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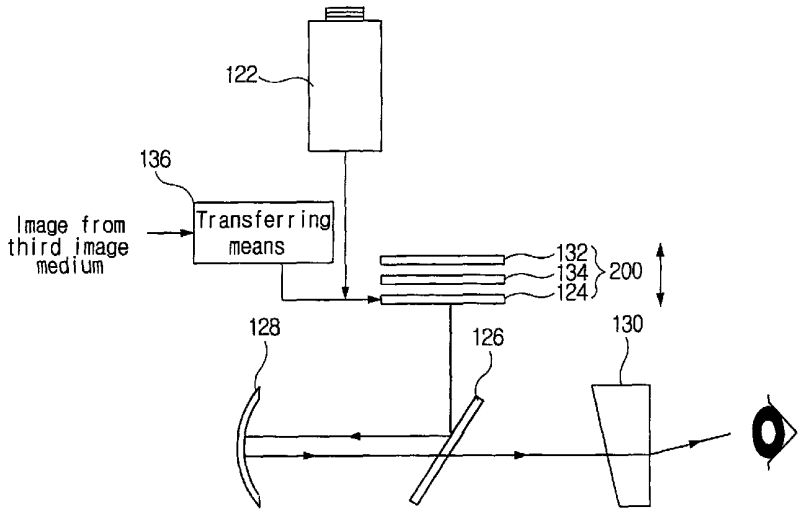
(54) Title: HEAD-MOUNTED TYPE IMAGE DISPLAY SYSTEM



(57) Abstract: The present invention relates to a head-mounted type image display system. The image display system comprises a pair of CCD cameras for taking an image of an object; transferring means for transferring the image from the CCD camera and a third medium to a pair of LCD displays; a pair of LCD displays for displaying the transferred image; a light source for illuminating a rear portion of the LCD display, while controlling luminous intensity of the image displayed on each LCD display; a filter for eliminating infrared rays and ultraviolet rays from light of the light source; a half mirror for reflecting the image displayed on each LCD display to a multiplying reflector; a multiplying reflector which is disposed at a desired angle with respect to each LCD display, for receiving the image from the half mirror and passing a part of the image through the half mirror and then transferring the image to eyes of a user.

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HEAD-MOUNTED TYPE IMAGE DISPLAY SYSTEM

TECHNICAL FIELD

The present invention relates to a head-mounted type image display such as glasses or goggles worn in front of eyes of a user to see a real-time image taken by a CCD (charge coupled device) camera and a previously recorded image.

BACKGROUND ART

Up to now, there has not been proposed a technique for taking an image using two CCD cameras while a user is moving and displaying the image in real time.

Meanwhile, in a conventional image system, a large image having a wide angle of view could not be displayed due to limitations of an optical system according to a view angle of a camera and a display size. And, since focus, illuminance of an image and optical path could not be properly adjusted in a wide range according to personal conditions, it is difficult for an ordinary person to facilely use it. Furthermore, in case of visually handicapped persons, they are completely excluded from the use of the image system.

DISCLOSURE OF THE INVENTION

Therefore, an object of the present invention is to provide a head-mounted type image display which can freely

adjust focus of an image without separate auxiliary means according to the status of eyes of a user.

Another object of the present invention is to provide a head-mounted type image display in which a view angle and size of an image can be displayed twice or more wider and larger and an optical path can be also freely adjusted according to the status of visual disturbance

Yet another object of the present invention is to provide a head-mounted type image display which can freely adjust illuminance of an image on the basis of a light amount of an light source irradiated to a rear side of an LCD display according to the status of eyes of the user.

Yet another object of the present invention is to provide a head-mounted type image display which can provide nearly ordinary visual power to a visually handicapped person.

According to the head-mounted type image display of the present invention, if necessary, it is possible to refract an optical path of an image at a desired angle while adjusting focus and illuminance of a real time image or a recorded image, thereby serving as an image display for the exclusive use of the visually handicapped person. In addition, the head-mounted type image display may be applied to an image equipment

The present invention provides a head-mounted image

display system comprising a pair of CCD cameras for taking an image of an object; transferring means for transferring the image from the CCD camera and a third medium to a pair of LCD displays; a pair of LCD displays for displaying the transferred image; a light source for illuminating a rear portion of the LCD display, while controlling luminous intensity of the image displayed on each LCD display; a filter for eliminating infrared rays and ultraviolet rays from light of the light source; a half mirror for reflecting the image displayed on each LCD display to a multiplying reflector; a multiplying reflector which is disposed at a desired angle with respect to each LCD display, for receiving the image from the half mirror and passing a part of the image through the half mirror and then transferring the image to eyes of a user; power supplying means for supplying power to the CCD camera, the transferring means, the LCD display and the light source. Further, if necessary, the image display system may include a prism for changing an optical path of the image from the multiplying reflector.

Furthermore, the present invention provides A head-mounted image display system comprising a pair of CCD cameras for taking an image of an object; transferring means for transferring the image from each camera and a third medium to a pair of LCD displays; a pair of LCD displays for displaying

the transferred image; a pair of light sources for illuminating a rear portion of the LCD display, while controlling luminous intensity of the image displayed on each LCD display; a filter for eliminating infrared rays and ultraviolet rays from the light source; a pair of optical lens groups for enlarging the image displayed on each LCD display; power supplying means for supplying power to the CCD camera, the transferring means, the LCD display and the light source. Further, if necessary, the image display system may include a prism for changing an optical path of the image from the lens group.

BRIEF DESCRIPTION OF DRAWINGS

Figs. 1a to 1c are schematic views showing a retinal image forming theory;

Fig. 2a is a view showing a basic image of an object;

Fig. 2b is a schematic view showing a view angle using two cameras in an image display according to the present invention;

Fig. 2c is a view showing a status that the basic image taken by each camera is displayed on an LCD display;

Fig. 2d is a view showing a status that the basic image of Fig. 2c is formed on the retina of each of left and right eyeballs;

Fig. 2e is a view showing a status that the basic image

formed on the retina of each eyeball is recognized by brains;

Fig. 2f is a view showing a principle of changing an optical path to an inner portion of the retina using an optical prism;

Fig. 2g is a view showing a status that the basic image is recognized by brains after the changing of the optical path using the optical prism of Fig. 2f;

Fig. 3a is a view showing variously deformed types of retinal cells of a visually handicapped person;

Fig. 3b is a view showing a status that left and right images of the basic image are separately taken by two cameras to widen the view angle according to the present invention;

Fig. 3c is a view showing a status that the basic image is recognized by brains in case of Nos. 3 and 4 of A type of Fig. 3a;

Figs. 4a to 4d are views showing steps that the visually handicapped person of B type of Fig. 3a recognizes the image using the image display according to the present invention;

Fig. 5a is a view showing steps that the visually handicapped person of I type of Fig. 3a recognizes the image using the image display according to the present invention;

Fig. 5b is a view showing the view angle using a camera having a wide view angle and a short focus, in case that the image display according to the present invention cannot be applied to the visually handicapped person of the I type;

Fig. 6 is a schematic view showing a principle of adjusting the focus in the image display according to the present invention;

Fig. 7a is a view showing a method of adjusting the focus in the image display according to the present invention;

Fig. 7b is a view showing a principle of changing the optical path to the left and right in the image display according to the present invention;

Fig. 7c is a view showing an idea equivalent to the principle of changing the optical path in Fig. 7b;

Fig. 8a is a view showing a method of adjusting the focus of an image up and down using a prism according to the present invention;

Fig. 8b is a view showing a principle of refracting light by the prism.

Figs. 9a to 9e are views showing an image aberration in the image display according to the present invention;

Figs. 10a to 10e are views showing a relationship between a visual field in the eyeball and the image display, and a size of an object in the eyeball and image display;

Figs. 11a to 11c are views showing a visual field of a camera system according to the present invention;

Figs. 12a and 12b are views a modified CCD camera according to the present invention;

Fig. 13 is a perspective view of a head-mounted type

image display according to an embodiment of the present invention;

Fig. 14 is a schematic view of a structure of an optical system in the image display of Fig. 13;

Figs. 15a and 15b are views showing a structure and an operation of a left and right optical path changing unit in the optical system of Fig. 14;

Fig. 16 is a view showing a structure and an operation of a focus adjustment unit of the image display of Fig. 13;

Fig. 17 is a perspective view showing another embodiment of the present invention;

Fig. 18 is a schematic view of a structure of the optical system of Fig. 17; and

Fig. 19 is a view showing intensity and wavelength of light passing through the image display according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention will now be described in further detail by examples. It would be obvious to those skilled in the art that these examples are intended to be more concretely illustrative and the scope of the present invention as set forth in the appended claims is not limited to or by the examples.

Retinal image forming theory of an object

Images of objects A, B, c formed on the retina are not formed on the same position of the retina due to a distance between both eyes and a difference between a left eye and a right eye.

However, when the images are recognized by brains, the minute difference is properly controlled so that we can naturally see the objects A, B, c without any confusion (referring to Fig. 1a).

However, in either of the eyes, if optical paths of the objects A, B, c are changed by a proper optical system such as a prism, etc., so that images A', B', C' are positioned among the images A, B, c, since each of the left and right eyes separately recognizes the objects, it seems that there are six objects not three objects A, B, c (referring to Fig. 1b).

In addition, in either of the eyes, if the images formed on the retina are moved to an inner portion of the retina, i.e., the left side in the right eye and the right side in the left eye, the images are overlapped, and then, the images at one side are moved. That is, in the right eye, the images are moved to the right side of the left eye, and in the left eye, the images are moved to the left side of the right eye. Therefore, it seems that there are additionally further three objects (referring to Fig. 1c).

Using this fact, if the optical paths of the images formed on the retinas of the left and right eyes are changed so that the images are moved to the inner portion of each of the retinas, additional objects can be separately recognized with only small adjustment of an angle of the optical path.

Two camera or video systems

If two camera or video system are designed using the retinal image forming theory, as described above, it will provide an image and a view angle which are twice larger and wider than those in all of the existing optical devices. Therefore, according to an embodiment of the present invention, it is possible to overcome an optical limitation due to a size of an LCD.

In order to fully describe the above theory, there is provided a basic image as shown in Fig. 2a.

If an ordinary person sees the basic image of Fig. 2a, it will be seen very well as it is shown in Fig. 2a. However, since an image display system according to the embodiment of the present invention is comprised of a camera, an LCD display and an optical system, and there are many restrictions in the image display system, such as a view angle of the camera, a size of the LCD display and a magnification of the optical system, etc., there is a large difference from the actual image.

Therefore, in consideration of the above point, the image display system of the present invention was designed to have an ability which is very similar to the human being's eyes.

Now, the view angle of the image display system will be described. There are provided two cameras to widen the view angle of the image display system. The cameras respectively take a half of the basic image of Fig. 2.

The images of each camera are transferred to the left and right LCD displays corresponding to each camera to display the images, as shown in Fig. 2c.

The images transferred to the left and right cameras are formed on the retina like images shown in Fig. 2d.

Brains recognizes the images of Fig. 2d as an overlapped image in Fig. 2e.

To solve the problem, if the optical paths of the images are changed to the inner portion of each retina by a prism using the retinal image forming theory, as shown in Fig. 2f, each of the images are not overlapped and formed on a desired position of each retina. Therefore, they look like an image of Fig. 2g.

Till now, the images from the two cameras are described. It is possible to obtain the same effect with two video signals.

Hereinafter, it will be described from the viewpoint of a visually handicapped person.

The visually handicapped person has the various deformed type retina, which is quite different from the retina of an ordinary person, due to R.P. (Retinitis Pigmentosa) or detachment of the retina. Fig. 3a shows the deformed types of the retina, wherein a small circle of the retina designates a normal portion in which the retinal cell is normally alive, and the rest portion of the retina designates an injured portion.

Some representative types of the deformed retina will be described.

[Nos. 1, 2 and 5 of A type of Fig. 3a]

This type shows a status that visual sensitivity exists at only the inner portion of the left and right retinas. As described above, if two cameras are used as described above, it is possible to detect objects in a wide range, thereby recognizing the objects with a wide view angle. That is, as shown in Fig. 3b, the basic image is divided into a left portion and a right portion. The left and right portions of the basic image are separately taken by the left and right cameras (referring to No. 1 of Fig. 3b).

The images taken by the cameras are transferred to LCD displays corresponding to each camera, and thus, the images as shown in No. 2 of Fig 3b are obtained.

If the images are formed on each of the left and right retinas, and at the same time, the optical paths of the images

are changed to the inner portion of each retina (Nos. 3 and 4 of Fig. 3b), brains recognizes the images like an image shown in No. 5 of Fig. 3b.

[Nos. 3 and 4 of A type of Fig. 3a]

In this type, the images can be moved to the inner portions of the left and right retinas, as described above. However, since the positions of the images are different from each other, they are recognized like the images of Fig. 3c. However, it has an advantage over the sensing of narrow view angle.

[B type of Fig. 3a]

This type shows a status that visual sensitivity exists at only the outer portion of the left and right retinas. In this case, if the images are moved to the outer portion of the retina, it seems that the objects are gradually moved to a center portion of a visual field and then crossed to each other. Therefore, in order to provide a wide and large erect image, other method has to be requested as follows.

When transferring the images taken the cameras as shown in Fig. 4a to the LCD display, the transfer directions of the images have to be changed each other. That is, the image of the left camera is transferred to the right LCD display, and the image of the right camera is transferred to the left LCD.

Meanwhile, the left and right cameras may be arranged to take the opposite images and then transfer to the LCD displays, as shown in Fig. 4b.

Fig. 4c shows a status that the left and right images are moved to the outer portion of each retina corresponding to a position of the normal portion of the retinas as shown in Nos. 1,2, and 3 of Fig. 3a. At this time, it seems that the objects are gradually moved to a center portion of a visual field and then crossed to each other. The objects are moved to the center portion of the visual field and then crossed to each other, so that it seems to be widened. However, since the images are widened while being moved to the center portion of the visual field, the images of the left and right cameras have to be respectively transferred to the opposite LCD display panel.

Fig. 4d shows Nos. 4 and 5 of the B type. It is the same as the case of Nos. 4 and 5 of the A type.

[I type of Fig. 3a]

This type is a tunnel vision which is limited to see a large and wide image according to a deformed state of the retina. However, if the image is within an extent of the view angle of the image display system, it is possible to see the image using the two cameras, as described in Nos. 1,2 and 3 of the A type of Fig. 3a.

If the image is not within the extent of the view angle, a magnification of the image has to be reduced. Therefore, although the size of image is reduced, it is possible to secure a wide visual field taking an advantage of a short focal length

of a camera lens and the inner portions of the retina having the visual sensitivity.

If the above method of Fig. 5a is not accepted, there is provided a one-camera system having a wide view angle and a short focus. In this case, although the size of the image is reduced, it is possible to provide a wider view angle (the detailed description will be provided below with reference to Figs. 12a and 12b).

Now, focus adjustment of the image display system according to the present invention will be described.

The eyesight of the visually handicapped person is also classified into near-sightedness and long-sightedness due to a difference in a curvature of a crystalline lens. Especially, in case of most of the visually handicapped persons who lost the sight by glaucoma, the crystalline lens is removed to reduce the intraocular pressure. In this case, the sight of the visually handicapped person is seriously long-sighted. As a result of a clinical testing, the applicant realized that a large number of the visually handicapped persons were serious near-sighted. Therefore, it is important to increase light intensity. However, since the sensitivity of optical nervous system is lowered, if the images are out of focus on the retina, it is of no use, although the light intensity is increased. From this point of view, the ability of focus

adjustment is largely increased in a positive and negative direction (referring to Fig. 6).

Referring to Fig. 6, assuming that an optical system having a focus of 24mm is used and **b** is a visual range of an ordinary person of 250mm, a distance **a** of an object which is intended to see is about 21.898mm.

The case of the long-sightedness is that the value of **b** is increased. When the visual range is increased to 500mm or 1000mm, the value of **a** is further apart from the optical system. According to a lens formula, when the visual range is 500mm, the value of **a** is 22.9mm. In the same manner, when the visual range is 1000mm, the value of **a** is 23.4375mm. Meanwhile, the case of the near-sightedness is that the value of **b** is decreased. When the visual range is decreased to 150mm or 50mm, the value of **a** is also decreased. According to the lens formula, when the visual range is 50mm, the value of **a** is about 16.216mm. When the visual range is 150mm, the value of **a** is 20.69mm. Therefore, the value of **a** is shorter than the value of **a** of 21.898mm when the visual range is 250mm.

Since a deviation of the value of **a** is large, as described above, the ability of focus adjustment is largely increased out in the image display system of the present invention. In the present invention, while the optical system is fixed, the LCD display corresponding to the value of **a** of the lens formula is

moved to the positive direction (+) or the negative direction (-) to adjust the focus (referring to Fig. 7).

Adjustment of the left and right images in the image display system according to the present invention

Since the visually handicapped person has the various type of the injured portion of the retina, the optical path has to be adjusted to all directions in order to transfer the image to the normal portion of the retina, which has the relatively good visual sensitivity.

First, the optical paths of the image will be described (referring to Fig. 7b). No. 1 of Fig. 7b shows a normal state in which the optical path passes the center portion of the retina. However, when the image is moved to the left and right side, a direction of the optical system is changed, as shown in Nos. 2 and 3 of the Fig. 7b, so as to change the optical path. This is the same as a definition of the focus of the lens, in which the focus of incident light inclined at an angle of f is formed at a position apart at a distance of f tana.

Adjustment of the upper and lower images in the image display system according to the present invention

Next, adjustment of the upper and lower images will be described.

As described above, the adjustment of the left and right images is performed by turning the optical system to the left

and right sides. However, it is impossible to adjust the upper and lower images using the optical system judging from the a size and design of the image display system of the present invention. Therefore, in the present invention, the upper and lower images are adjusted using a prism designed by the applicant (referring to Fig. 8a). Meanwhile, if a prism having a dihedral angle is used, it is possible to adjust the optical path in all directions.

Now, a principle of light refraction in the prism will be described. The light is refracted in the prism due to an index (nd) of refraction and an angle of glass of the prism. This principle will be mathematically described with reference to Fig. 8b.

The refraction of light is caused by a difference in speed of the light. When the light moving in a medium at a constant passes through another medium, the speed of light is reduced. Assuming that the speed of light in the air is 1, a speed rate, i.e., an index (nd) of refraction of a medium can be variously designated in 1.1 ~ 2, etc.

As shown in Fig. 8b, if there is provided a prism having a refractive index of 1.5 and an angle of 10°, when the light moving in the air is arrived at the prism, the speed of the light is lowered. Therefore, while light 3 of Fig. 8b passes through the medium, light 1 comes out of the medium to the air and moves faster than the light 3. That is, just as the light 3

comes out of the medium, the light 1 moves further than a distance a of Fig. 8b. In other words, assuming that the distance a is 1, a distance b is 1.5, since the refractive index is 1.5. Accordingly, the light is refracted due to the difference in speed. Such difference can be mathematically calculated. In the drawing, when the angle of the prism is 10°, an angle C is 5.029°. When the angle of the prism is 20°, an angle C is 10.315° (physical optics is excluded). Based on this theory, if the refractive index of the glass of the prism is high, the light is more refracted although the angle is small.

Hereinafter, aberration of an image according to the present invention will be described.

In the image display system of the present invention, an aberration of an image does not mean spherical aberration which is Siedel aberration, coma aberration, astigmatism, a curve of an upper face, and distortion which are occurred by erroneous design of the lens or erroneous selection of the glass, but means an aberration which is occurred by changing the image forming angle to all directions.

When the light is refracted in a left, right, upper and lower direction, the image formed on the retina may be displayed by the aberration. This is caused by the value of **b** of the lens formula (referring to Fig. 9a).

In order to secure the images shown in Fig. 9b, the images taken from the lens of the camera to a CCD is reversely formed

within an extent that the value of **b** does not exceedingly deviate, (i.e., the focus is not precisely adjusted), as shown in Fig. 9b. In other words, Nos, 1,2,3,4 of Fig. 9a are respectively taken along with Nos, 1,2,3,4 of Fig. 9b, and then transferred to the LCD display (referring to Fig. 9c).

Next, an image of the camera will be described.

As described above, in order to oppositely form the images to each other, which are respectively formed on the CCD and the retina, the images of the camera have to be formed like the images of Fig. 9b. In that case, the aberration may be somewhat secured. Toward this goal, the images of the camera, which are taken on the CCD, have to be refracted (referring to Fig. 9d).

Fig. 9d shows a status that a circular prism is disposed at a rear portion of the lens. The circular prism is properly selected to have having a desired refractive index and angle according to the deformed state of the images, so that the images are reversely taken.

Fig. 9e shows a status that the optical path is changed according to the refractive index and the angle of the prism.

Next, visual fields of the eyes and the image display system according to the present invention will be described. The visual field of the eyes has a range of 60° upward, 60° inward, 70° downward and 100° outward, as shown in Fig. 10a.

In the present, the focus of the optical system is 24mm. Therefore, a distance to the LCD display, which is calculated

by the lens formula, is about 21.898mm on the basis of the visual range of 250mm. At this time, a magnification is as follows: 250/21.898 = 11.42.

In the image display system of the present invention, since a size of the LCD display is 14.5mm x 11mm, it seems to see an LCD having a size of 165.59mm x 125.62mm (referring to Fig. 6).

Further, in the case of the angle, it is calculated that the visual field of the center portion is 28.206° and the visual field of the left and right side is 36.658°. In comparison with the eyes, a rate of the visual field of the upper and lower side is 1:2.217 and a rate of the visual field of the upper and lower side is 1:2.742. In other words, the rates means rates of a size or an angle of the image in the case that the image display system is not worn and the image display system is worn.

A relationship of the size taken by the image display of the present invention and the human being's eyes will be described.

For example, when an ordinary person sees an object having a length of 1m at a distance of 2m, the image of the object is transferred to the eyes at an angle of about 28.072° with respect to all directions (referring to Fig. 10b).

In the present invention, the optical path is designed assuming that the LCD display is apart from the eyes at a distance of 250mm which is a visual range. Therefore, it seems

to see the object having a length of 125mm at a distance of 250mm (referring to Fig. 10c).

Substantially, the image having the length of 125mm and recognized through the image display system is displayed in a size of about 10.946mm on the LCD display.

A length of the object in the CCD and the lens of the camera is calculated as follow:

If the CCD of the camera has a size of 1/3 inches in the present invention, a length of its diagonal line is about 8.47mm. Further, a length of a diagonal line of the LCD display is about 18.2mm. Therefore, a rate of the sizes of the CCD and the LCD display is 1:2.149. If an image is formed in a size of 1mm on the camera CCD, the image is formed in a size of 2.149mm on the LCD display.

A goal of the present invention is to make a person recognize identically the size of the object, which has the length of 1m and is positioned at a distance of 2m, regardless of whether the person wears the image display of the present invention or not. Therefore, if the image is formed in the size of 10.946mm on the LCD display, it satisfies the above condition. Taking an advantage of this point, a size of the image in the lens of the camera is calculated below (Fig. 10d).

As shown in Fig. 10d, assuming that a distance from the lens to the object is 2m and a size of the object is 1m, a rate of sizes of the object and the image of the lens is 1m:5.093mm,

since the rate of CCD and the LCD display is 1:2.149. Since this relation can be applied to the distance, a distance of the object in the lens is as follows: 2m/196.348=10.186mm.

Further, a focal distance of the lens is 10.134mm based on the lens formula. Therefore, the image display system is designed based on the aforementioned result, thereby making a person recognize identically the size of the object regardless of whether the person wears the image display of the present invention or not.

Furthermore, when wearing the image display system, a visual field, which can be recognized by brains, is also calculated below using the aforementioned theory (the visual field of the image display system, referring to Fig. 9a).

In the image display system of the present invention, since the visual angle is 28.206° in an upper and lower side and 36.648° left and right side and the visual field is 165.59mm x 125.62mm on the basis of the visual range of 250mm, assuming that the object is positioned at a distance of 2.5m, the visual field, which can be recognized by brains, is 10 times, which is a rate of a difference in distance ld, i.e., 1655.9mm x 1256.2mm.

In this situation, if only the left and right portions of the images are synthesized, the synthesized image has a size of 3311.8mm x 1256.2mm (referring to Fig. 10e). That is, it seems

that two displays with an 80-inch are horizontally disposed at a distance of 2.5m.

Next, a relation of the camera and the visual field will be described.

The view angel of the camera is an important point for exactly observing the image. If an angle of the camera is not proper, a portion of the object, which exceeds a predetermined distance, may be overlapped (in the case that the view angle of the camera is overlapped) or may be cut (in the case that the view angle of the camera can not cover the entire image). In order to overcome the weak point, the view angle of the camera can be adjusted using a sensor and a motor (according to a distance of the object) (referring to Fig. 11a).

However, this may exert a serious influence on a volume and a weight of the image display system of the present invention, resulting in trouble in wearing the image display system. In order to overcome the problem, one surface of an iris diaphragm is blocked with a center line in the center, and the CCD positioned at a center portion is moved to a corresponding position. And, there is also provide a specific camera which can remove the right or upper image, or the left or lower image. Fig. 11c shows the visual angle of the camera.

Fig. 11b shows a camera system which can adjust the visual angle in all directions.

When two-camera system is disposed in the image display system, as shown in Fig. 11c, a gap d between the two cameras, i.e., an A portion of Fig, 12a corresponding to half portions of each lens can not take the image. Therefore, the image corresponding to the A portion is cut. For example, assuming that an entire diameter of the lens is 12mm, the image corresponding to an area having a diameter of 12mm (6mm x 2 = 12mm) is not taken by the camera.

In addition, in the two-camera system, each camera has to be aligned in an exact direction which is identical with the image. In that case, the image is exactly displayed.

In order to overcome the problem, a specific camera, as shown in Fig. 12b, is provided.

In the Fig. 12b, a circuit of the cameral is divided into two portions. The camera is has one lens and a CCD having a lateral length twice as large as a conventional one. In the camera, an image taken by an a portion of the CCD is transferred to a left LCD display, and an image taken by a b portion of the CCD is transferred to a right LCD display, thereby obtaining the same effect as that in the two-camera system. Further, it is easy to adjust the camera with respect to the object.

Finally, an adjustment of the luminous intensity in the image display system of the present invention will be described.

First, it is possible to adjust the luminous intensity of a light source itself and then use the adjusted luminous intensity according to conditions. Particularly, the visually handicapped person generally has the lowered sensitivity of optical nervous. Therefore, since it is not possible to solve the problem with only the conventional light source and luminous intensity, a light source having a higher luminous intensity, and an adjustment of the luminous intensity in a wider extent are needed. In this present invention, there is provided a light source which is thin and generates light having a high luminous intensity and also in which the luminous intensity can be facilely and widely adjusted.

Meanwhile, in the present invention, in consideration of an influence on the human body worried by using the light source having the high luminous intensity, a multiplying reflector and a prism are coated. In addition, there is also provided a filter for removing harmful wavelength such as infrared rays and ultraviolet rays. Therefore, as shown in Fig. 19, transmittance of the infrared rays and the ultraviolet rays is near to zero.

First embodiment

Some preferable embodiments of the present invention will be described fully with reference to Figs. 13 and 14.

Fig. 13 is a schematic perspective view of a head-mounted type image display system 1 according to the present invention.

As shown in Fig. 13, the image display system 1 comprises a main body 12 having an electronic or optical unit, and the bows 14 of a pair of spectacles. The bows 14 functions to maintain the main body 12 at a desired position to transfer an image to the retina. A strap may be additionally provided to maintain the image display system 1 at the desired position. Further, a control unit 18 communicates with a CCD camera 122 and a third image medium and also controls an operation of the image display system 1.

Next, in the embodiment of the present invention, as shown in Figs. 13 and 14, the main body 12 has the optical unit. The optical unit includes the CCD camera 112 and an LCD display set 200 which are disposed in an upper housing 13a, a half mirror 126 which is disposed in a lower housing 13b, a multiplying reflector 128 and selectively a prism 130. The LCD display set comprises an LCD display panel 124, a light source 132 and an infrared filter 134.

The light source 132 is disposed at a rear portion of the LCD display panel 124 to provide backlight to the LCD display (channel). The light source 132 is a light emitting body in which a plurality of semiconductor luminous devices are aligned in the form of a matrix. The light source 132 has a luminous intensity of about 200,000 lux at a distance of about 7cm.

The light source 132 is connected through a cable path 24 and a cable 20 to a power supplying means (not shown) of the control unit 18. The luminous intensity of light illuminating from the light source 132 to the display panel 124 is controlled by an illuminance controlling means 28 provided to the control unit 18 according to a status of optical nervous of a visually handicapped person. The illuminance controlling means 28 is connected to the power supplying means.

Preferably, the infrared filter 134 is disposed between the light source 132 and the LCD display panel 124 to filter the infrared rays having high thermal energy which exerts an influence on an eyeball of the visually handicapped person.

The control unit 18 has a connecting terminal 26 for connecting with a computer, a video tape recorder or a TV. Therefore, according to the image display system, an image taken by the CCD camera is transferred to the LCD display panel 124, and an image displayed in the computer, the video tape recorder or the TV is transferred through an image transferring cable 20 to the LCD display panel 124, so that the visually handicapped person can watch the computer, the video tape recorder or the TV.

When the computer, the video tape recorder or the TV is connected to the control unit 18, the control unit 18 cuts off the transmission of the image taken by the CCD camera 122 to the LCD display panel 124. Therefore, the visually handicapped

person can watch the computer, the video tape recorder or the TV.

In the image display system, a view angle is an important point to exactly see an object. In a conventional camera, if an angle of the camera is not correct, i.e., the view angle of the camera is overlapped, the images of the object, which exceeds a predetermined distance, may be overlapped, or may be cut (in the case that the view angle of the camera can not cover the entire image). In order to overcome the problems, the conventional camera has to be provided with a sensor and a motor to automatically adjust the focus of the image according to conditions. However, according to the CCD camera 122 of the present invention, in order to improve the problem exerting on a volume and a weight of the conventional image display system and thus resulting in trouble in wearing the image display system, one surface of a field stop is blocked with a center line in the center, and the CCD positioned at a center portion is moved to a corresponding position. Therefore, there is provided a new specific camera which can remove the right or upper image, or the left or lower image.

Further, as shown in Fig 2b, the CCD camera 122 of the present invention has two cameras for respectively taking a half of image of Fig. 2a. Then, each image of each camera 122 is transferred to the LCD panel 124, as shown in Fig. 2c. The image formed on the retina is shown in Fig. 2d. When brains

recognizes the images, they seems to be overlapped, as shown in Fig. 2e. To solve the problem, if an optical path is changed to an inner portion of the retina by a prism or a multiplying reflector, taking an advantage of the retinal image forming theory, it is prevented that the images are respectively formed on a desired portion of the retina. Therefore, they are recognized like an image of Fig. 2g.

The images taken by the pair of specific cameras of the present invention are formed on the CCD based on the retinal image forming theory. Then, the images are transferred to the LCD display panel 124. The luminous intensity of the images transferred to the LCD display panel is controlled by adjusting the luminous intensity of the light source 132 using the luminance controlling means 28 disposed at the control unit 18.

In addition, the focus of the images transferred to the LCD display panel 124 is controlled by moving the LCD display panel 124 in an upper and lower direction (arrow directions of Fig. 14) by an focus controlling unit (Fig. 16). In other words, if a user of the image display system is long-sighted, the LCD display panel 124 is moved upward, and if the user is near-sighted, the LCD display panel 124 is moved downward, thereby adjusting the focus of the image. This is one of the important features.

A structure and an operational principle of the focus controlling unit will be described fully with reference to Fig. 16.

As shown in Fig. 16, the focus controlling unit is mounted along with the camera 122 in the upper housing 13a which is disposed at an upper side of the lower housing 13b. The focus controlling unit has a body 194. The body 194 of the focus controlling unit is formed of a rectangular frame defining a large inner space 196. Around an inner surface of the body 194, there are formed three guiding groove 198. Further, the LCD display set 200 comprises the light source, the filter and the LCD display panel. Around the LCD display set 200, there are formed three sliding portions 202 meshed with the guiding grooves 198 and a rack portion 204.

The LCD display set 200 is disposed in the inner space 196 of the body 194 so that the sliding portions 202 are respectively meshed with the guiding grooves 198. A rotating unit 210 for the focus controlling unit, including a pinion gear 206 meshed with the rack portion 204, is disposed through a through hole 208 of the body 194.

Therefore, in the focus controlling unit of the present invention, if a handle 212 of the rotating unit 210 is rotated clockwise or counterclockwise, the pinion gear 206 is rotated, and thus the LCD display set 200 having the rack meshed with the pinion gear 206 is moved upward or downward. Therefore,

according to the present invention, the user can properly and freely adjust the focus according to conditions. After adjusting the focus, the LCD display set 200 is maintained at the adjusted position, and then, fixed by an adhesive or other mechanical means. In the embodiment, the means for moving the LCD display set 200 upward and downward is just an example. It can be variously modified by those skilled in the art.

A half mirror 126 has an angle of 45° with respect to the LCD display 124, as shown in Fig. 14. The image transferred to the LCD display in which the luminous intensity is controlled is reflected to the multiplying reflector 128 by the half mirror 126. Herein, the multiplying reflector 128 is disposed at a desired angle, e.g., about a right angle with respect to the LCD display 124. Further, the multiplying reflector 128 is disposed to change the optical path to the left and right side of Figs. 15a and 15b.

As shown in Fig. 3a, the visually handicapped person has the variously deformed retina. Therefore, in order to transfer the image to a relatively preferable portion of the retina, which has the visual sensitivity, the multiplying reflector is tilted to the left and right side to change the optical path.

The change in optical path will be described fully with reference to the Figs. 15a and 15b.

As shown in Fig. 3a, in case the visually handicapped person has the retina which is injured at a center portion and

is relatively normal at left or/and right side, the image received from the half mirror 126 is passes through the half mirror 126 to form the image on the preferable portion of the retina. Toward this goal, in the embodiment, an optical system box 182 having the half mirror, the multiplying reflector and the prism (optional element) has to be tilted using a left and right adjusting screw 184 and a leaf spring 186. Herein, the optical system box 182 is rotatably mounted at a connecting member 188b formed at the lower housing 13b by a centering member 188a protruded to a rear portion of the optical system box 182. A tension spring 186 is disposed at a center portion of a front side of the lower housing 13b. The tension spring 186 is contacted with both opposite sides of the pair of the optical system box 182 (Fig. 15a). In case the optical system box is positioned like in Fig. 15a, the images are formed on the center portion of the retina.

Fig. 15b shows a status that the left optical system box 182a is rotated counterclockwise with a center portion (X') of the optical system box in the center, and the right optical system box 182a is rotated clockwise with a center portion (X'') of the optical system box in the center. This is achieved by respectively moving the optical system boxes using the left and right adjusting screw 184 mounted at the left and right sides of the lower housing 13b. At this time, the tension spring 186 functions to push out each of the left and right

optical system boxes 182a, 182b and maintains the optical system boxes at desired positions. As shown in Fig 15b, in case the optical system boxes are arranged, the optical path is changed like in No.2 of Fig. 7b by tilting of the left optical system box, and the optical path is also changed like in No.3 of Fig. 7b by tilting of the right optical system box.

Therefore, in case of the visually handicapped person who has the preferable right portion of the left retina and the preferable left portion of the right retina, he or she can see the images from the CCD camera or the third image medium by the controlling of the optical system boxes. It is preferable that the multiplying reflector is a concave mirror.

In the embodiment, the image received from the half mirror 126 is reflected from the multiplying reflector. A part of the reflected light passes through the half mirror and then transfer the image to the retina. The half mirror 126 is disposed to receive the image from the LCD display and then reflect the image to the multiplying reflector 128. The half mirror 126 is disposed between the multiplying reflector 128 and the eyes of the user.

Next, a structure of changing the optical path upward and downward and an optional principle thereof will be described with reference to Figs. 8a, 8b and 14.

Some of the visually handicapped person has the retinal which is injured at a upper portion or a lower portion. For

this kind of the visually handicapped person, it is necessary to change the optical path so that the images passing the half mirror 126 from the multiplying reflector 128 are formed at the preferable portion of the retina. In this case, the optical path has to be changed downward using the prism. Concretely, the light refracting principle using the prism is described above with reference to Fig. 8b. In case of the visually handicapped person who has the injured lower portion and the normal upper portion of the retina, the prism is disposed between the half mirror 126 and the eyeball so that the optical path of the images from the multiplying reflector is changed upward, thereby forming the images on the upper portion of the retina, as shown in No. 1 of Fig 8a. However, In case of the visually handicapped person who has the injured upper portion and the normal lower portion of the retina, the prism is disposed like in No. 2 of Fig 8a so that the optical path of the images from the multiplying reflector is changed downward, thereby forming the images on the lower portion of the retina.

Meanwhile, in case the retinal state of the visually handicapped person is corresponding to A to H type of Fig. 3a, a prism of dihedral angle is disposed between the eyeball and the half mirror 126 to refract the optical path in all directions. Since the visually handicapped person have variously deformed portions of the retina, as shown in Fig. 3a, it is necessary to control the optical path in all directions

to form the images on the normal portion of the retina, which has a relatively preferable visual sensitivity. If the prism of dihedral angle is used, it is possible to obtain the same effect without any unit for tilting the optical system boxes including the multiplying reflector toward the left and right side.

Accordingly, there is provided an optical path which passes through in turn the LCD display, the half mirror and the multiplying reflector from the pair of CCD cameras, and passes the half mirror again and then is transferred to the retina.

Meanwhile, the control unit 18 comprises an image transferring means, the power supplying means and the luminance controlling means. The power supplying means functions to supply power to the CCD camera, the image transferring means, the LCD display and the light source. The control unit 18 is connected to the cable for transferring the image and also connected to the cable for supplying power to each unit. In the drawing, a reference numeral 20 designates the cables. That is, the cables function to transfer the images and also supply the power to the LCD backlight, LCD and/or an image generating means. Various displaying means may be provided on a surface of the control unit 18.

Second embodiment

Fig. 17 is a schematic perspective view showing a structure of an image display system 1 according to another embodiment of the present invention. The same reference numeral in the first embodiment designates the same element, and thus a description thereof will be omitted.

An image taken by a specific camera 122 of the present invention is transferred through an image transferring means 136 to an LCD display 124. The transferred image is enlarged by a lens group 138 and then formed on the retina.

In the embodiment, an LCD display set 200 is moved to left and right sides of Fig. 18 to adjust focus of a user.

Further, a reference numeral 12 of Fig. 17 designates a main body including the LCD display set 200, the optical lens group 138 and a prism 140. The LCD display set 200 comprises a light source 132, a filter 134 and an LCD display 124. Of cause, the main body 12 may employ a tilting structure to be tilted in the left and right side like in the first embodiment. The image can be transferred to a normal portion of the retina by the tilting.

The prism 140 is disposed between the eyeball and the optical lens group 138, and selectively used to refract the optical path in case the user is corresponding to the A to H types of Fig. 3a. Of course, a prism of dihedral angle may be used as the prism 140 to move the image to the left and right side.

According to the present invention, the image can be transferred from the image generating means (the CCD camera or the third image medium) to a desired portion of the retina by various optical units.

INDUSTRIAL APPLICABILITY

According to the present invention, as described above, it is possible to control the luminous intensity, the focal distance and the optical path through the CCD camera, the LCD display, the backlight, the prism and the multiplying reflector. Further, since the view angle can be widened, the image can be transferred in real time to an ordinary person as well as the visually handicapped person who has a normal portion of the retina.

Since components such as a small camera and a TV channel can be detachably mounted in the main body of the image display system of the present invention, the main body is much leaner and lighter. Since some components are selectively used according to the application, the application of the image display system is widened. Further, since the image of the LCD display is directly formed on the retina by the light source, it is possible to provide clear image to the visually handicapped person regardless of the visual power.

What is claimed is:

1. A head-mounted image display system, comprising:

a pair of CCD cameras for taking an image of an object;

transferring means for transferring the image from the CCD camera and a third medium to a pair of LCD displays;

a pair of LCD displays for displaying the transferred image;

a light source for illuminating a rear portion of the LCD display, while controlling luminous intensity of the image displayed on each LCD display;

a filter for eliminating infrared rays and ultraviolet rays from light of the light source;

a half mirror for reflecting the image displayed on each LCD display to a multiplying reflector;

a multiplying reflector which is disposed at a desired angle with respect to each LCD display, for receiving the image from the half mirror and passing a part of the image through the half mirror and then transferring the image to eyes of a user;

power supplying means for supplying power to the CCD camera, the transferring means, the LCD display and the light source;

a housing for mounting the CCD camera, the LCD display, the light source, the multiplying mirror and the half mirror on a head portion of the user,

wherein an optical path is formed from the CCD camera through the LCD mirror, the half mirror, the multiplying reflector and the half mirror again to the eyes of the user.

2. The system according to Claim 1, wherein the CCD camera is provided with an iris diaphragm of which one surface is blocked, and a CCD which is moved from a center portion of the CCD camera to a desired corresponding position.

3. The system according to Claim 1, wherein the pair of LD displays are respectively moved upward and downward to adjust focus.

4. The system according to Claim 1, wherein the multiplying reflector is tilted clockwise or counterclockwise to change the optical path of the image received from the half mirror.

5. The system according to Claim 1, further comprising a prism which is disposed between the half mirror and the eyes of the user.

6. The system according to Claim 5, wherein the prism is a prism of dihedral angle.

7. The system according to Claim 1, wherein the light source is a light emitting body in which a plurality of semiconductor light emitting devices are aligned in the form of a matrix.

8. The system according to Claim 1, wherein the multiplying reflector is a concave mirror.

9. A head-mounted image display system, comprising:

a pair of CCD cameras for taking an image of an object;

transferring means for transferring the image from each camera and a third medium to a pair of LCD displays;

a pair of LCD displays for displaying the transferred image;

a pair of light sources for illuminating a rear portion of the LCD display, while controlling luminous intensity of the image displayed on each LCD display;

a filter for eliminating infrared rays and ultraviolet rays from the light source;

a pair of optical lens groups for enlarging the image displayed on each LCD display;

power supplying means for supplying power to the CCD camera, the transferring means, the LCD display and the light source;

a holder for mounting the CCD camera, the LCD display

and the light source on a head portion of a user.

10. The system according to Claim 9, wherein the CCD camera is provided with an iris diaphragm of which one surface is blocked, and a CCD which is moved from a center portion of the CCD camera to a desired corresponding position.

11. The system according to Claim 9, further comprising a prism which is disposed between the half mirror and the eyes of the user.

12. The system according to Claim 9, wherein the light source is a light emitting body in which a plurality of semiconductor light emitting devices are aligned in the form of a matrix.

13. The system according to claim 9, wherein the LCD display is movable in a front and rear direction.

14. The system according to claim 11, wherein the prism is a prism of dihedral angle.

15. The system according to claim 11, wherein the optical lens group and the LCD display set are integrally formed and tilted.

16. A head-mounted image display system, comprising:

a CCD camera which is comprised of one camera for taking an image of an object and has a CCD which is larger twice or more in a lateral direction thereof than a CCD of a conventional;

transferring means for transferring the image from the CCD camera and a third medium to a pair of LCD displays;

a pair of LCD displays for displaying the transferred image;

a light source for illuminating a rear portion of the LCD display, while controlling luminous intensity of the image displayed on each LCD display;

a filter for eliminating infrared rays and ultraviolet rays from light of the light source;

a half mirror for reflecting the image displayed on each LCD display to a multiplying reflector;

a multiplying reflector which is disposed at a desired angle with respect to each LCD display, for receiving the image from the half mirror and passing a part of the image through the half mirror and then transferring the image to eyes of a user;

power supplying means for supplying power to the CCD camera, the transferring means, the LCD display and the light source;

a housing for mounting the CCD camera, the LCD display, the light source, the multiplying mirror and the half mirror on a head portion of the user,

wherein an optical path is formed from the CCD camera through the LCD display, the half mirror, the multiplying reflector and the half mirror again to the eyes of the user.

17. A head-mounted image display system, comprising:

a CCD camera which is comprised of one camera for taking an image of an object and has a CCD which is larger twice or more in a lateral direction thereof than a CCD of a conventional;

transferring means for transferring the image from the camera and a third medium to a pair of LCD displays;

a pair of LCD displays for displaying the transferred image;

a pair of light sources for illuminating a rear portion of the LCD display, while controlling luminous intensity of the image displayed on each LCD display;

a filter for eliminating infrared rays and ultraviolet rays from light of the light source;

a pair of optical lens groups for enlarging the image displayed on each LCD display;

power supplying means for supplying power to the camera, the transferring means, the LCD display and the light source;

a holder for mounting the CCD camera, the LCD display and the light source on a head portion of the user,

FIG.1a

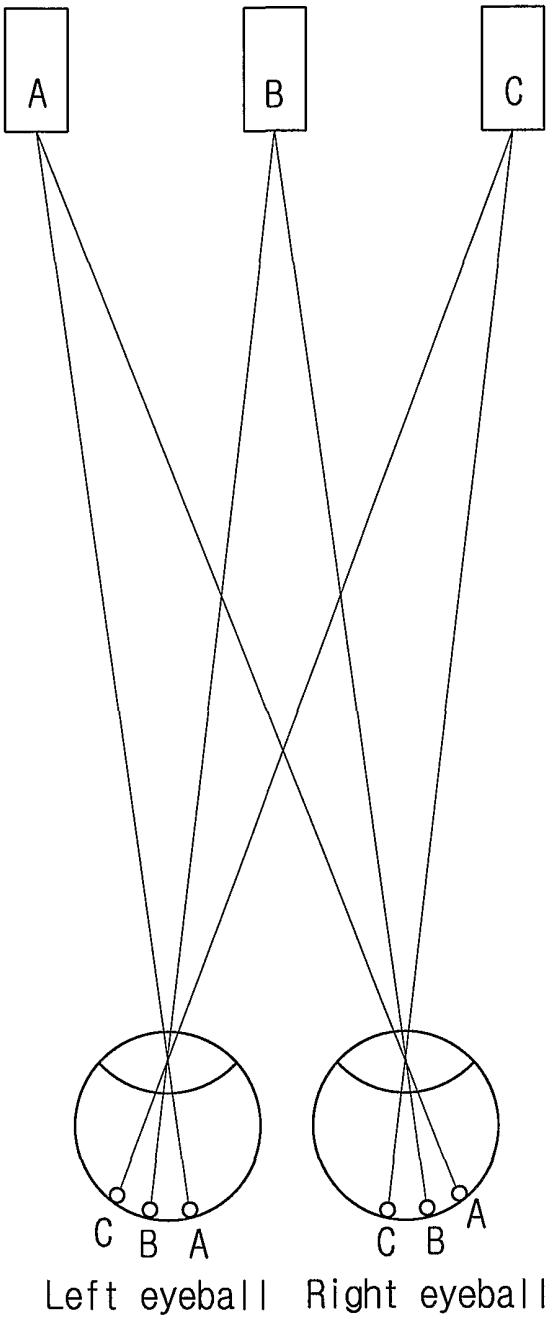


FIG.1b

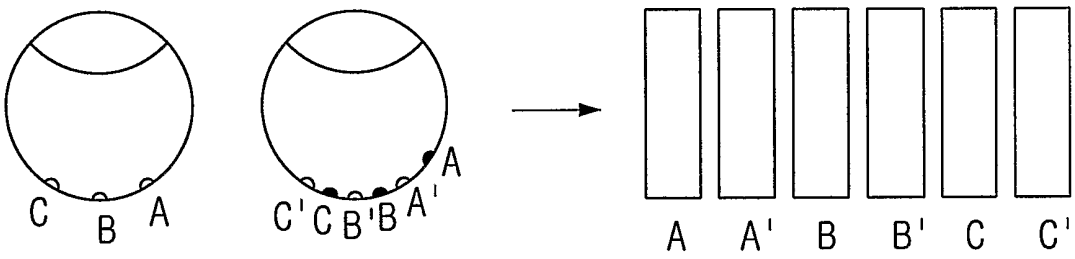


FIG.1c

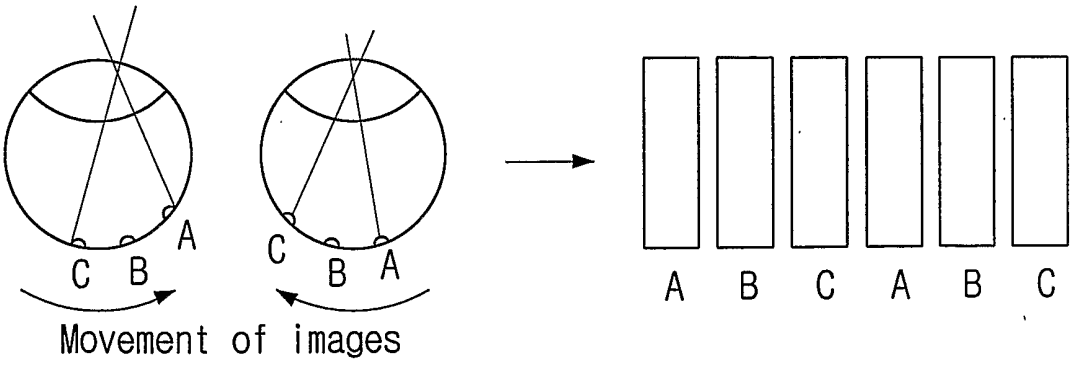


FIG.2a

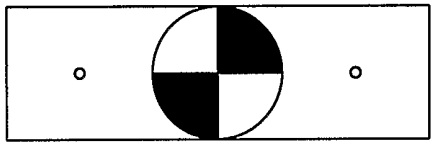


FIG.2b

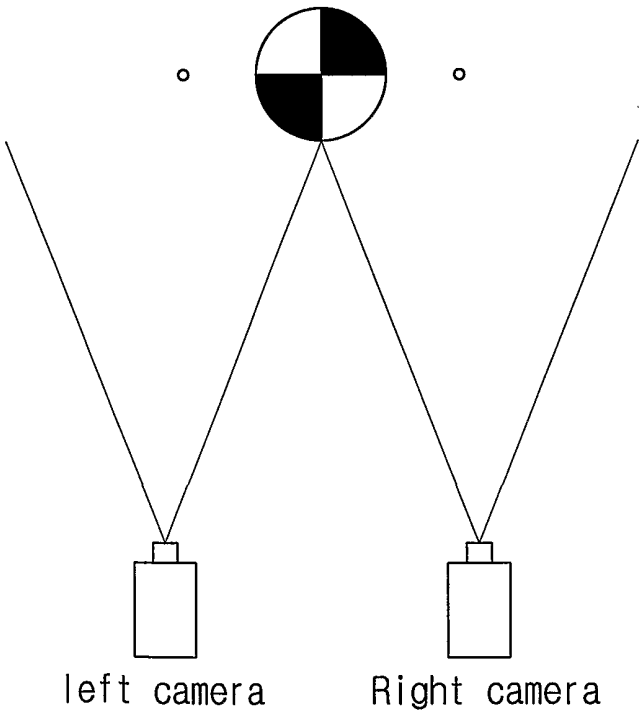


FIG.2c

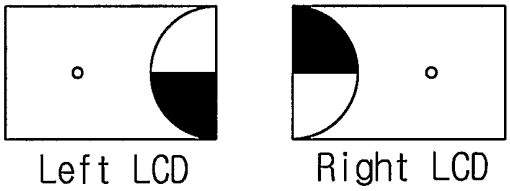


FIG.2d

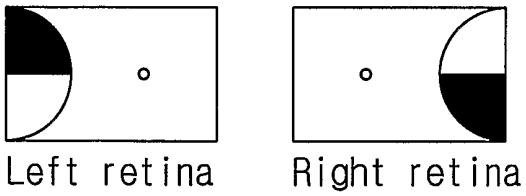


FIG.2e

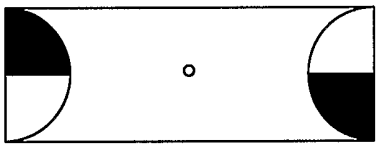


FIG.2f

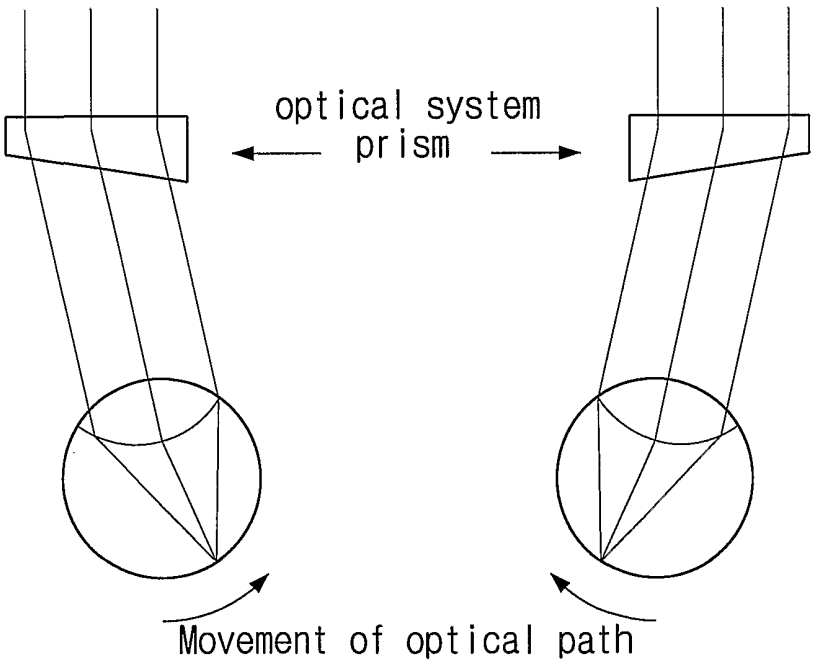


FIG.2g

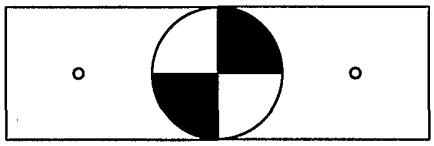


FIG.3a

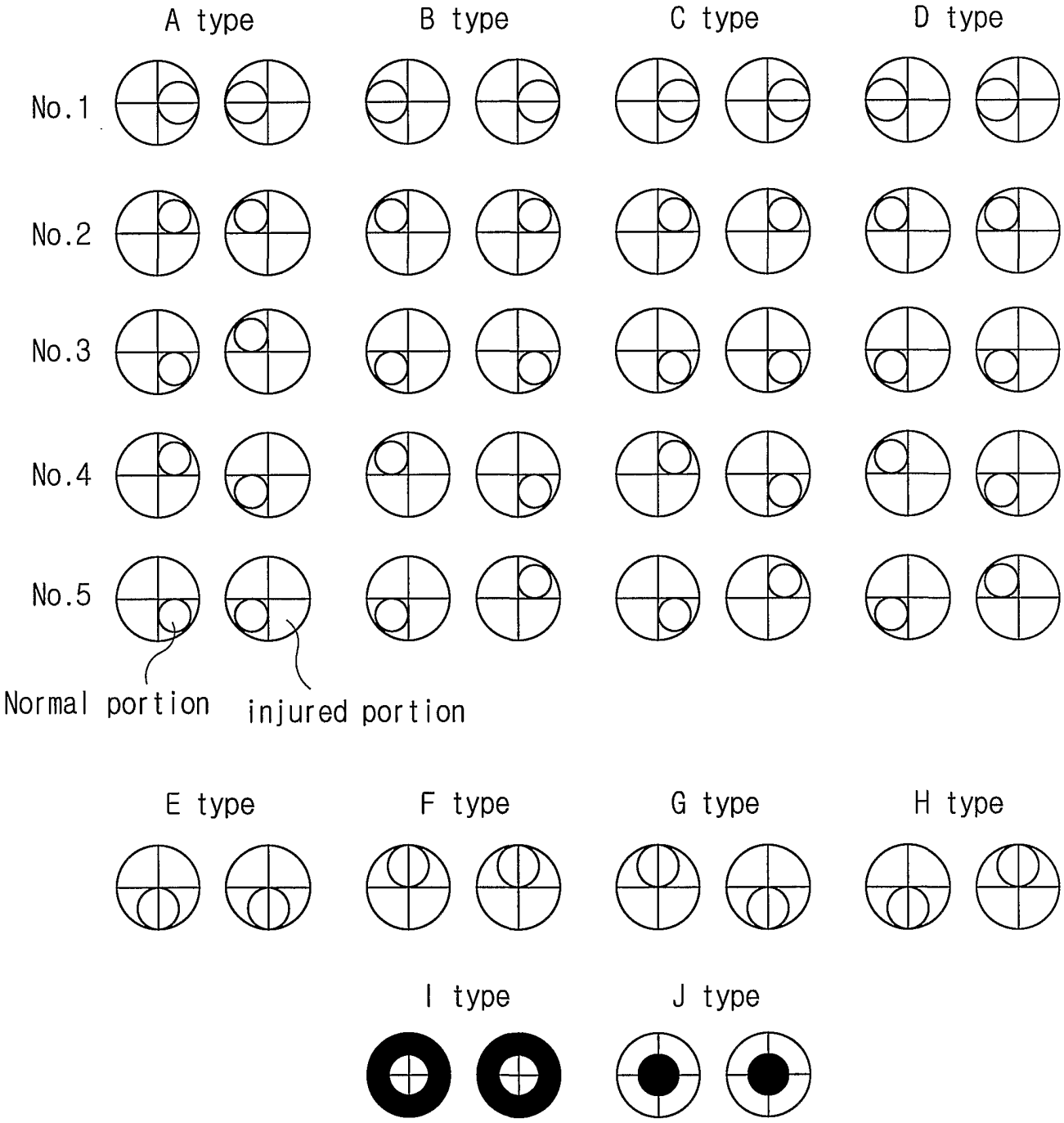
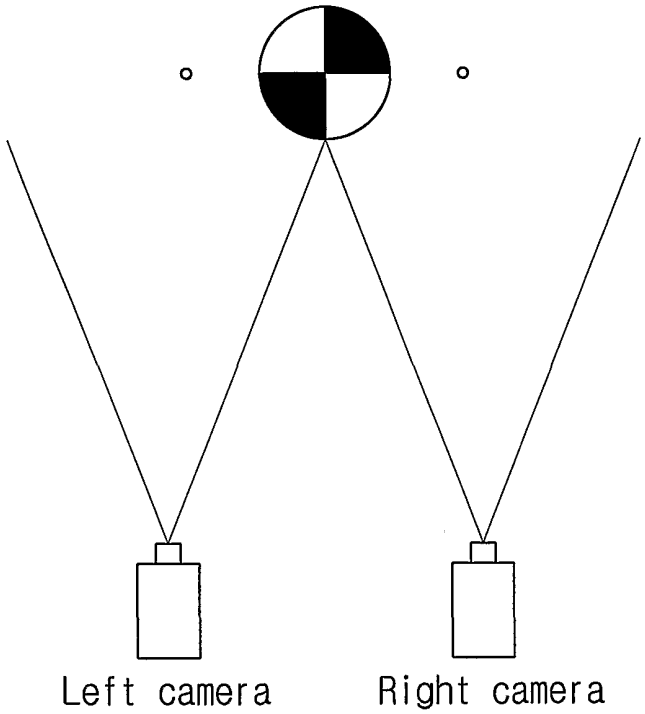
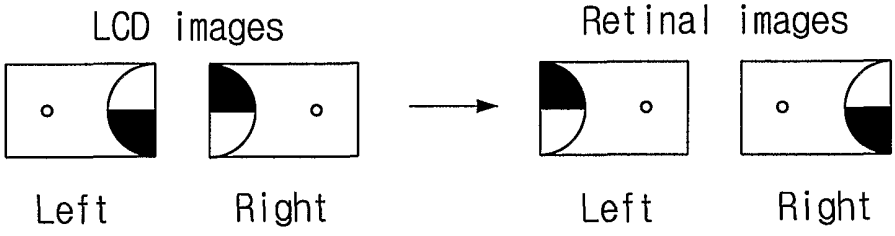

A type
B type
C type
D type
No.1
No.2
No.3
No.4
No.5
Normal portion
injured portion
E type
F type
G type
H type
I type
J type

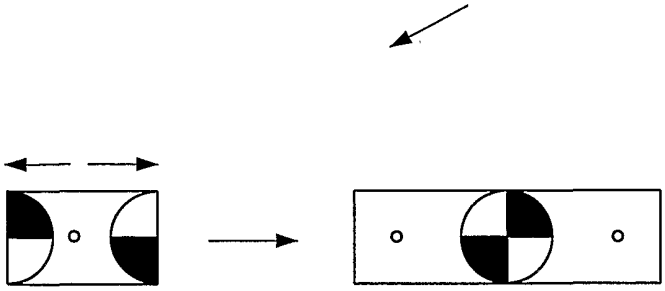
FIG.3b



No.1



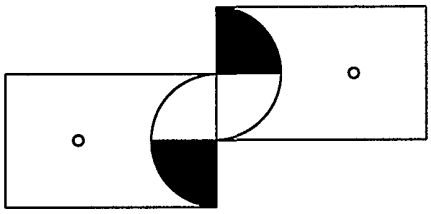
No.2 No.3



No.4 No.5

FIG.3c

No.3 type



No.4 type

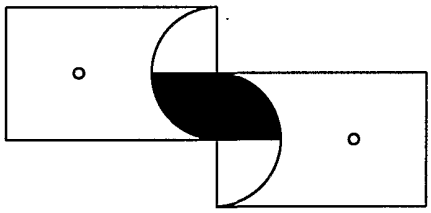


FIG.4a

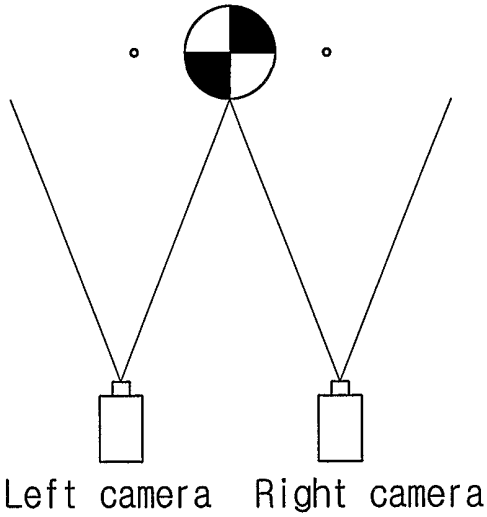


FIG.4b

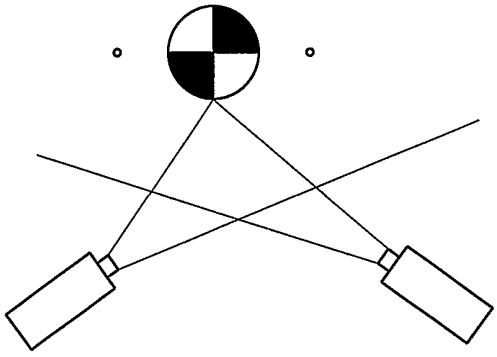
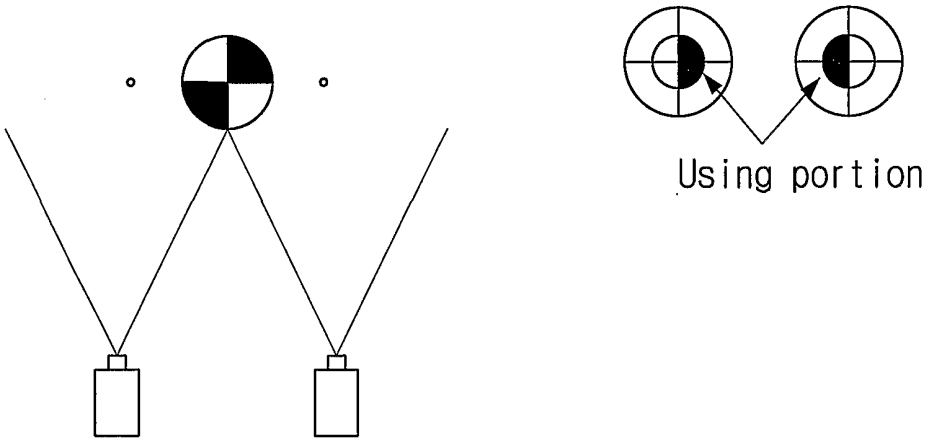


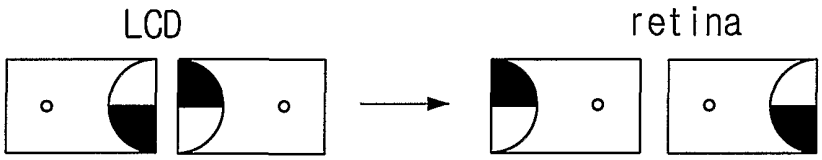
FIG.4c


L
LCD
R
Right camera
Left camera
retinal
Right camera
Left camera

FIG.4d

FIG.5a





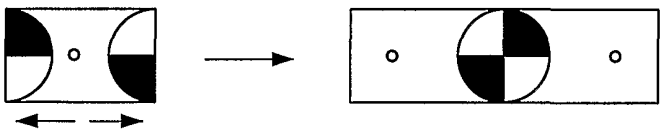


FIG.5b

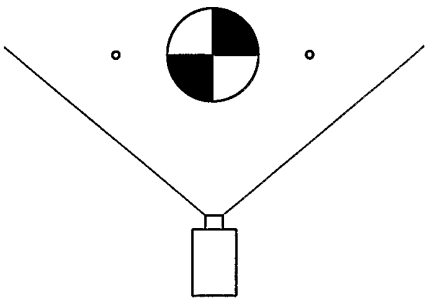


FIG.6

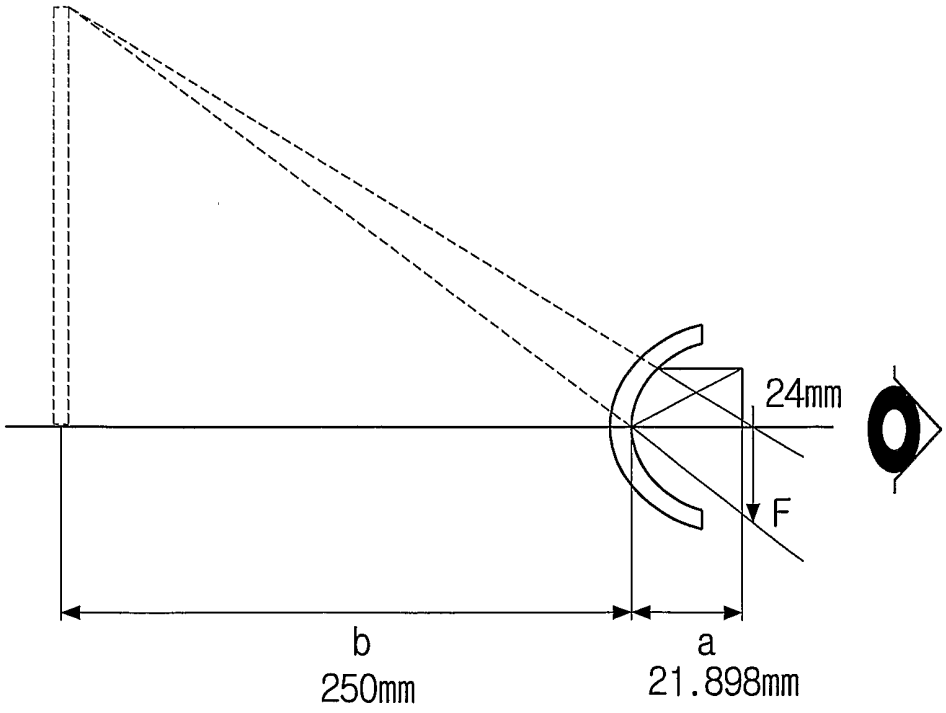
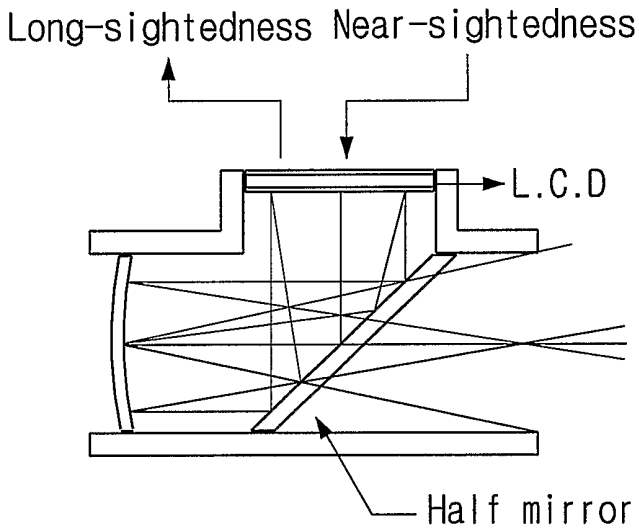


FIG.7a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L.C.D
Half mirror

FIG.7b

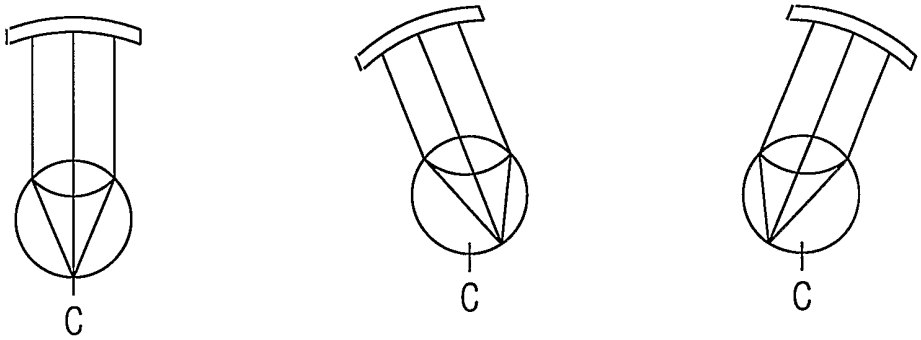

C
C
C
No.1
No.2
No.3

FIG.7c

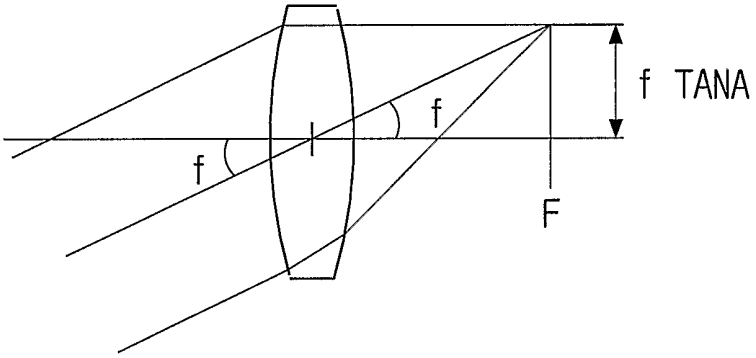
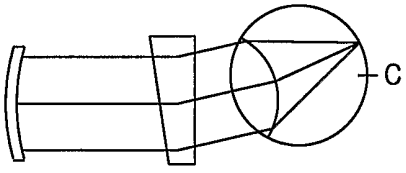


FIG.8a



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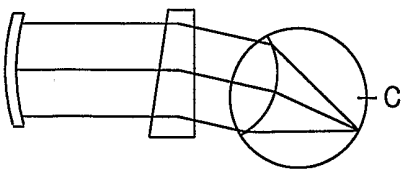


No.2

FIG.8b

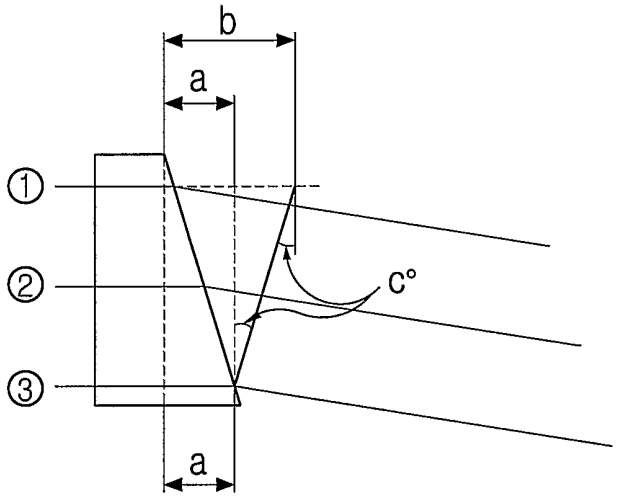


FIG.9a

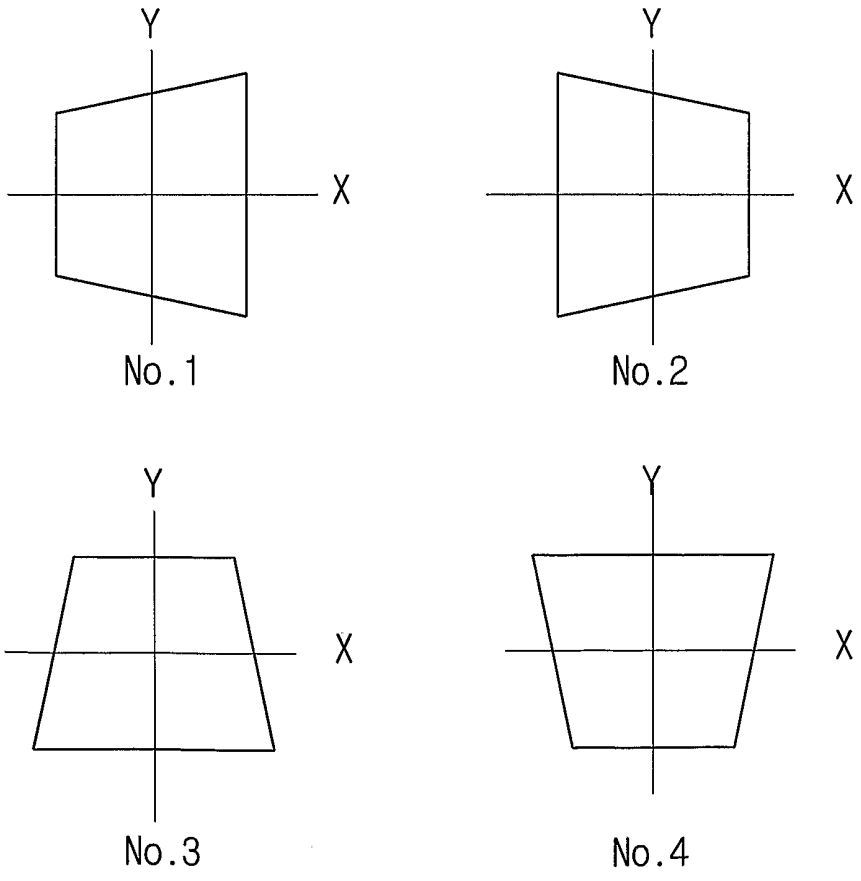
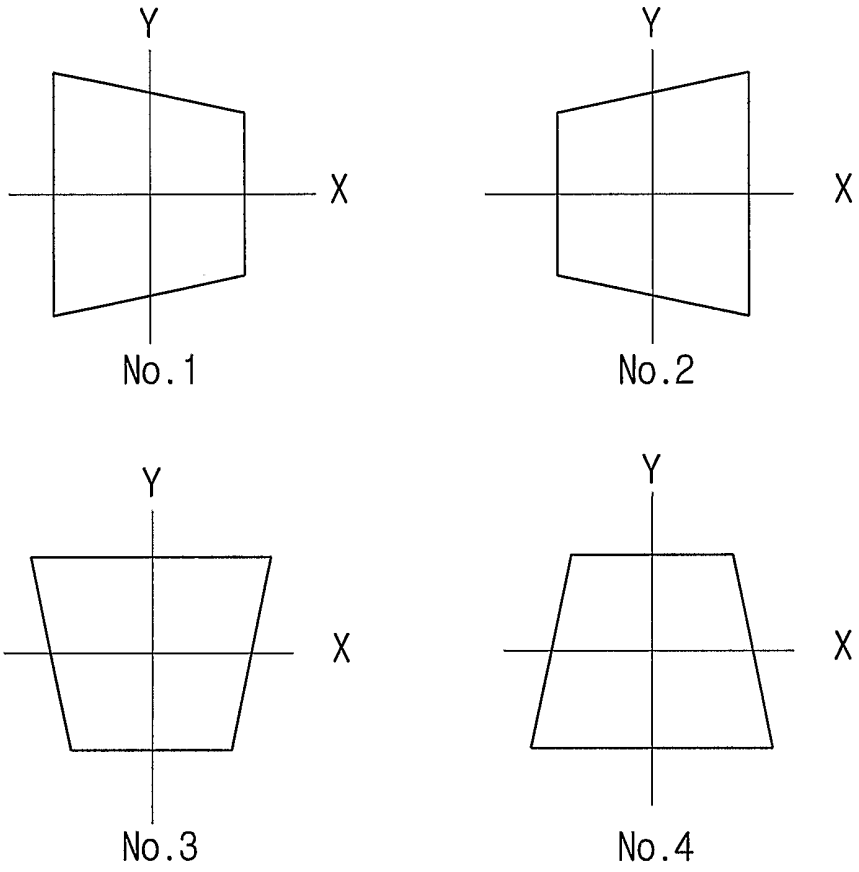


FIG.9b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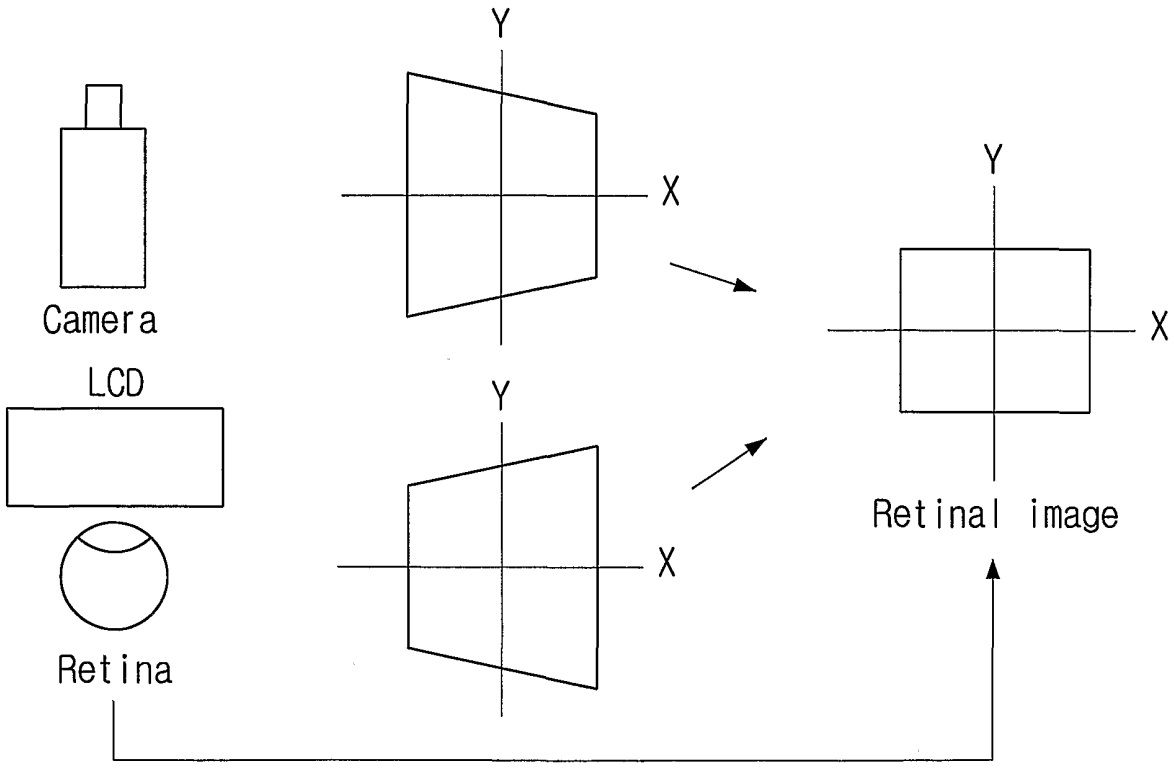
Y
X
No.2
Y
X
No.3
Y
X
No.4

FIG.9c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LCD
Retina
Y
X
Y
X
Y
X
Retinal image

FIG.9d

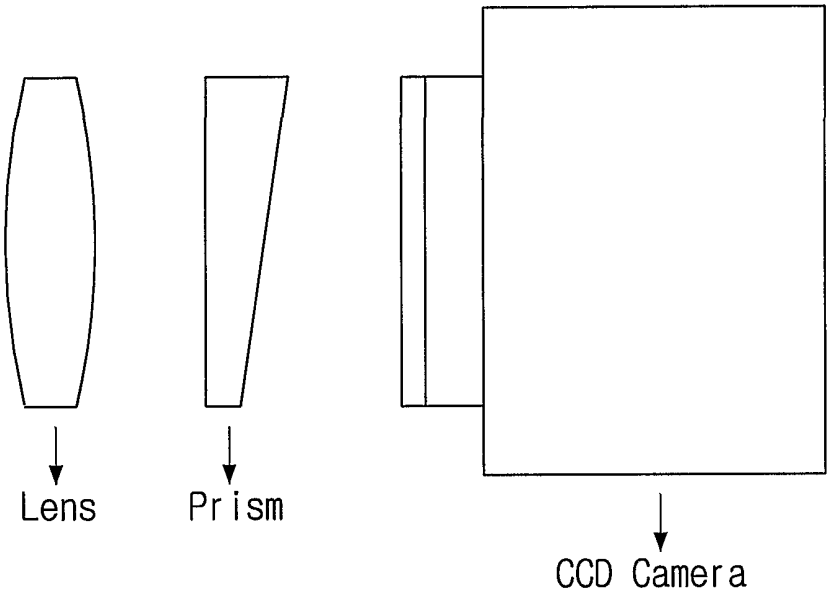


FIG.9e

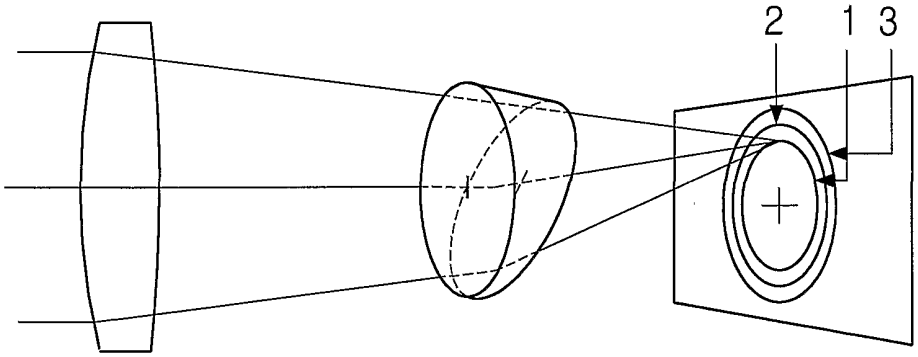


FIG.10a

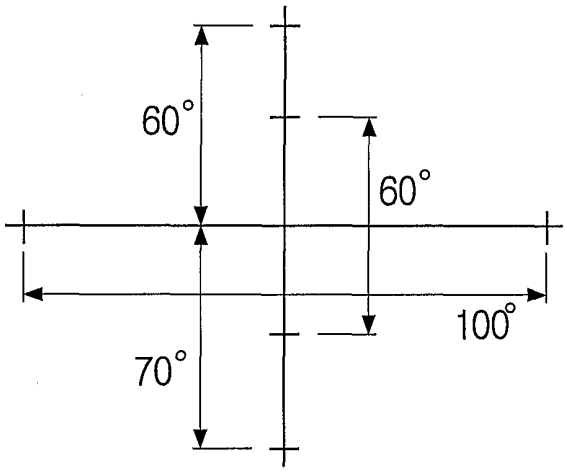


FIG.10b

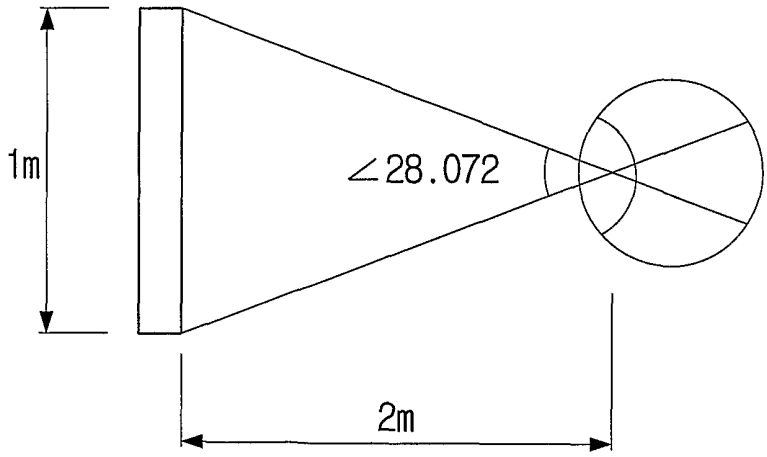


FIG.10c

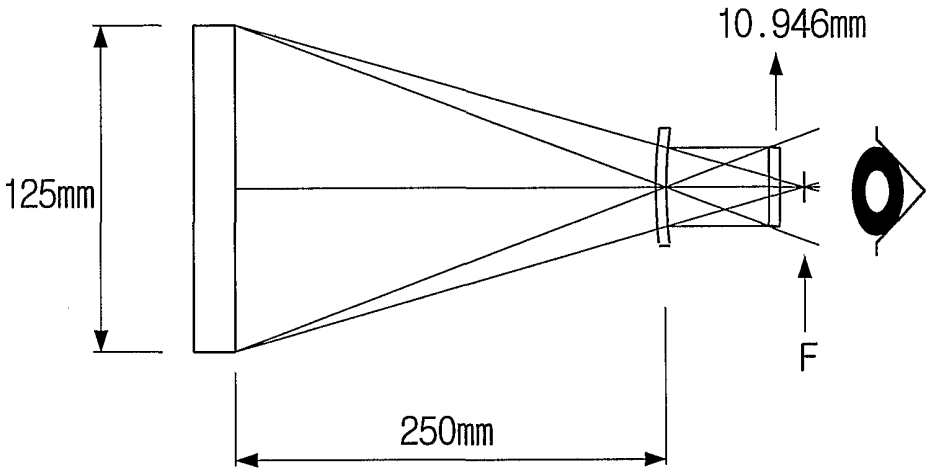


FIG.10d

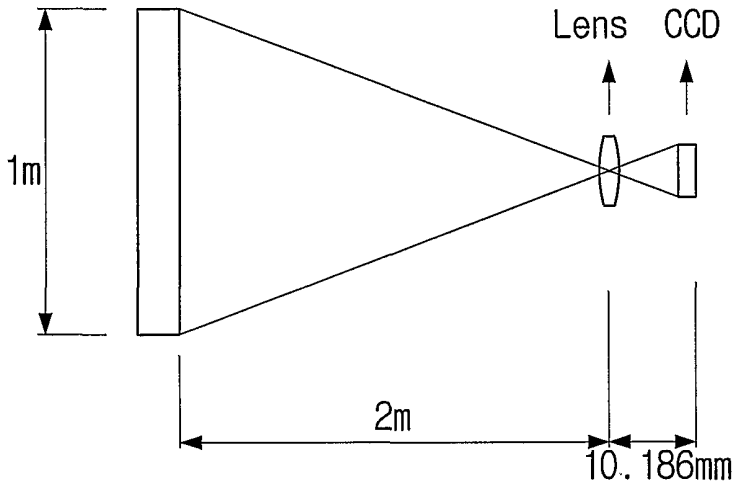


FIG.10e

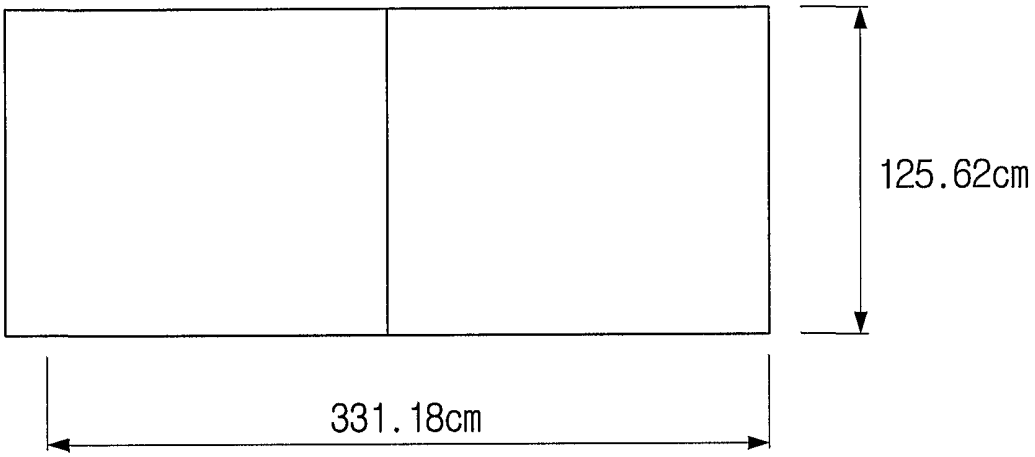


FIG.11a

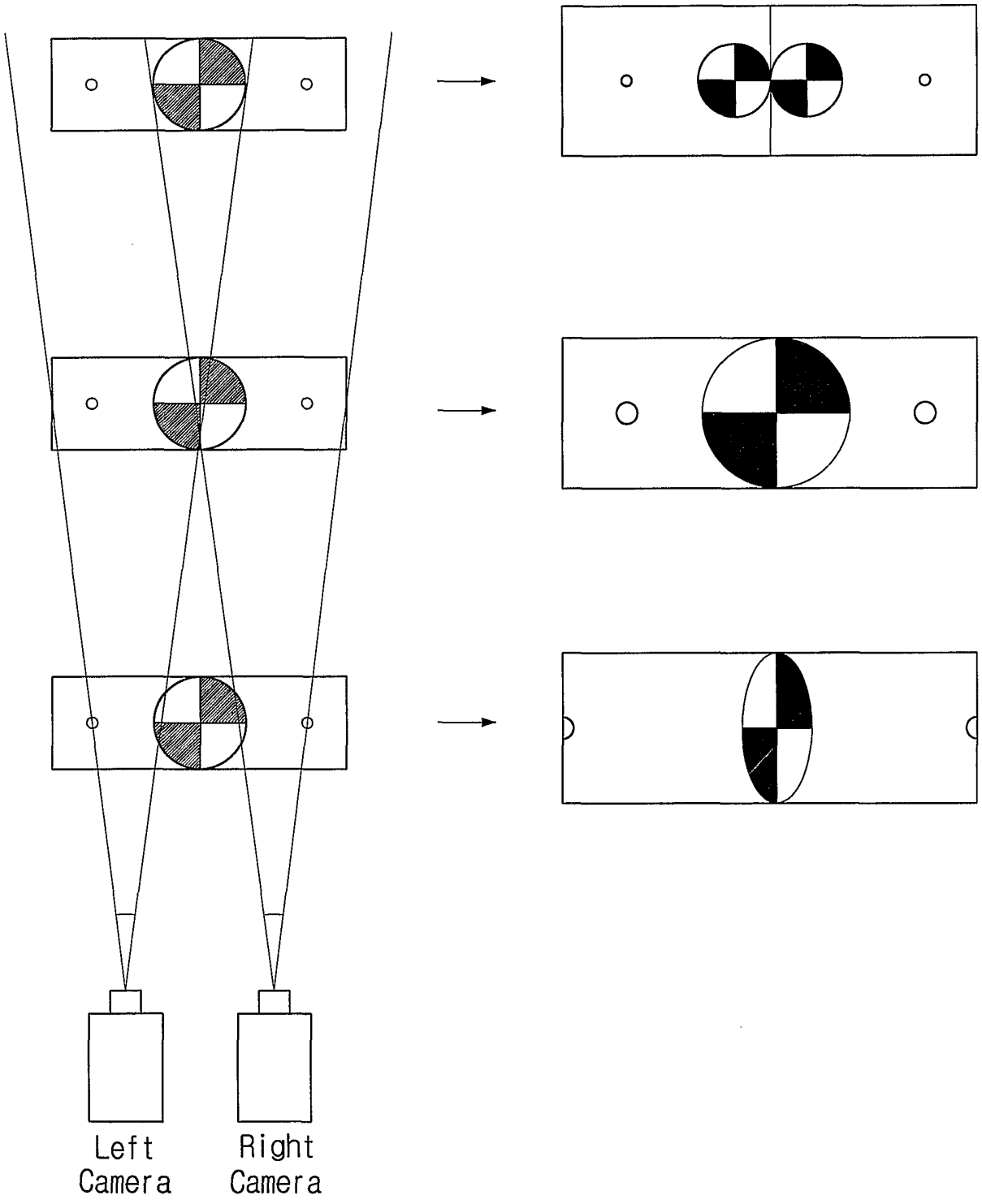


FIG.11b

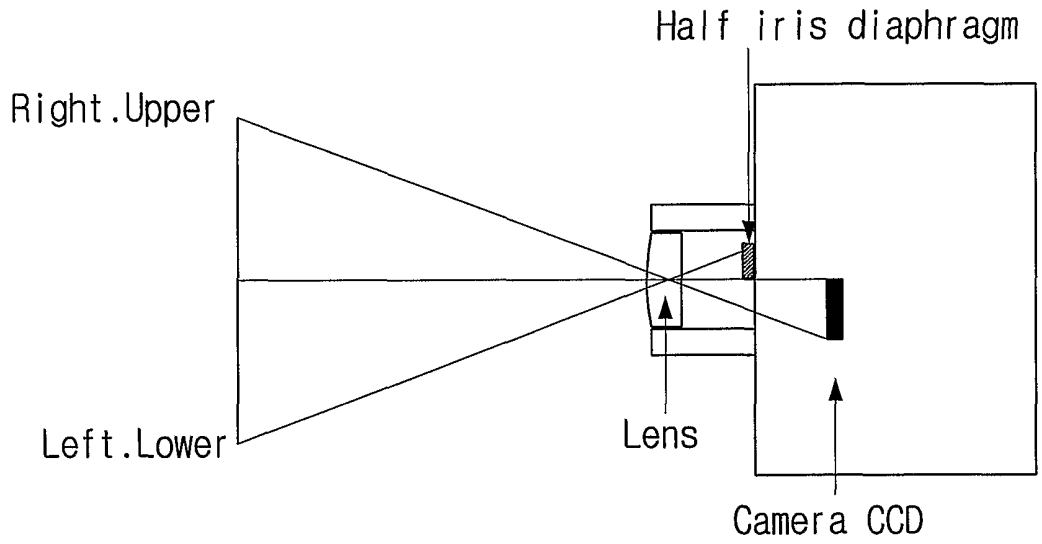


FIG.11c

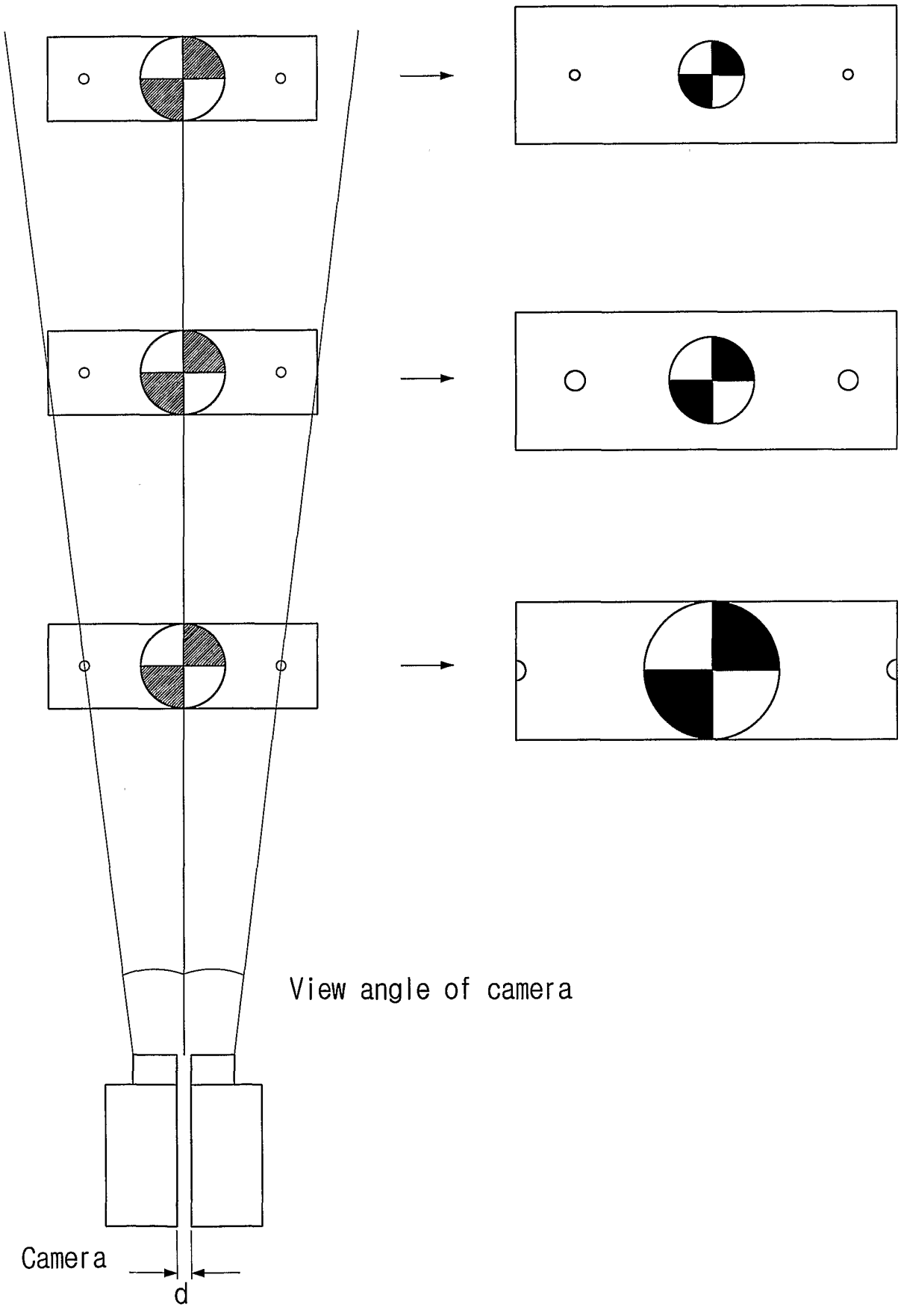


FIG.12a

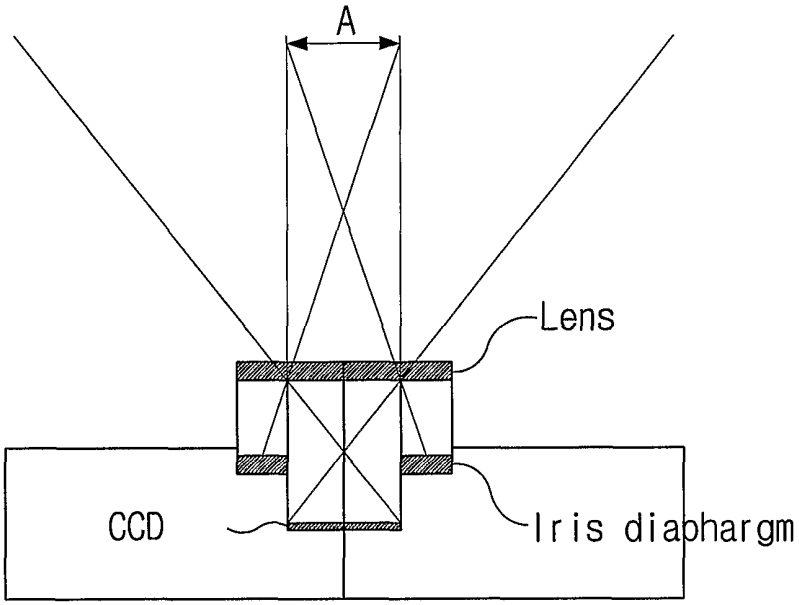


FIG.12b

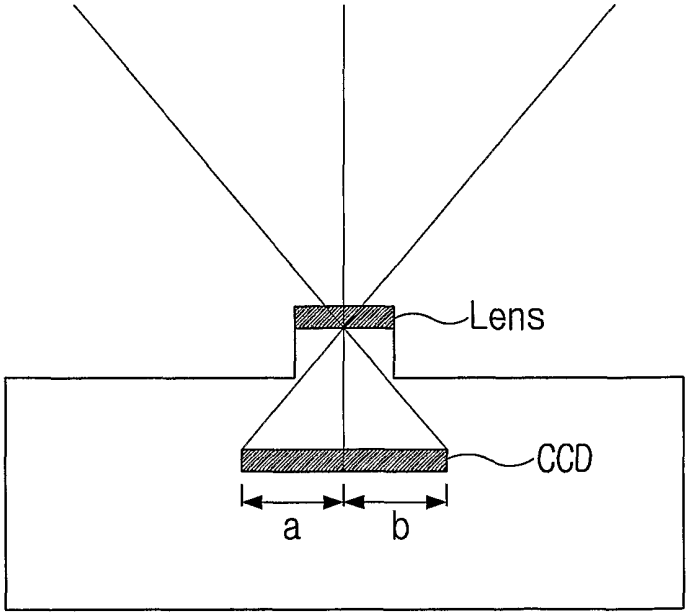
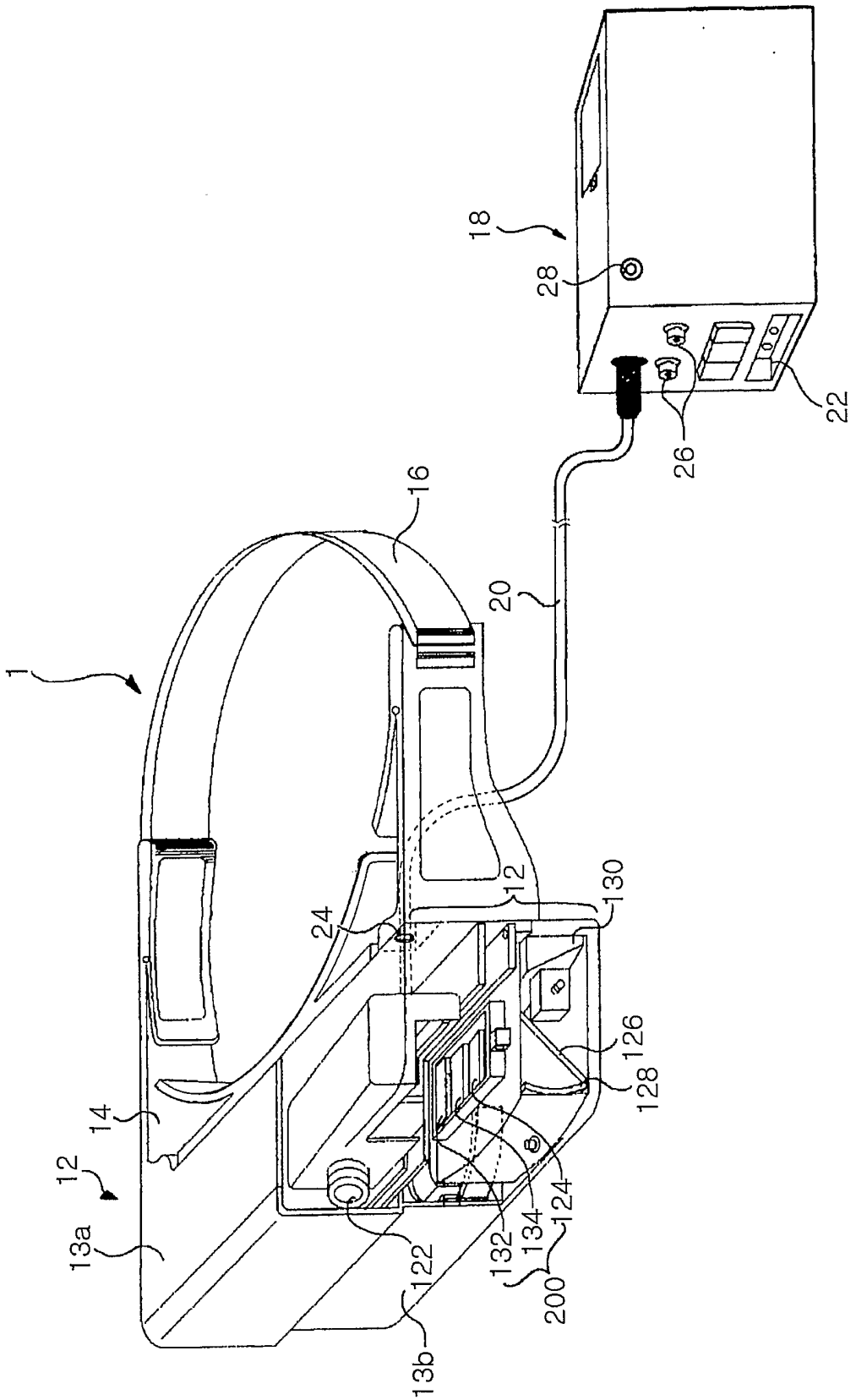


FIG.13


18
28
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14
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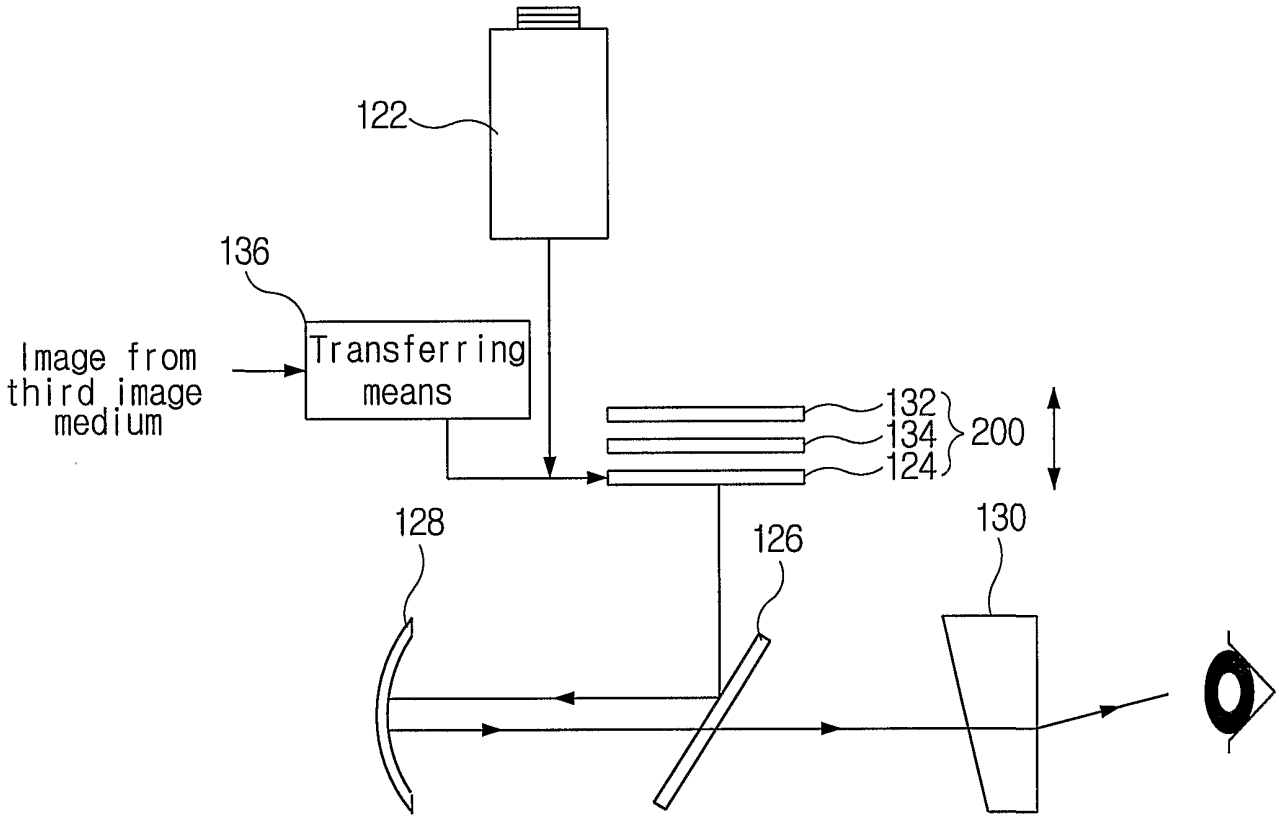
13a
124
132
134
122
200
13b

FIG. 14


122
136
Image from third image medium
Transferring means
132
134
124
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128
126
130

FIG.15a

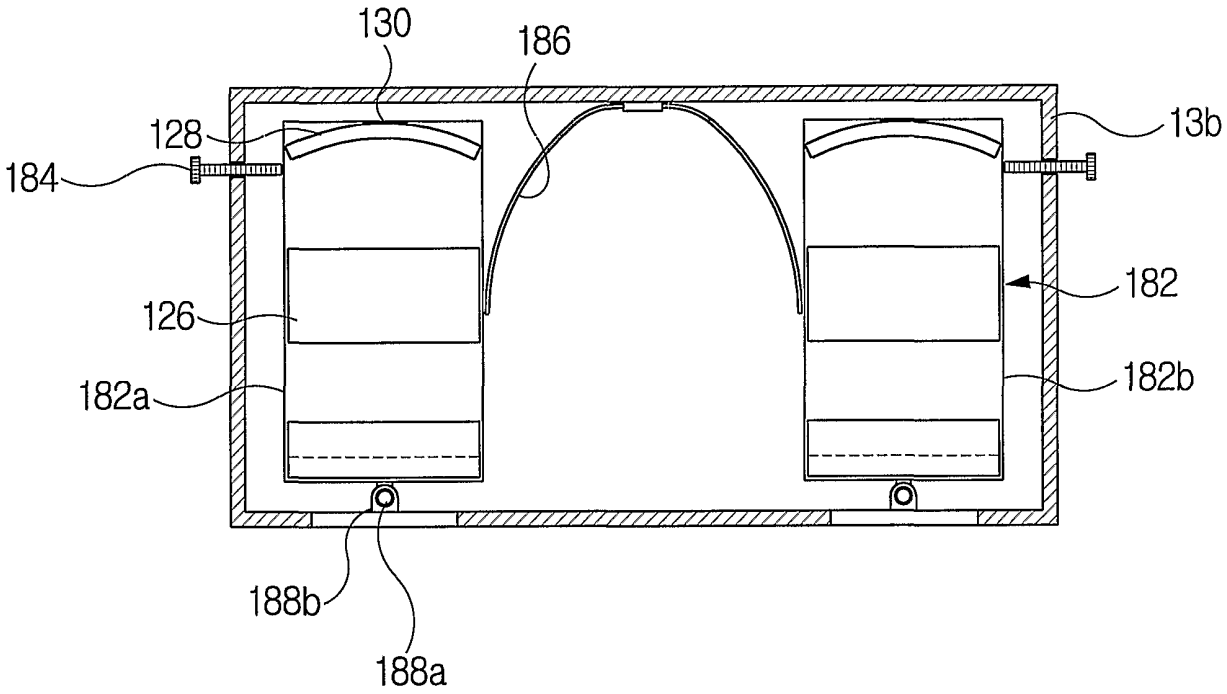

FIG.15b

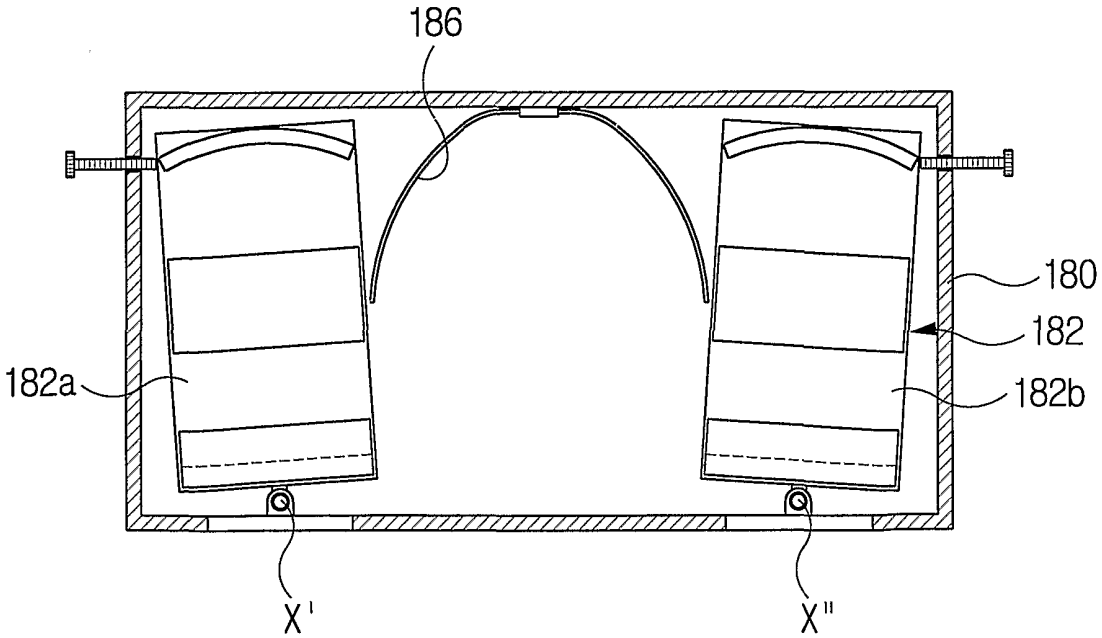

FIG.16

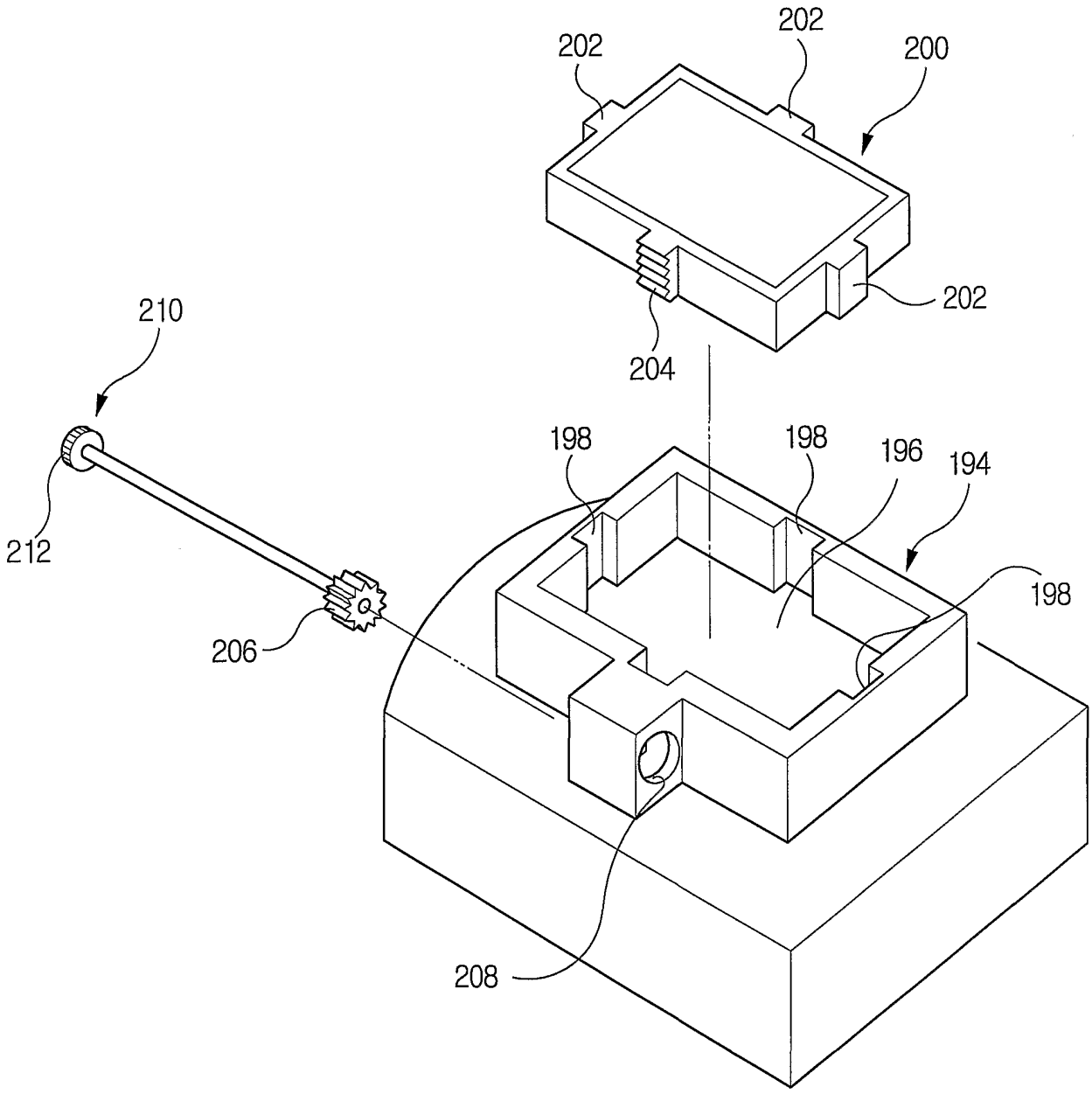

FIG. 17

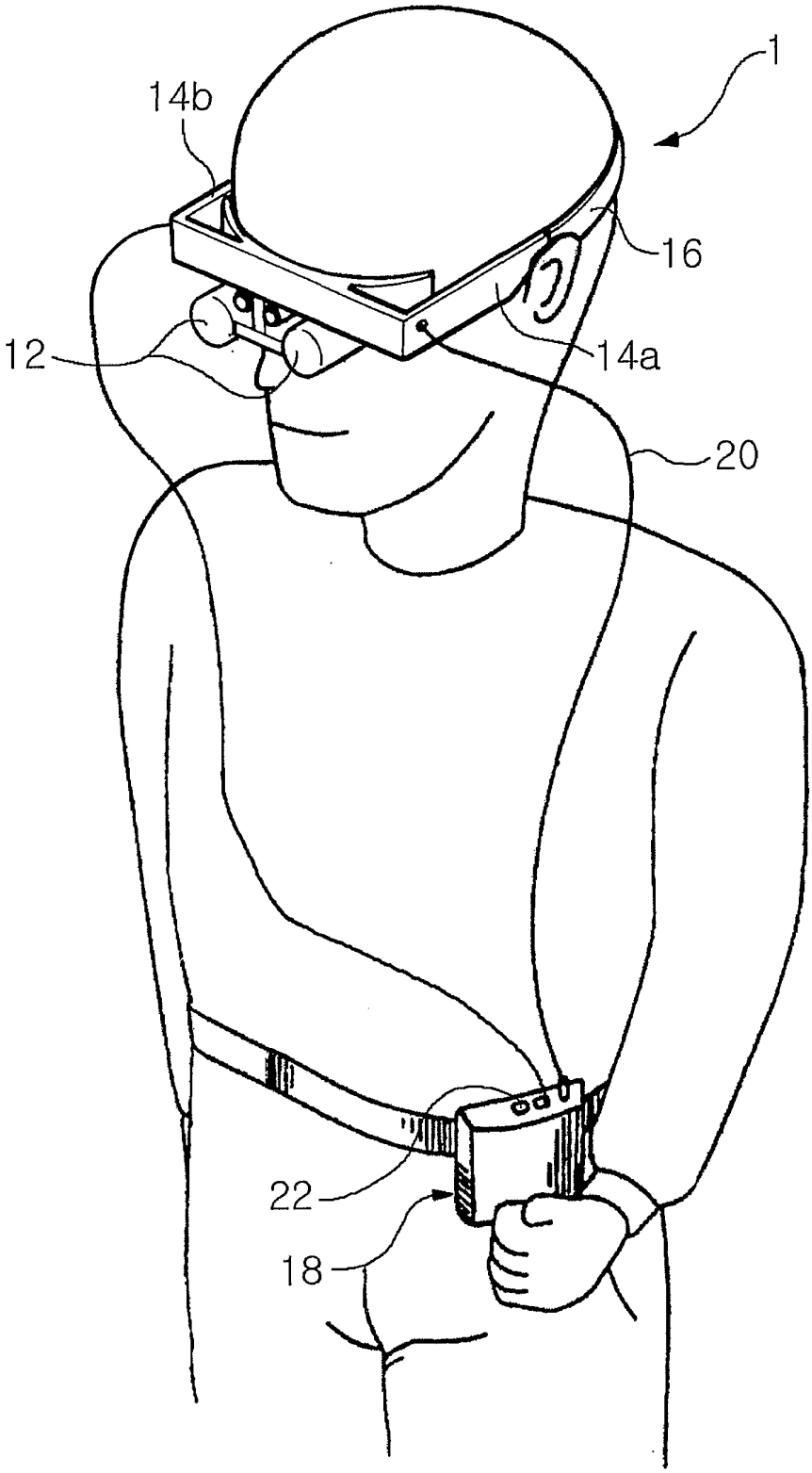

FIG.18

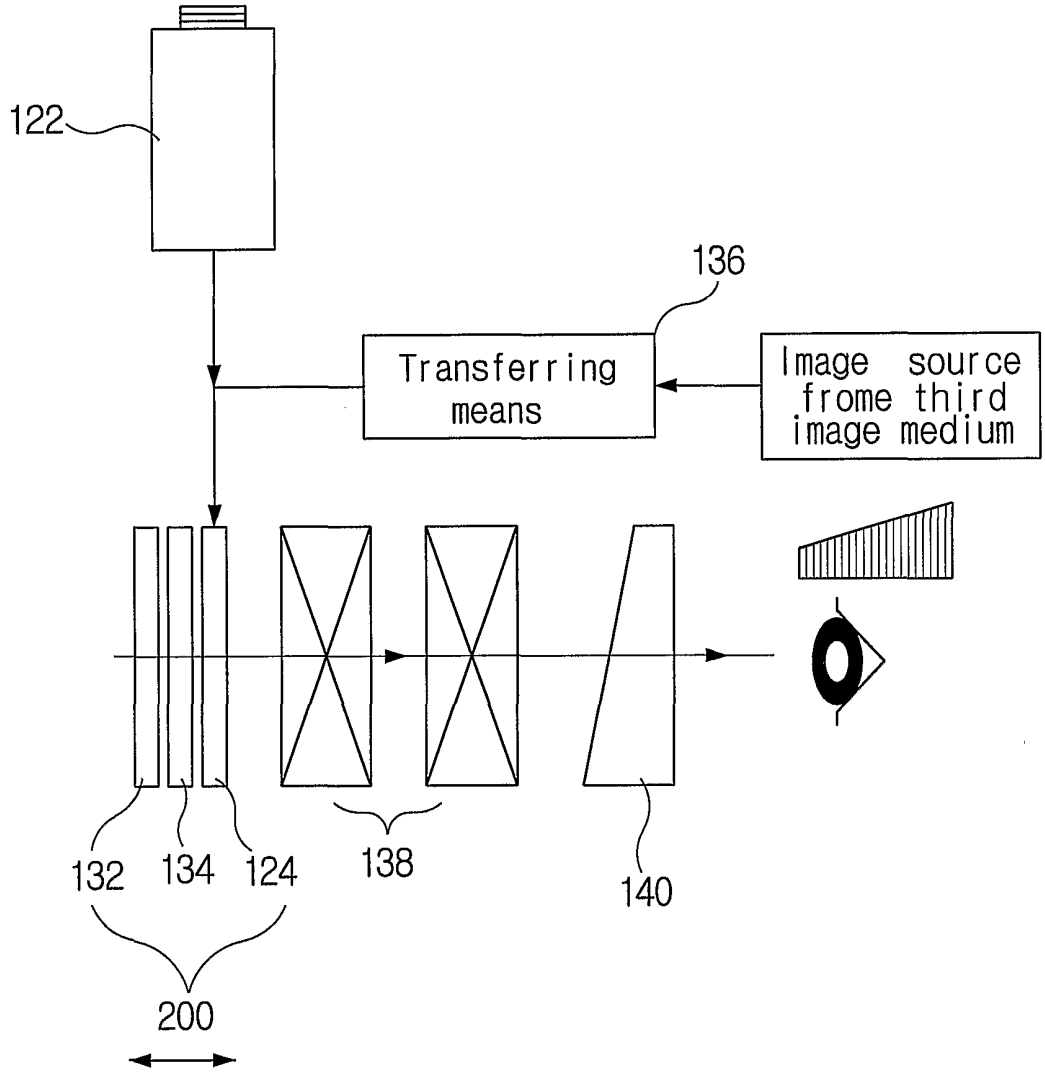
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Image source frome third image medium
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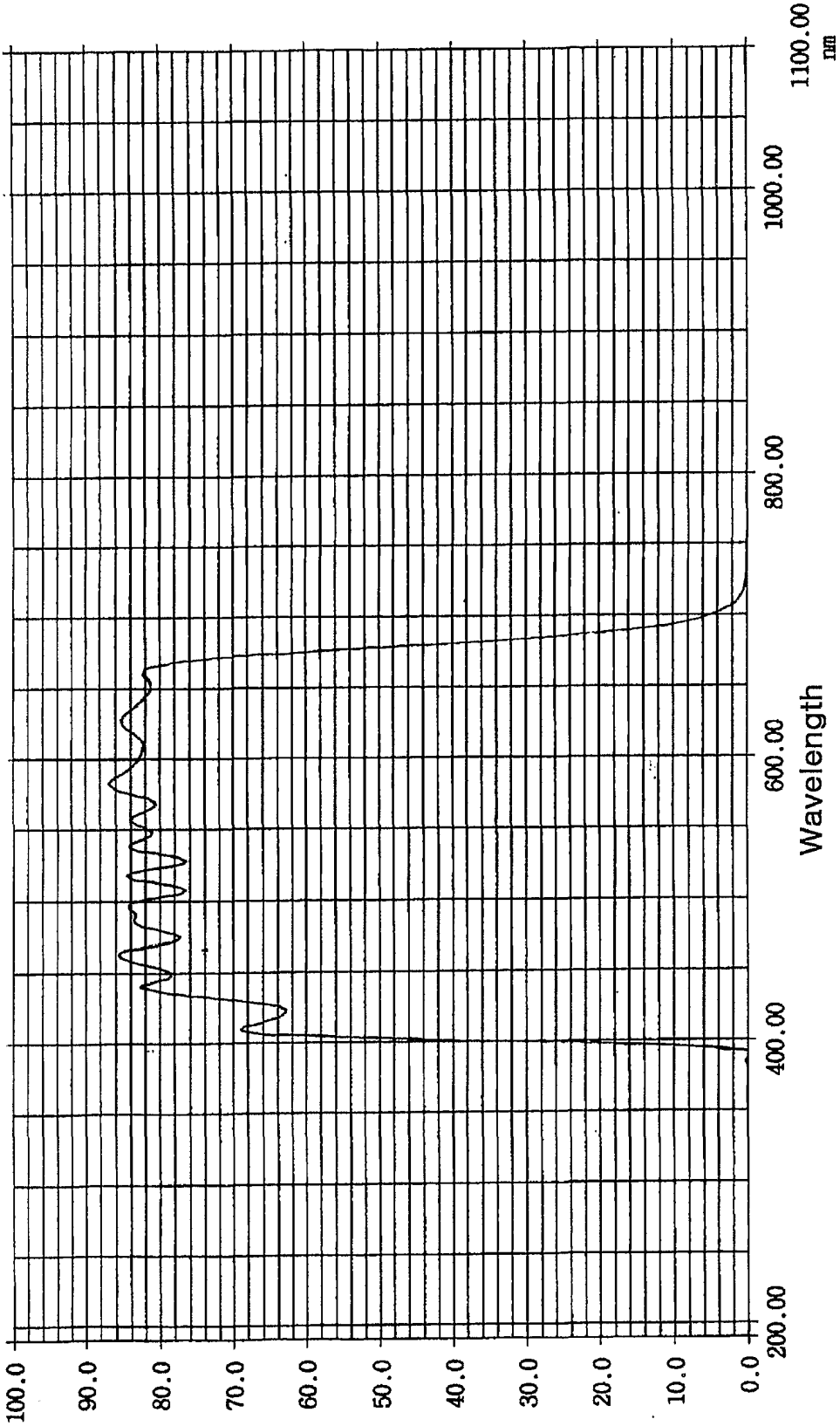
FIG. 19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800.00
1000.00
1100.00
nm
Wavelength

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR01/00032

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G02B 27/01

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

B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)
G02B 27/00, 27/01, 27/02, G02B 19/00, H04N 5/64, 5/74

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched
KR : IPC as above

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search trerms used)
NPS "camera", "display", "visual-aid", "adjustment", "half-mirror"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 8-130695 A (OLYMPUS OPTICAL CO.) 21 MAY 1996	1,3,8,9,13,16,17
Y	US 5777715 A (ALLEN VISION SYSTEMS, INC.) 7 JULY 1998	1,5,6,9,11,14-17
Y	JP 5-48991 A (SONY CORPORATION) 26 FEBRUARY 1993	1,9,15-17
Y	JP 4-23579 A (SONY CORPORATION) 27 JANUARY 1992	1,9,16,17
Y	KR 1998-087669 A (CHO) 5 DECEMBER 1998	1,9,16,17
Y	US 5712649 A (SEGA ENTERPRISES) 27 JANUARY 1998	1,3,8,9,13,16,17
Y	US 6050717 A (SONY CORPORATION) 18 APRIL 2000	1,3,8,9,13,16,17
Y	US 5243450 A (SEXTANT AVIONIQUE) 7 SEPTEMBER 1993	3

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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"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 citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
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"X" document of particular relevence; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 APRIL 2001 (20.04.2001)	20 APRIL 2001 (20.04.2001)

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
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Facsimile No. 82-42-472-7140

Authorized officer
KIM, Hyong Chol
Telephone No. 82-42-481-5653

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR01/00032

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 5777715 A	07.07.1998	WO 9832044 A2 AU 6110798 A1	23.07.98 07.08.98
JP 5-48991 A	26.02.93	None	
JP 4-23579 A	27.01.1992	None	
KR 1998-087669 A	05.12.1998	None	
US 5712649 A	27.01.1998	US 5392158 A JP 6110013 A2 JP 5176260 A2 JP 5130532 A2 EP 539907 A2	21.02.95 22.04.94 13.07.93 25.05.93 05.05.93
US 6050717 A	18.04.00	None	
US 5243450 A	07.09.93	CA 2066993 AA EP 511058 A1 FR 2675911 A1 JP 5157987 A2	26.10.92 28.10.92 30.10.92 25.06.93