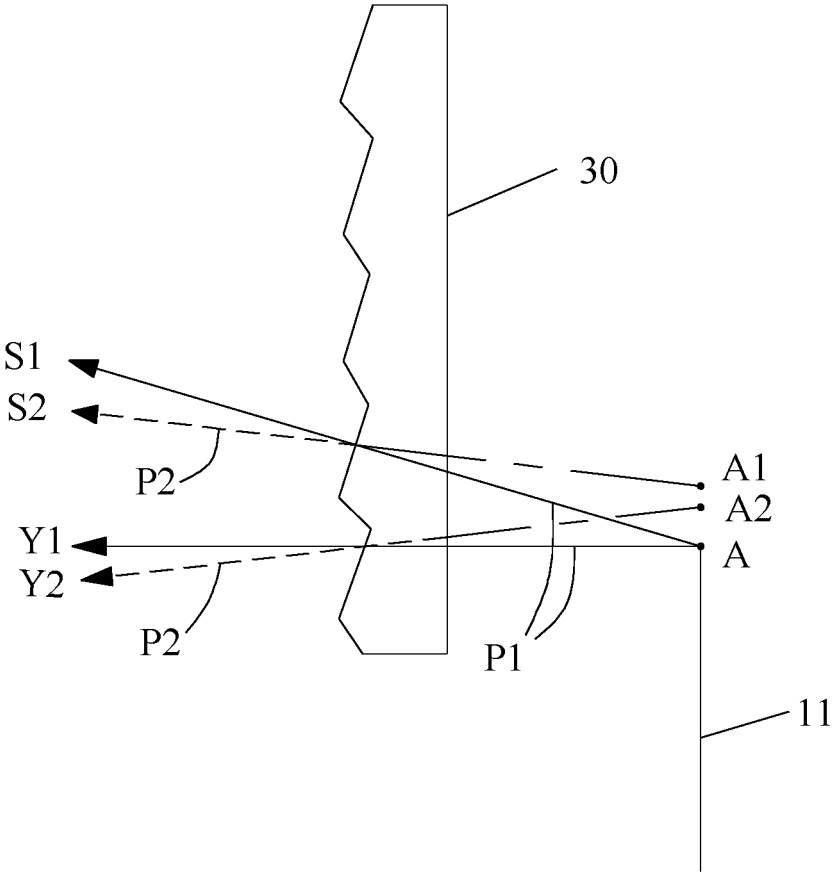

Fig. 15

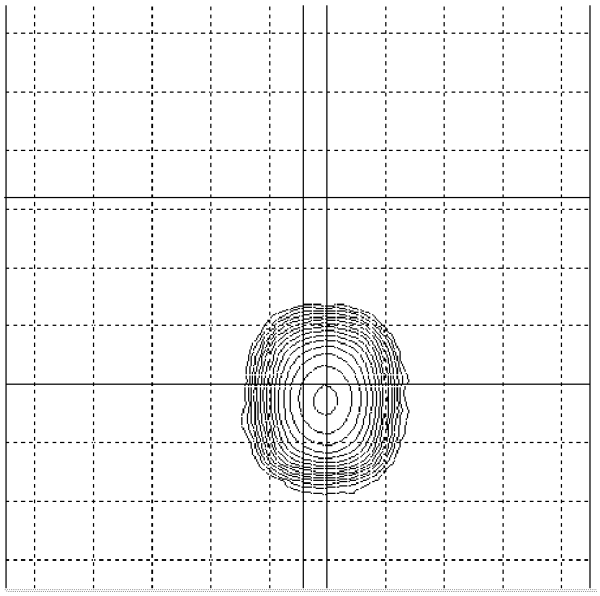

Fig. 16

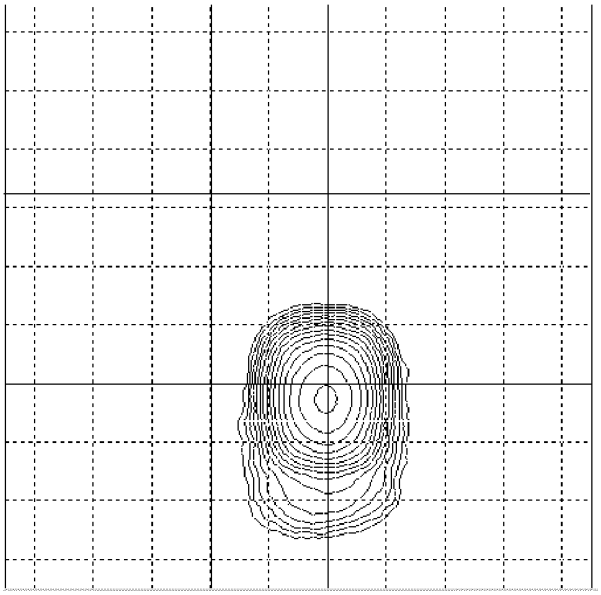

Fig. 17

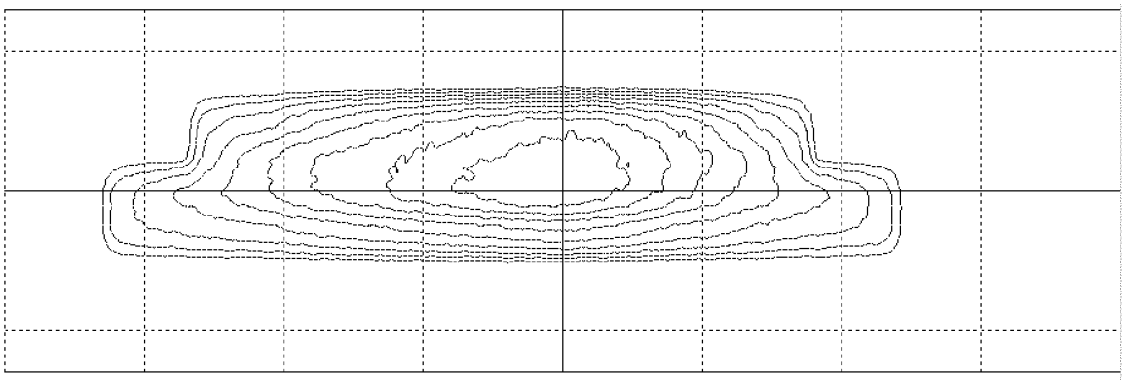

Fig. 18

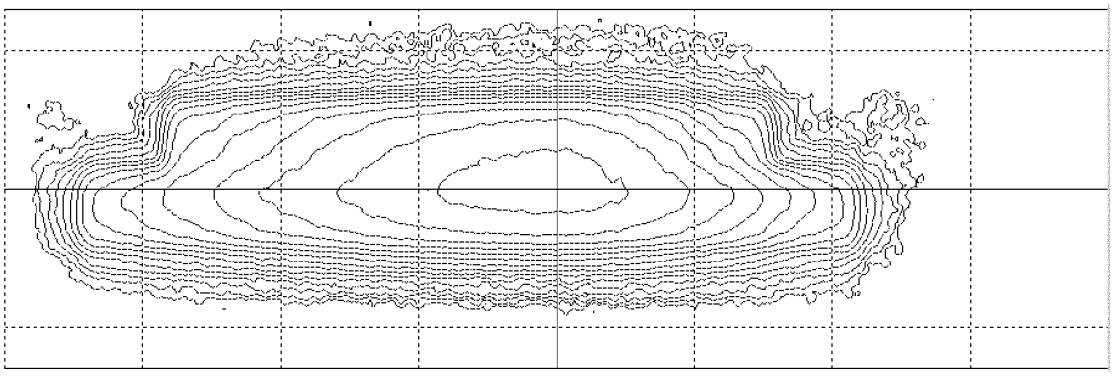

Fig. 19

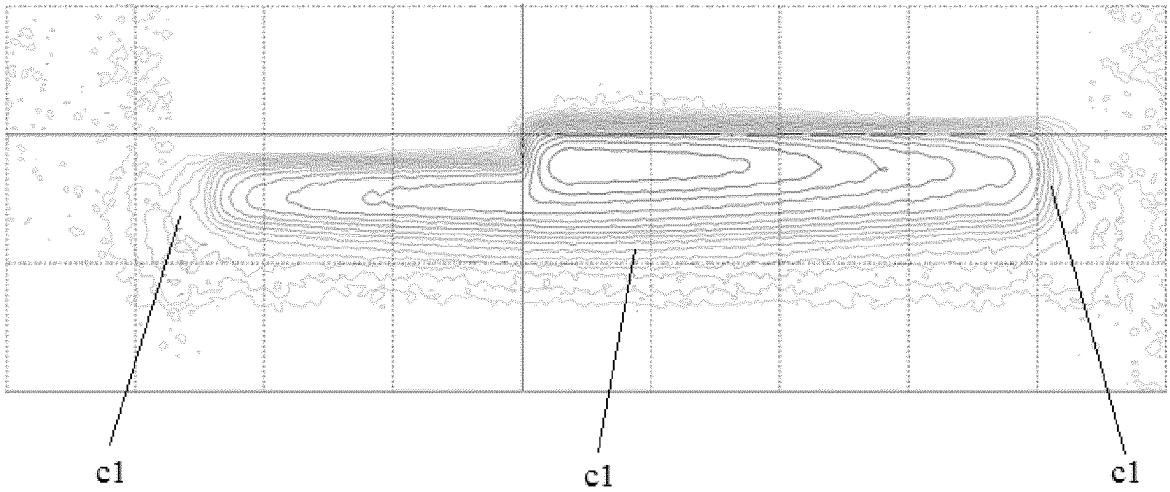

Fig. 20

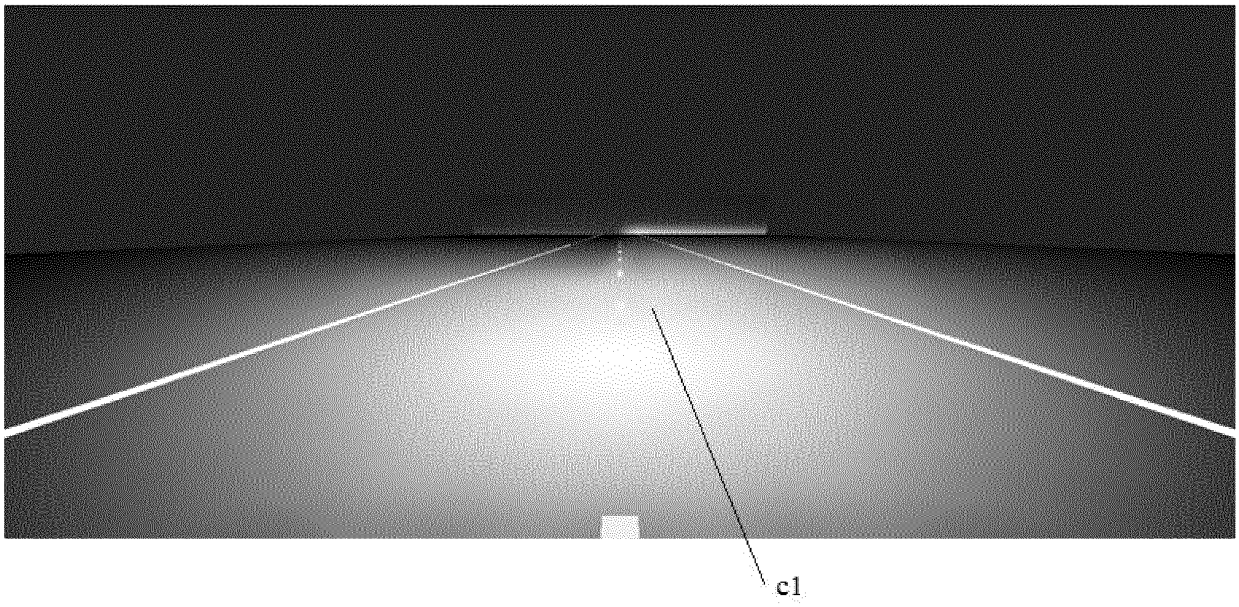

Fig. 21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/112340

A. CLASSIFICATION OF SUBJECT MATTER

F21S 41/20(2018.01)i; F21S 41/155(2018.01)i; F21S 41/63(2018.01)i; F21S 45/48(2018.01)i; F21Y 115/10(2016.01)i; F21V 5/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F21S; F21V; F21Y

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

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

CNPAT, CNKI, WPI, EPODOC: 像素化, 照明, 发光, 光源, LED, 边界, 边缘, 覆盖, 遮挡, 遮盖, 透镜, 偏折, 折射, 扩散, 均匀, pixelated, lighting, luminous, light source, LED, border, edge, cover, shade, mask, lens, deflection, refraction, diffusion, uniformity

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 211345142 U (HUAYU VISION TECHNOLOGY (SHANGHAI) CO., LTD.) 25 August 2020 (2020-08-25) description, paragraphs 0039-0062, and figures 1-5	1-15
A	CN 111237712 A (HUAYU VISION TECHNOLOGY (SHANGHAI) CO., LTD.) 05 June 2020 (2020-06-05) entire document	1-15
A	CN 109477621 A (ZKW GROUP GMBH) 15 March 2019 (2019-03-15) entire document	1-15
A	CN 103765086 A (KOITO MANUFACTURING CO., LTD.) 30 April 2014 (2014-04-30) entire document	1-15
A	CN 104879665 A (BEIJING ANDAWELL CIVIL AVIATION TECHNOLOGY CO., LTD.) 02 September 2015 (2015-09-02) entire document	1-15
A	CN 112539393 A (FUDAN UNIVERSITY et al.) 23 March 2021 (2021-03-23) entire document	1-15

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 April 2022	**10 May 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/112340

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 209819455 U (GUANGZHOU CHAIYI LIGHT CO., LTD.) 20 December 2019 (2019-12-20) entire document	1-15
A	EP 3502550 A1 (VALEO VISION) 26 June 2019 (2019-06-26) entire document	1-15

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/112340

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