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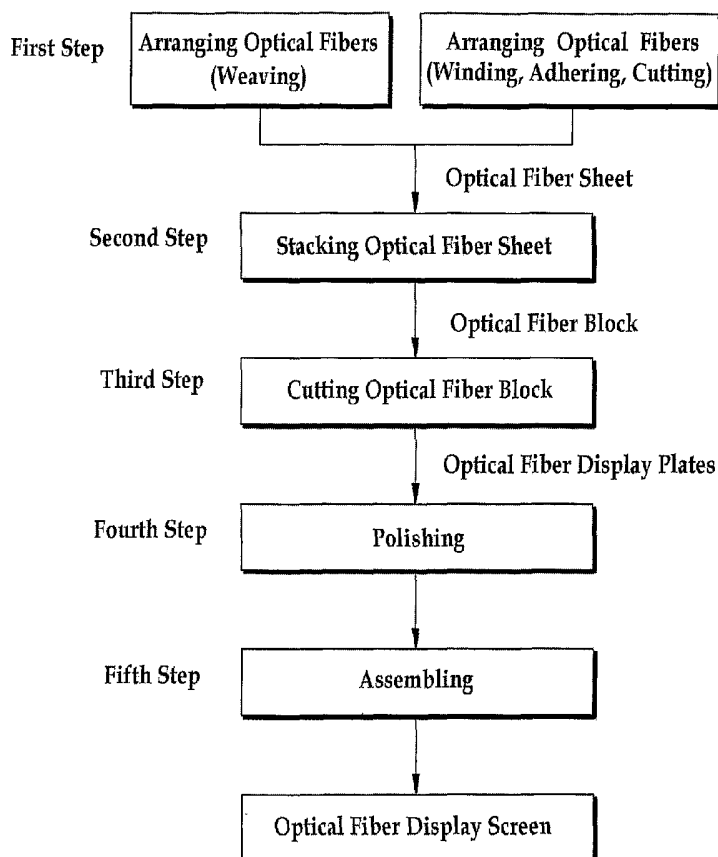
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(54) Title: PLASTIC OPTICAL FIBER DISPLAY SCREEN AND MANUFACTURING METHOD THEREOF



(57) Abstract: Provided are an optical fiber display screen and a method of manufacturing the optical fiber display screen. According to the optical fiber display screen and the method of manufacturing the optical fiber display screen, it is possible to reduce loss of a projected image, obtaining high resolution and brightness of image with low power consumption. The method of manufacturing an optical fiber display screen includes a first step of forming a plurality of optical fiber sheets, each of the optical fiber sheet being formed by arranging optical fibers in a predetermined interval; a second step of forming an optical fiber block by stacking the optical fiber sheets while applying an adhesive between the optical fiber sheets, and cutting the stacked optical fiber sheets; a third step of forming optical fiber display plates by cutting the optical fiber block in a predetermined thickness to expose cross sections of the optical fibers; a fourth step of polishing a cut plane of each of the optical fiber display plates; and a fifth step of forming an optical fiber display screen by attaching the optical fiber display plates side by side with an adhesive.



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PLASTIC OPTICAL FIBER DISPLAY SCREEN AND MANUFACTURING METHOD THEREOF

TECHNICAL FIELD

5 The present invention relates to an optical fiber display screen and a method of manufacturing the optical fiber display screen, and more particularly, to an optical fiber display screen capable of reducing loss of projected image, obtaining high resolution and brightness of image with low power consumption, and a method of manufacturing the optical fiber display screen. The method of manufacturing an optical fiber display screen includes a first step of forming a plurality of optical fiber sheets, each of the optical fiber sheet being formed by arranging optical fibers in a predetermined interval; a second step of forming an optical fiber block by stacking the optical fiber sheets while applying an adhesive between the optical fiber sheets, and cutting the stacked optical fiber sheets; a third step of forming optical fiber display plates by cutting the optical fiber block in a predetermined thickness to expose cross sections of the optical fibers; a fourth step of polishing a cut plane of each of the optical fiber display plates; and a fifth step of forming an optical fiber display screen by attaching the optical fiber display plates side by side with an adhesive.

BACKGROUND ART

20 A display apparatus for visually displaying images or letters on a screen includes a CRT apparatus, an LCD apparatus, a PDP apparatus, an EL display apparatus, an LED display board, a projection type display apparatus, and so on. A large display apparatus such as an indoor/outdoor video AD board and a theater screen has mainly utilized the LED display board or the projection type display

apparatus due to its advantages in cost and power consumption.

The LED display board having over millions of LED lamps individually turning on and off has an advantage of capable of displaying a highly bright and large image. However, the LED display board has disadvantages of high cost, low resolution, and
5 high power consumption.

On the contrary, the projection type display apparatus displaying images by projecting an image from a projector on a screen has advantages of low cost and low power consumption compared to LED display board. The projection type display apparatus is classified into front and rear projection type apparatuses. In the front
10 projection type apparatus, the projector disposed in front of the screen projects an image on the screen, and the screen reflects the projected image. In the rear projection type apparatus, the projector disposed behind the screen projects an image on the screen, and the screen passes the projected image.

In the case of the front projection type apparatus, since the projector is
15 exposed to the outer environment, the image quality may be easily lowered due to the influences by the environment. In addition, loss of image and interference of external light may increase. In particular, since a white screen cloth or coated cloth used for a conventional front projection type screen simply reflects or scatters rays of light projected from the projector, the image quality may be lowered.

20 On the contrary, since the projector of the rear projection type apparatus is disposed at the interior thereof, the image quality may be not easily lowered due to outer environment. In addition, loss of image and interference of external light may not increase. Therefore, it is possible to effectively display the image.

Referring to FIG. 1, a rear projection type apparatus comprises a projector 2
25 and a screen 4. The screen 4 is made of a translucent material such as acryl or

polycarbonate. A plurality of lenticular lenses 6 and Fresnel lenses 5 are provided on front and rear planes of the screen 4, respectively. Rays of light 3 projected from the projector 2 pass through the screen 4 and emit from the lenticular lenses 6 in accordance with a principle of scattering. Since loss of light increases due to the scattering, resolution and brightness of image are lowered. Therefore, the conventional rear projection type apparatus is not suitable for an outdoor display apparatus in a daytime.

An approach to solve the problems of the conventional rear projection type apparatus is disclosed in Korean Utility Model Registered No. 0259941. Referring to FIG. 2, a plurality of optical fibers 10a are inserted into spaces defined by weft and warp yarns 50a and 50b of a screen cloth 50. A transparent or translucent, flexible synthetic resin 52 is applied to fill spaces between the optical fibers and the screen cloth 50. Next, one surface of the screen cloth 50 is coated with a polarization film 53. In this screen, since the synthetic resin 52 is attached to the optical fibers, it is difficult to transfer a high resolution image. In addition, since the optical fibers, as pixels, are not firmly fixed, pixel defects and image distortion occur. Since it is difficult to effectively perform the process for inserting the optical fibers 10a into space defined by the weft and warp yarns 50a and 50b of the screen cloth 50, its cost increases. In addition, since a long-term operation causes a changing of the position of each optical fiber, it is difficult to transfer an accurate image.

Another approach to solve the problems of the conventional rear projection type apparatus is disclosed in Korean Utility Model Registered No. 0305229. Referring to FIG. 3a, a screen comprises a spreading sheet 60, a transmission sheet 61, a light focusing sheet 62, a translucent sheet 63, and black marks 64. The spreading sheet 60 woven with warp and weft yarns in the structure shown in FIG. 3b

has a function of spreading rays of light projected from a projector in the warp and weft directions. The transparent sheet 61 made of a transparent thermoplastic resin is provided to fill spaces between the warp and weft yarns and cover both sides of the spreading sheet 60. The light receiving sheet 62 is stacked on one surface of the transparent sheet 61, to receive the light projected from the projector. The translucent sheet 63 stacked on the other surface of the transparent sheet 61 spreads light transmitted or spread over the screen to form an image. The black marks 64 prevent scattered reflection from the screen to the audiences and increase the contrast ratio of the images. The screen described above has higher brightness, wider viewing angle, and higher contrast ratio than the screen made of conventional polycarbonate and acryl resin. However, the screen does not efficiently utilize the specific characteristics of an optical fiber passing rays of light, but it utilizes only the transparency of the optical fiber. In addition, since yarns and translucent sheet 63 are used, the image is scattered, so that resolution of image is lowered. Moreover, it is not suitable for an outdoor display apparatus in a daytime due to its low brightness.

SUMMARY OF THE INVENTION

In order to solve problems of a conventional rear projection type screen, an object of the present invention is to provide an optical fiber display screen capable of implementing an image having high resolution and brightness with low power consumption by efficiently transferring an image projected from various types of optical imaging apparatuses and a method of manufacturing the optical fiber display screen.

According to an aspect of the present invention, there is provided a method of

manufacturing an optical fiber display screen, the method comprising: a first step of forming a plurality of optical fiber sheets, each of the optical fiber sheet being formed by arranging optical fibers in a predetermined interval; a second step of forming an optical fiber block by stacking the optical fiber sheets while applying an adhesive
5 between the optical fiber sheets, and cutting the stacked optical fiber sheets; a third step of forming optical fiber display plates by cutting the optical fiber block in a predetermined thickness to expose cross sections of the optical fibers; a fourth step of polishing a cut plane of each of the optical fiber display plates; and a fifth step of forming an optical fiber display screen by attaching the optical fiber display plates
10 side by side with an adhesive.

According to another aspect of the present invention, there is provided method of manufacturing an optical fiber display screen, the method comprising: an integrated step (an integrated step of the first and the second step described above) of forming an optical fiber block by winding a plurality of optical fibers around a
15 rotating reel while applying an adhesive to the optical fibers; a third step of forming optical fiber display plates by cutting the optical fiber block in a predetermined thickness to expose cross sections of the optical fibers; a fourth step of polishing a cut plane of each of the optical fiber display plates; and a fifth step of forming an optical fiber display screen by attaching the optical fiber display plates side by side
20 with an adhesive.

According to still another aspect of the present invention, there is provided an optical fiber display screen having a plurality of optical fiber display plates of which are fixed side by side in horizontal and vertical directions, wherein each of the optical fiber display plates comprises: a plurality of optical fibers, wherein both ends of each
25 of the optical fibers are exposed to front and rear surfaces of each of the optical fiber

display plates, wherein the plurality of optical fibers are stacked and arranged; and an adhesive filled in spaces between the plurality of the optical fibers, wherein the adhesive and the plurality of the optical fibers comprise the front and rear surfaces of the optical fiber display plates, wherein the adhesive fixes and supports the plurality
5 of the optical fibers.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with
10 reference to the attached drawings in which:

FIG. 1 is a view of a conventional display screen;

FIG. 2 is a view of another conventional display screen;

FIG. 3a and FIG. 3b are a cross sectional view and a plan view of still another conventional display screen;

15 FIG. 4 is a block diagram of a method of manufacturing an optical fiber display screen according to an embodiment of the present invention;

FIG. 5a is a perspective view illustrating a woven sheet of optical fibers according to the present invention;

FIG. 5b is a cross sectional view illustrating a single-core optical fiber and a
20 multiple-core optical fiber;

FIG. 6 is a view illustrating a winding process of optical fiber;

FIG. 7a is view illustrating a process applying adhesive and a winding process of optical fiber sheets;

FIG. 7b is a perspective view illustrating examples of a rotating reel used in
25 the present invention;

FIG. 7c is a perspective view illustrating a cutting process with respect to a stacked optical fiber sheet according to the present invention;

FIG. 8a is a perspective view illustrating a cutting process with respect to an optical fiber block according to the present invention;

5 FIG. 8b is an enlarged view of a cut plane of FIG. 8a;

FIG. 8c is a perspective view illustrating examples of optical fiber display plates according to the present invention;

FIG. 9 is a perspective view of a polishing process according to the present invention;

10 FIG. 10a is a perspective view of an optical fiber display screen according an embodiment to the present invention;

FIG. 10b is a perspective view of an optical fiber display screen according another embodiment to the present invention;

15 FIG. 10c is a perspective view of an optical fiber display screen according still another embodiment to the present invention;

FIG. 11 is a view illustrating an operation of an optical fiber display screen according to an embodiment of the present invention;

FIG. 12 is a view illustrating a method of manufacturing an optical fiber block according to another embodiment of the present invention;

20 FIG. 13 is a view illustrating a method of manufacturing an optical fiber block according to still another embodiment of the present invention;

FIG. 14 is a block diagram of a method of manufacturing an optical fiber display screen according to another embodiment of the present invention; and

FIG. 15 is a perspective view illustrating an integrated step in FIG. 14.

BEST MODE FOR CARRYING OUT THE INVENTION

Now, the preferred embodiments according to the present invention will be described in details with reference to the accompanying drawings.

[First Embodiment]

5 FIG. 4 is a block diagram of a method of manufacturing an optical fiber display screen according to an embodiment of the present invention. The method comprises: a first step of forming a plurality of optical fiber sheets, each of the optical fiber sheet being formed by arranging optical fibers in a predetermined interval; a second step of forming an optical fiber block by stacking the optical fiber sheets while
10 applying an adhesive between the optical fiber sheets, and cutting the stacked optical fiber sheets; a third step of forming optical fiber display plates by cutting the optical fiber block in a predetermined thickness to expose cross sections of the optical fibers; a fourth step of polishing a cut plane of each of the optical fiber display plates; and a fifth step of forming an optical fiber display screen by attaching the optical fiber
15 display plates side by side with an adhesive.

 The first step of forming the optical fiber sheet can utilize one of two processes. In the one process, the optical fiber sheet is formed by weaving with the optical fiber. In the other process, the optical fiber sheet is formed by winding the optical fibers while applying an adhesive to the optical fibers and cutting the wound
20 optical fibers. The optical fiber sheet formed by any of the two processes has more uniform arrangement of optical fibers than that formed by other processes. In particular, it is advantageous that productivity and durability of the sheet increase in production of a large sheet.

 Firstly, the process for forming the optical fiber sheet by weaving will be
25 described. Referring to FIG. 5a, the optical fiber sheet 200 is densely woven in a

plain structure with a typical loom using optical fibers 100a as warp yarns (or weft yarns) and chemical fibers or cotton yarns 100b as weft yarns (or warp yarns). The chemical fibers or cotton yarns 100b function as a supporter for supporting and fixing the optical fibers 100a to their correct positions. The diameter of the optical fiber 100a is in a range of 0.05 to 1.00 mm. The fineness of the chemical fiber 100b is in a range of 20 to 10,000 deniers. The fineness of the cotton yarn 100b is in a range of 1 to 225 UK cotton numbers. Here, one denier is defined as the thickness of a fiber that has a mass of one gram per 9000 meters. One UK cotton number is defined as a length of 840 yards per a mass of one pound. If the optical fiber 100a has a diameter below 0.05 mm, it is too thin and its workability is too bad. And each optical fiber plays a role as a pixel in the final product, the optical fiber display screen, if the optical fiber 100a has a diameter above 1.00 mm, the pixel made of one optical fiber 100a is too large to implement a high resolution image. In order to accommodate a maximum number of optical fibers 100a, the weaving density of optical fibers 100a is in a range of 25 to 70 % of a unit length of the optical fiber sheet filled with optical fibers. The diameter and weaving density of the chemical fibers or cotton yarns 100b are determined based on those of the weaving density of optical fibers. For example, if the diameter of the optical fiber used as the weft yarn is 0.01 mm, 25 to 70 weft yarns per one centimeter are interlaced. In addition, if the diameter of the optical fiber used as the weft yarn is 0.25 mm, 10 to 28 weft yarns per one centimeter are interlaced. At this time, 2 to 5 warp/weft yarns can be woven together in a modified plain structure.

The optical fiber 100a comprises a core portion 101 made of polymethyl methacrylate (PMMA) and a clad portion 102 made of fluorinated polymer (F-polymer). If the core portion 101 comprises a single core, the optical fiber 100a is

referred to as a single core optical fiber shown in the left side of FIG. 5b. If the core portion 101 comprises a plurality of cores, the optical fiber 100a is referred to as a multi-core optical fiber shown in the right side of FIG. 5b. The clad portion 102 functions as a matrix surrounding the core(s).

5 The chemical fiber 100b is one selected from nylon, polyethylene terephthalate, polypropylene, and polyethylene yarns.

 The preferred loom is a Repier Jacquard type loom. Since the tensile strength and elongation of the optical fiber is lower than general fibers, the optical fiber 100a used as the weft yarn may be cut at the carrier portion of the loom.

10 Therefore, in case of the optical fiber 100a used as the weft yarn, the weaving speed of the loom is preferably in a range of 50 to 300 rpm, and more preferably, in a range of 100 to 200 rpm. If the weaving speed is below 50 rpm, productivity of the process for manufacturing the optical fiber sheet 200 is too low. If the weaving speed is above 300 rpm, the optical fiber 100a used as the weft yarn may be cut at the carrier

15 portion of the loom due to the pressure derived at the carrier. On the other hand, in case of the optical fiber 100a used as the warp yarn, the weaving speed of the loom is preferably in a range of 50 to 300 rpm, and more preferably, in a range of 100 to 200 rpm. If the weaving speed is below 50 rpm, productivity of the process for manufacturing the optical fiber sheet 200 is too low. If the weaving speed is above

20 300 rpm, the optical fiber 100a used as the warp yarn may be cut due to its low tensile strength and elongation as well as stress derived from interlaced weft chemical or cotton yarns and abrasion derived from a beat-up operation.

 Next, the process for forming the optical fiber sheet 200 by winding of optical fibers while applying an adhesive to the optical fibers and cutting the wound optical

25 fibers, adhering, and cutting processes will be described. Referring to FIG. 6, the

optical fiber sheet 200 is formed by winding the optical fibers 100a. The diameter of the optical fiber 100a is in a range of 0.05 to 1.00 mm. If the optical fiber 100a has a diameter below 0.05 mm, it is too thin and its workability is too bad. If the optical fiber 100a has a diameter above 1.00 mm, the pixel made of one optical fiber 100a is too large to implement a high resolution image.

More specifically, an end of the optical fiber 100a is fixed at one end of a winding roller 110. Next, while the winding roller rotates, the optical fiber 100a slowly reciprocates between the one and other ends of the winding roller 110. At the completion of the winding process, 1 to 20 optical fiber layers are stacked around the winding roller 110 and the other end of the optical fiber 100a is fixed at the other end of the winding roller 110. The winding speed is in a range of 1 to 20 m/s, so that a tension of the optical fiber 100a is maintained constant during the winding process. The wound optical fibers are arranged in contact with each other in parallel in the same layer. If the winding speed is below 1 m/s, workability of the process for manufacturing the optical fiber sheet 200 is too low. If the winding speed is above 20 m/s, the optical fiber 100a may be cut due to its high tension derived from the high winding speed. In order to effectively manufacture the optical fiber sheet 200, the 1 to 20 optical fiber layers are stacked. If the number of the optical fiber layers is above 20, it is difficult to maintain internally stacked structure of the optical fiber sheet 200.

The optical fibers 100a wound around the winding roller 110 resist external impact in the circumferential direction of the winding roller 110. However, the optical fibers 100a wound around the winding roller 110 cannot resist external impact in the longitudinal direction of the winding roller 110. Therefore, an adhesive 130 is applied between the optical fibers 100a in order to increase the longitudinal strength

of the optical fiber sheet 200. The adhesive 130 is an improved epoxy adhesive. When the winding roller 110 rotates, the optical fiber 100a pass through an adhesive applicator 120 which reciprocates between the one and other ends of the winding roller 110. As a result, optical fiber 100a applied with the adhesive 130 is wound around the winding roller 110. When cured, the epoxy adhesive generates curing heat, so that temperature of adhesive-applied position increases. If the temperature due to the curing heat is above 85°, the optical fiber may be damaged. In addition, if the curing time of the adhesive is longer than 24 hours, the productivity is too low. Therefore, the preferred adhesive must have much lower curing temperature and shorter curing time than a general epoxy adhesive. In addition, the preferred adhesive must stably retain its shape after cured. Namely as the curing temperature is lower and the curing time is shorter, the condition for the adhering operation is better. An example of the preferred adhesive is an epoxy AF (a tentative name), a mixture of bisphenol-A-type epoxy and diaminodiphenylmethan (a curing agent). The epoxy AF satisfies the aforementioned condition. The chemical equivalent ratio of the epoxy and the curing agent is 1:1. In addition, carbon components may be added to the epoxy AF, so that the epoxy AF applied to a portion excluding the optical fibers in the optical fiber display screen can function as a black mark.

The curing time and temperature of the epoxy AF is measured in comparison with the general adhesive. The measured epoxy AF is a mixture of bisphenol-A-type epoxy and diaminodiphenylmethan (a curing agent) with the chemical equivalent ratio of the epoxy and the curing agent being 1:1. The carbon is added to the epoxy AF in order to function as a black mark. The compared general adhesive is a mixture of bisphenol-F-type epoxy and amine (a curing agent) with the chemical equivalent ratio of the epoxy and the curing agent being 1:1.

The result of the comparison is indicated in the following Table 1.

[Table 1]

	20 min	60 min	120 min	150 min	180 min
General Adhesive	35 °C	140 °C	cured		
Epoxy AF	35 °C	35 °C	50 °C	56 °C	cured

As shown in Table 1, since the curing temperature of the general adhesive increases up to 140 °C, the general adhesive is not suitable to be used together with
 5 an optical fiber having a glass transition temperature of 110 °C. On the contrary, since the curing temperature of the epoxy AF increases only up to 56 °C, it is suitable for the optical fibers 100a.

In addition, a plurality of support sheets 140 may be applied to the wound optical fibers, so that the plurality of support sheets can be interposed between
 10 optical fiber layers in order to prevent the optical fiber layers from being sliding in the longitudinal direction of the winding roller 110.

The support sheet 140 is woven in a plain structure with chemical fibers 100b having fineness of 20 to 10000 deniers or cotton yarns 100b having fineness of 1 to 255 UK cotton numbers as warp and weft yarns. The chemical fiber 100b is one
 15 selected from nylon, polyethylene terephthalate, polypropylene, and polyethylene yarns.

Next, the optical fiber layers 100a winding around the winding roller 110 is cut in the longitudinal direction thereof with a diamond cutter 150. The cut optical fiber layers 100a are unrolled, thereby obtaining the planer optical fiber sheet 200.

20 The second step is a step of forming an optical fiber block 300 by performing

winding, adhering, and cutting processes on the optical fiber sheet 200 obtained in the first step. The second step may be formed in two manners.

The first manner of the second step is illustrated in FIG. 7a. The optical fiber sheet 200 manufactured by using any of two processes described in the first step is wound around a winding roller 210. The optical fiber sheet 200 wound around the winding roller 210 is unwound and transferred through an adhesive container into a rotating reel 220. In the adhesive container, an adhesive 130 is continuously applied to the optical fiber sheet 200. The adhesive-applied optical fiber sheet 200 is wound around the rotating reel 220, so that stacked optical fiber layers of the wound optical fiber sheet 200 can be obtained. As a result, the adhesive 130 is interposed between the stacked optical layers of the wound optical fiber sheet 200. The enhanced epoxy AF is used as the adhesive for the same reason as the first step. In addition, if tension on the optical fiber sheet 200 during the winding process is adjusted, the optical fiber sheet 200 can be uniformly and densely wound. The rotating reel 220 may have various shapes. As shown in FIG. 7b, the rotating reel 220 includes a planer rotating reel 220a, a triangular rotating reel 220b, a crossed rotating reel 220c, and a rotating reel having any other various shapes. Depending on the types of the rotating reel, the different number of optical fiber blocks is obtained from one rotating reel during the later-described cutting process. As shown in FIG. 7a and 7b, if the winding and adhering processes are successively performed on the optical fiber sheet 200, it is possible to obtain a highly dense optical fiber block having uniform array of optical fibers. In addition, it is possible to increase productivity and efficiency of optical fiber blocks by successively performing the processes.

Next, as shown in FIG. 7c, the cutting process using a diamond cutter 310 is

performed on the optical fiber sheets 200 wound and stacked around the rotating reel 220. In the case of using a crossed rotating reel 220c, four optical fiber blocks 300 can be cut out from the wound and stacked optical fiber sheets on the four sides of the rotating reel.

5 In the second manner of the second step, the first and the second steps can be performed successively without interruption. More specifically, the optical fiber sheet 200 formed by weaving the optical fibers at the first step is not wound around a roller 210 but directly wound the rotating reel 220.

The third step is a step of forming optical fiber display plates 400 by cutting
10 the optical fiber block 300 in a wet cutting process using a diamond cutter 310, as shown in FIG. 8a. As shown in FIG. 8b, the optical display plate 400 has a plurality of optical fiber ends at the cut plane. The thickness of the optical display plate 400 is determined to be in a range of 5 to 50 mm in accordance with the dimension of the optical fiber display screen, a final product. If the thickness of the optical fiber
15 display plate 400 is below 5 mm, the optical fiber display screen is easy to be fragile. If the thickness of the optical fiber display plate 400 is above 50 mm, the route of the projected lights in an optical fiber is so long that loss of light and cost may increase.

In FIG. 8a, the cross section of the optical fiber display plate 400 which shows the plurality of cross sections of optical fibers is a rectangular or square shape.
20 However, the optical fiber display plate 400 can be various shapes of plate by shaping its edges as illustrated in FIG. 8c. For example, the optical fiber display plate further includes lozenge, trapezoid, parallelogram, triangle, pentagon, hexagon, heptagon, octagon, etc.

In addition, if the cross section of the optical fiber block 300 or the optical fiber
25 display plate 400 has a shape of rectangular with its aspect ratio of 4:3 or 16:9, the

generally used display screen size having its aspect ratio of 4:3 or 16:9 can be easily implemented.

The fourth step is a step of polishing a surface of the optical fiber display plate 400 with a wet polishing process. As shown in FIG. 9, the optical fiber display plate 400 is fixed on a plane board 420 by means of vacuum pressure. A diamond polisher 410 polishes the surface of the optical fiber display plate 400 which exposes the cross sections of the optical fibers.

In addition, as shown in the lowest figure of FIG. 9, intaglios are provided on the surface of the optical fiber display plate 400. The intaglios have a function of preventing interference generated by straight rays of light such as sun light. The intaglio has various shapes including circle, rectangular, square, lozenge, trapezoid, parallelogram, triangle, pentagon, hexagon, heptagon, octagon, etc.

The fifth step is a step of forming an optical fiber display screen 500 by attaching a plurality of the optical fiber display plates 400 side by side in horizontal and vertical directions. As shown in FIG. 10a, the optical fiber display screen 500 has a shape of rectangular. In addition, the aforementioned enhanced epoxy AF is used to attach the plurality of the optical fiber display plates.

In order to increase durability of the optical fiber display screen 500, the optical fiber display plates 400 may be inserted into partitions of a screen support frame 430, and then, an adhering process is performed on the screen support frame 430 as shown in FIG. 10b. The screen support frame 430 is made of metal or plastic. Otherwise, as shown in FIG. 10c, for the purpose of maintenance, the optical fiber display plates may be inserted into corresponding plate support frames 440, and then, the adhering process is performed on the plate support frames 440. The plate support frames 440 are made of metal or plastic. Next, the plate support

frames 440 are inserted into the partitions of the screen support frame 430. In this method, each of the optical fiber display plates 400 with the plate support frames 440 is detachable.

Now, an optical fiber display screen manufactured by the aforementioned method according to an embodiment of the present invention will be described. As shown in FIG. 10a, a plurality of optical fiber display plates 400 are arranged to be attached side by side in horizontal and vertical directions with an adhesive. As shown in FIG. 8b, plurality of optical fibers 100a are stacked and arranged in the optical fiber display plates 400. An epoxy adhesive 130, as a matrix, is applied at spaces between the optical fibers 100a. The cured epoxy adhesive has a function of supporting the plurality of optical fibers 100a.

Each of the optical fiber display plates 400 may further comprises support materials having a function of fixing the optical fibers at their predetermined locations. Examples of the support materials include chemical fibers or cotton yarns 100b. As shown in FIG. 13, the support materials are disposed to surround the optical fibers in a zigzag form.

Now, an operation of the optical fiber display screen will be described. As shown in FIG. 11, rays of light 30 projected from a projector 20 enter at the back surface of an optical fiber display screen 10. Due to the difference of the refractive index of the core and clad of the optical fibers, the rays of light incident on the back surface pass through the optical fiber in an internal total reflection manner to emit from the opposite side of the screen so that the images formed on the screen are visible in front of the screen. According to the present invention, loss of the light passing through the optical fibers can be minimized and loss of the light due to scattering can be eliminated. Therefore, the optical fiber display screen according

to the present invention can provide higher resolution and brightness than a conventional back surface projection screen of the rear projection type, made of acryl or polycarbonate, using a plurality of Fresnel lenses and lenticular lenses.

The optical fiber display screen is manufactured by assembling the optical
5 fiber sheets. Each of the optical fiber sheets is formed by arranging the optical fibers in a high density. Each of the optical fiber display plates constituting the optical fiber display screen has a thickness of 5 to 50 mm. The surface of the optical fiber display screen is wet polished in a level of micrometer with a diamond polisher, so that a high resolution image can be obtained. The optical fiber display
10 screen can be manufactured by attaching the adjacent optical fiber display plates side by side in horizontal and vertical directions with adhesive, so that a desired dimension of the optical fiber display screen can be easily obtained.

As shown in FIG. 8b, a high density of the cross sections of the optical fibers is exposed on the surface of the optical fiber display screen. The density of the
15 cross sections of the optical fibers is in a range of 6 to 40,000 pieces/cm², and the density is variable with the diameters of the optical fibers used. Therefore, the optical fiber display screen can have a higher resolution than the conventional LED display boards. The smaller the diameter of the optical fiber is, the higher the density of the cross sections of the optical fibers are. For example, in a case where
20 optical fibers having a diameter of 1.00 mm, the density of the cross sections of the optical fibers is in a range of 6.25 to 100 pieces/cm². In a case where optical fibers having a diameter of 0.25 mm, the density of the cross sections of the optical fibers is in a range of 100 to 1,600 pieces/cm². In a case where optical fibers having a
25 diameter of 0.05 mm, the density of the cross sections of the optical fibers is in a range of 2,500 to 40,000 pieces/cm².

In addition, the optical fibers of the optical fiber display screen are not individually turn on/off rather than the LED lamps of the LED display board. The optical fibers have a function of simply passing the light for an image projected from the projector. Therefore, the optical fiber display screen has an advantage in terms of cost and power consumption in comparison with the conventional LED display board (see later-described Table 2).

[Second Embodiment]

A method of an optical fiber display screen according to the second embodiment of the present invention is the same as that of the first embodiment except for the second step. In one example of the second step of second embodiment, the optical fiber blocks is formed by stacking and pressing a plurality of the optical fiber sheet obtained from the first step of the first embodiment while applying an adhesive to the optical fiber sheets (see FIG 12). In another example of the second step, the optical fiber block is formed by winding the optical fiber sheet in a form of a roll (see FIG. 13). In the description of the second embodiment, the same steps as the first embodiment is omitted and only the differences are described.

Firstly, the step of forming the optical fiber block by stacking and pressing the optical fiber sheets while the adhesive being applied to the optical fiber sheets will be described. As shown in FIG. 12, the plurality of the optical fiber sheets 200 obtained from the first step are stacked. During the stacking thereof, the adhesive is applied between the optical fiber sheets 200. The adhesive is the enhanced epoxy AF described in the first embodiment. The stacked optical fiber sheets are pressed with a press 230 to obtain the optical fiber block 300. The example of the second step can be mainly utilized for a case where a continuous process for mass production is not needed.

Secondly, the step of forming the optical fiber block by winding the optical fiber sheet in a form of a roll will be described. As shown in FIG. 13, the optical fiber sheet 200 obtained from the first step is wound in a form of a roll by using a machine while an adhesive being applied to the optical fiber sheet and tension of the optical fiber sheet being maintained. After that, the roll of the optical fiber sheet is cut in its longitudinal direction as shown in the exploded view of FIG. 13. The adhesive is also the enhanced epoxy AF.

[Third Embodiment]

A method of an optical fiber display screen according to the third embodiment of the present invention comprises an integrated step of the first and second steps of the first embodiment. As shown in FIG. 14, the integrated step is a step of forming an optical fiber block by winding a plurality of optical fibers around a rotating reel while an adhesive being applied to a plurality of optical fibers. In the description of the third embodiment, the same steps as the first embodiment is omitted and only the differences are described.

In the integrated step of the third embodiment, the plurality of optical fibers 100a are simultaneously transferred and wound around the rotating reel 220 as shown in FIG. 15. In the course of the transferring process, the plurality of the optical fibers 100a are coated with the adhesive 130 in a container. The adhesive is also the enhanced epoxy AF similar to the first embodiment. According to the third embodiment using the integrated step, since a separate process for forming an optical fiber sheet(s) is not necessary, it is possible to simplify the overall process.

[Experimental Examples]

Now, experimental examples of the method of manufacturing the optical fiber display screen according to the present invention will be described in comparison

with conventional methods.

[Experimental Example 1]

The first step of Experimental Example 1 is a step of weaving an optical fiber sheet 200 with optical fibers 100a. The weaving process is performed with a Repier
5 Jacquard type loom. A plastic optical fiber 100a having a diameter of 0.25 mm is used as a weft yarn, and a polyethylene terephthalate multi-filament 100b having a diameter of 0.22 mm is used as warp yarn. The weft and warp densities are 24 and 12 yarns per one centimeter, respectively. The weaving speed is 100 rpm. The dimension of the obtained optical fiber sheet is 300 m x 1 m (length x width). The
10 axis of the optical fiber is parallel to the direction of the width.

The second step of Experimental Example 1 is a step of forming an optical fiber block. The optical fiber sheets 200 obtained by the method described in the first step are wound around a roller having a dimension of 180 cm x 18 cm (width x diameter). The optical fiber sheets 200 wound around the winding roller are
15 unwound and are continuously transferred to an adhesive container to be applied with the aforementioned epoxy AF 130 as shown in FIG. 7a. The epoxy-applied optical fiber sheets 200 are wound around a rotating reel 220 as shown in FIG. 7a and are adhered one another. The width of the crossed rotating reel 220 having a shape of a cross is 1 m and the distance between ends of adjacent branches of the
20 cross is 1 m. The optical fiber sheet 200 is wound around the crossed rotating reel 220 at a speed of 5 cm/sec with its tension being maintained constant. The winding process is performed to obtain the wound and stacked optical sheet having a thickness of 2.5 cm. After that, the optical fiber sheets wound around the crossed rotating reel 220 are cured for 24 hours. Next, a cutting process using a cutter 310
25 is performed at two edges of each of four rectangular sides of the crossed rotating

reel 220. The distal end portion of the cutter 310 is coated with diamond. As a result, the optical fiber block 300 having a dimension of 1 m x 1 m x 2.5 cm (length x width x thickness) are obtained as shown in FIG. 7c. The axis of the optical fiber is parallel to the direction of the width.

5 The third step of Experimental Example 1 is a step of forming an optical fiber display plate 400 by cutting the optical fiber block 300 in an interval of 1 cm with a diamond-coated cutter 310 in a direction perpendicular to the optical fiber axis. As a result, the optical fiber display plate has a dimension of 1 m x 1 cm x 2.5 cm (length x width x thickness). The axis of the optical fiber is parallel to the direction of the
10 width.

 The fourth step of Experimental Example 1 is a step of polishing a surface of the optical fiber display plate 400 with a wet polishing process using a diamond polisher to expose the cross sections of the optical fibers are exposed on the polished surface (see FIG. 9). The polished surfaces of the cross sections of the
15 optical fibers are tested by an x300 SEM (scanning electron microscopy). As a result, there are detected no defects. Therefore, it can be understood that the polishing process is fully performed in a level of micrometer.

 The fifth step of Experimental Example 1 is a step of forming an optical fiber display screen 500 by attaching 30 optical fiber display plates 400 side by side in
20 vertical direction with adhering and curing processes.

 As a result, the optical fiber display screen having a dimension of 1 m x 0.75 m (horizontal length x vertical length) is manufactured. The axis of the optical fiber is perpendicular to the direction of the horizontal length and vertical length.

 The adhesive used for the adhering process is the epoxy AF represented in
25 Table 1. The curing process is performed for 24 hours to fix the shape of the optical

fiber display screen 500. The optical fiber display screen 500 is hereinafter referred to as "Optical Fiber Screen A."

Next, resolution, power consumption, brightness, and density of optical fibers of Optical Fiber Screen A are tested while an image is projected on Optical Fiber Screen A. Two rear projection type projectors, Sharp model XG-P25X, are used. Since the optical fiber display screen is capable of realizing the full resolution of the projectors, the resolution of Optical Fiber Screen A remains the resolution of the projectors. Optical Fiber Screen A requires no power consumption, so that the overall power consumption is only the power consumption for operating the projectors. The brightness is tested with a luminance meter of Minolta model CS-100A. The density of optical fibers is measured by observing the surface of Optical Fiber Screen A 10 times with an optical microscope (see Table 2).

[Experimental Example 2]

In Experimental Example 2, an optical fiber display screen 500 having a dimension of 1 m x 0.75 m (horizontal length x vertical length) is manufactured by the same process as that of Experimental Example 1 using a polyethylene terephthalate multi-filament 100b having a diameter of 0.22 mm as weft yarn and a plastic optical fiber 100a having a diameter of 0.25 mm as a warp yarn. The axis of the optical fiber is perpendicular to the direction of the horizontal length and vertical length. The optical fiber display screen 500 is hereinafter referred to as "Optical Fiber Screen B." The optical properties of Optical Fiber Screen B are measured by the same methods as those in Experimental Example 2 (see Table 2)

[Experimental Example 3]

In Experimental Example 3, firstly, a plastic optical fiber 100a having a diameter of 1.00 mm is wound around a cylindrical winding roller 110 having a

dimension of 3 m x 1.1 m (diameter x width). The optical fiber 100a is wound around the cylindrical winding roller 110 at a speed of 3m/sec with its tension being maintained constant. Before wound around the cylindrical winding roller 110, the optical fiber 100a passes through an adhesive applier 120 which reciprocates in a longitudinal direction of the cylindrical winding roller 110, so that the wound optical fibers 100a are adhered one another. The reciprocating speed of the adhesive applier 120 is controlled to a degree that the optical fibers 110a are closely adhered not overlapped to each other in accordance with the winding speed of the cylindrical winding roller 110. The used adhesive 130 is the epoxy AF in the aforementioned experimental examples. As a result, an optical fiber sheet 200 having a dimension of 9.4 m x 1 m (length x width) is made. The axis of the optical fiber is parallel to the direction of the length. The optical fiber display plates are manufactured from the optical fiber sheet by using the same processes as those of Experimental Example 1. In Experimental Example 3, since the width of the crossed rotating reel 220c in FIG. 7b is 1 m and the distance between ends of adjacent branches of the cross is 10 cm, the dimension of the obtained optical fiber block is 10 cm x 1 m x 2.5 cm (length x width x thickness). The axis of the optical fiber is parallel to the direction of the length. The optical fiber block 300 is cut in a interval of 1 cm to obtain optical fiber display plates 400 having a dimension of 1 cm x 1 m x 2.5 cm (length x width x thickness). The axis of the optical fiber is parallel to the direction of the length. The lengths are measured in the axis of the optical fiber. Next, the optical fiber display screen 500 having a dimension of 1 m x 0.75 m (horizontal length x vertical length) is manufactured from the optical fiber block 300 by using the same polishing and assembling processes as those of Experimental Example 1. The axis of the optical fiber is perpendicular to the direction of the horizontal length and vertical

length. The optical fiber display screen 500 is hereinafter referred to as "Optical Fiber Screen C." The optical properties of Optical Fiber Screen C are measured by the same methods as those in Experimental Example 3 (see Table 2)

[Experimental Example 4]

5 In Experimental Example 4, an optical fiber display screen is manufactured by applying the third embodiment of the present invention.

As shown in FIG. 15, a thousand strips of plastic optical fibers 100a having a diameter of 1.00 mm are simultaneously wound around to a rotating reel 220. The width of the crossed rotating reel 220 is 1 m and the distance between
10 ends of adjacent branches of the cross is 1 m. The optical fibers 100a are wound at a winding speed of 5 cm/s with their tensions being maintained constant. The winding process is performed to obtain the wound optical sheet having a thickness of 2.5 cm. The bundle of optical fibers 100a wound around the crossed rotating reel 220 are cured for 24 hours. Next, a cutting process using a cutter 310 is
15 performed at two portions of the optical fiber sheet at two edges of each of four rectangular sides of the crossed rotating reel 220. The distal end portion of the cutter is coated with diamond. As a result, the optical fiber block 300 having a dimension of 1 m x 1 m x 2.5 (length x width x thickness) are obtained as shown in FIG. 7c. The axis of the optical fiber is parallel to the direction of the length. Next,
20 the optical fiber display screen 500 having a dimension of 1 m x 0.75 m (horizontal length x vertical length) is manufactured from the optical fiber block 300 by using the same cutting, polishing and assembling processes as those of Experimental Example 1. The axis of the optical fiber is perpendicular to the direction of the horizontal length and vertical length. The optical fiber display screen 500 is hereinafter
25 referred to as "Optical Fiber Screen D." The optical properties of Optical Fiber

Screen D are measured by the same methods as those in Experimental Example 4 (see Table 2)

[Comparative Examples]

Now, conventional screens of comparative examples will be described

5 [Comparative Example 1]

In Comparative Example 1, optical properties of a conventional rear projection screen, which is made of polycarbonate and commercially provided, are measured with the same methods as those of Experimental Example 1. In the conventional rear projection screen, rays of light projected from the projector are scattered on the
10 screen to form an image rather than the present invention, in which the rays of light pass through the screen without loss of light. Therefore, in the conventional rear projection type screen, it is difficult to represent the resolution of the projector. The used polycarbonate screen has a dimension of 1 m x 0.75 m (horizontal length x vertical length).

15 [Comparative Example 2]

In Comparative Example 2, optical properties of an LED display board are estimated by using information on a commercial RGB type product.

The optical properties of the screens of Experimental Examples 1 to 4 and Comparative Examples 1 and 2 are represented in the following Table 2.

20 [Table 2]

Screen	Resolution	Power Consumption (kW/m ²)	Brightness (cd/m ²)	Density of Optical Fibers (pieces/cm ²)
Optical Fiber	1600 x 1200	0.13	5900 ~ 6100	700 ~ 750

Screen A				
Optical Fiber Screen B	1600 x 1200	0.13	5900 ~ 6100	700 ~ 750
Optical Fiber Screen C	1600 x 1200	0.13	6400 ~ 6600	70 ~ 80
Optical Fiber Screen D	1600 x 1200	0.13	6400 ~ 6600	70 ~ 80
Polycarbonate Screen	-	0.13	800 ~ 900	-
LED Display Board	320 x 240	0.50	6000 ~ 6200	-

As shown in Table 2, the Optical Fiber Screens A, B, C, and D have a higher brightness than the conventional polycarbonate screen. The Optical Fiber Screens A, B, C, and D have a higher resolution and lower power consumption than the LED display board. Therefore, the conventional screens can be replaced by the optical
5 fiber display screen according to the present invention.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the
10 following claims.

According to the present invention, since an optical fiber display screen is lower power consuming and inexpensive, a large imaging medium can be widely provided to general users compared to the conventional rear projection type screen and the LED display board. Since the optical fiber display screen efficiently emit

light projected from a light source projection device such as a projector, it is possible to implement a large image with high brightness and resolution. Therefore, the optical fiber display screen can be adapted for an outdoor video AD board, an AD billboard, a display apparatus for interior design, a formative billboard, a video AD
5 vehicle, etc.

In addition, according to a method of manufacturing an optical fiber display screen of the present invention, since a plurality of optical fibers are efficiently and easily arranged, it is possible to easily manufacture a large optical fiber display screen with high productivity. In addition, since effective methods can be selected in
10 accordance with a diameter of the optical fiber, it is possible to increase process efficiency.

WHAT IS CLAIMED IS:

1. A method of manufacturing an optical fiber display screen, the method comprising:

5 a first step of forming a plurality of optical fiber sheets, each of the optical fiber sheet being formed by arranging optical fibers in a predetermined interval;

a second step of forming an optical fiber block by stacking the optical fiber sheets while applying an adhesive between the optical fiber sheets, and cutting the stacked optical fiber sheets;

10 a third step of forming optical fiber display plates by cutting the optical fiber block in a predetermined thickness to expose cross sections of the optical fibers;

a fourth step of polishing a cut plane of each of the optical fiber display plates; and

a fifth step of forming an optical fiber display screen by attaching the optical fiber display plates side by side with an adhesive.

15 2. The method according to claim 1, wherein the first step is a step of weaving the optical fiber sheet in a plain structure with a loom using the optical fibers as warp yarns (or weft yarns) and chemical fibers or cotton yarns as weft yarns (or warp yarns).

20 3. The method according to claim 2, wherein the weaving density of optical fibers is in a range of 25 to 70% of an unit length of the optical fiber sheet filled with optical fibers.

25 4. The method according to claim 2, wherein the loom is a Repier Jacquard

loom and a weaving speed is in the range of 50 to 300 rpm.

5 5. The method according to claim 1, wherein the first step is a step of forming the optical fiber sheet by winding the optical fibers around a winding roller while applying an adhesive between the optical fibers to obtain the wound optical fiber sheet; cutting the wound optical fiber sheet; and separating the wound optical fiber sheet from the winding roller.

10 6. The method according to claim 5, wherein the first step further comprises a step of interposing support sheet between the layers of the wound optical fibers.

15 7. The method according to claim 1, wherein the second step is a step of forming the optical fiber block by winding the optical fiber sheet around a rotating reel while applying the adhesive to a surface of the optical fiber sheet; and cutting a portion of the wound optical fiber sheet.

20 8. The method according to claim 1, wherein the second step is a step of forming the optical fiber block by stacking and pressing the optical fiber sheets while applying the adhesive between the optical fiber sheets.

9. The method according to claim 1, wherein, the second step is a step of forming the optical fiber block by winding the optical fiber sheet in a shape of a roll while applying the adhesive to the optical fiber sheet.

25 10. A method of manufacturing an optical fiber display screen, the method

comprising:

an integrated step of forming an optical fiber block by winding a plurality of optical fibers around a rotating reel while applying an adhesive to the optical fibers;

a third step of forming optical fiber display plates by cutting the optical fiber block in a predetermined thickness to expose cross sections of the optical fibers;

a fourth step of polishing a cut plane of each of the optical fiber display plates; and

a fifth step of forming an optical fiber display screen by attaching the optical fiber display plates side by side with an adhesive.

10

11. The method according to claim 1 or 10, wherein the third step is a step of obtaining the plurality of the optical fiber display plates by performing a wet cutting process on each of the optical fiber blocks in a thickness of 5 to 50 mm in a direction perpendicular to the axis of the optical fiber with a diamond cutter.

15

12. The method according to claim 11, wherein each of the optical fiber display plates have a shape of a polygon formed with a cutting process.

20

13. The method according to claim 1 or 10, wherein the fourth step is a step of performing a wet polishing process on the cut plane of each of the optical fiber display plates with a diamond polisher.

14. The method according to claim 13, wherein a plurality of intaglios are provided on the surface of each of the optical fiber display plates.

25

15. The method according to claim 1 or 10, wherein the diameter of the optical fiber is in a range of 0.05 to 1.00 mm.

16. The method according to any one of claims 1, 5, 7, to 10, wherein the
5 adhesive is an epoxy adhesive or an epoxy adhesive containing carbon.

17. An optical fiber display screen having a plurality of optical fiber display plates which are fixed side by side in horizontal and vertical directions, wherein each of the optical fiber display plates comprises:

10 a plurality of optical fibers, wherein both ends of each of the optical fibers are exposed to front and rear surfaces of each of the optical fiber display plates, wherein the plurality of optical fibers are stacked; and

an adhesive filled in spaces between the plurality of the optical fibers, wherein the adhesive is exposed to the front and rear surfaces of the each of the optical fiber
15 display plates, wherein the adhesive supports the plurality of the optical fibers.

18. The optical fiber display screen according to claim 17, wherein the diameter of the optical fiber is in a range of 0.05 to 1.00 mm.

20 19. The optical fiber display screen according to claim 17, wherein the surface density of optical fibers on each of the optical fiber display plates is in a range of 6 to 40,000 pieces/cm².

20. The optical fiber display screen according to claim 17, wherein the adhesive
25 contains carbon.

21. The optical fiber display screen according to claim 17,
wherein each of the optical fiber display plates further comprises support
elements for supporting the plurality of the optical fibers, and

5 wherein the adhesive fixes and supports the plurality of the optical fiber and
the support elements.

22. The optical fiber display screen according to claim 17, wherein support sheets
are interposed between the plurality of the optical fiber layers.

10 23. The optical fiber display screen according to claim 17, wherein each of the
optical fiber display plates have a shape of a polygon.

24. The optical fiber display screen according to claim 17, wherein a plurality of
15 intaglios are provided on each of the optical fiber display plates.

25. The optical fiber display screen according to claim 17, wherein sides of the
optical fiber display plates are attached side by side with an adhesive.

20 26. The optical fiber display screen according to claim 17,
wherein the optical fiber display screen further comprise a screen support
frame having a plurality of partitions, and

wherein the optical fiber display plates are inserted into the partitions and
attached thereto with an adhesive.

25

27. The optical fiber display screen according to claim 17, wherein the optical fiber display screen further comprises:

a plurality of plate support frames, each of the plate support frames having a space,

5 a screen support frame having a plurality of partitions; and

wherein each of the optical display plates are inserted and attached into the space of each of the plate support frames with an adhesive,

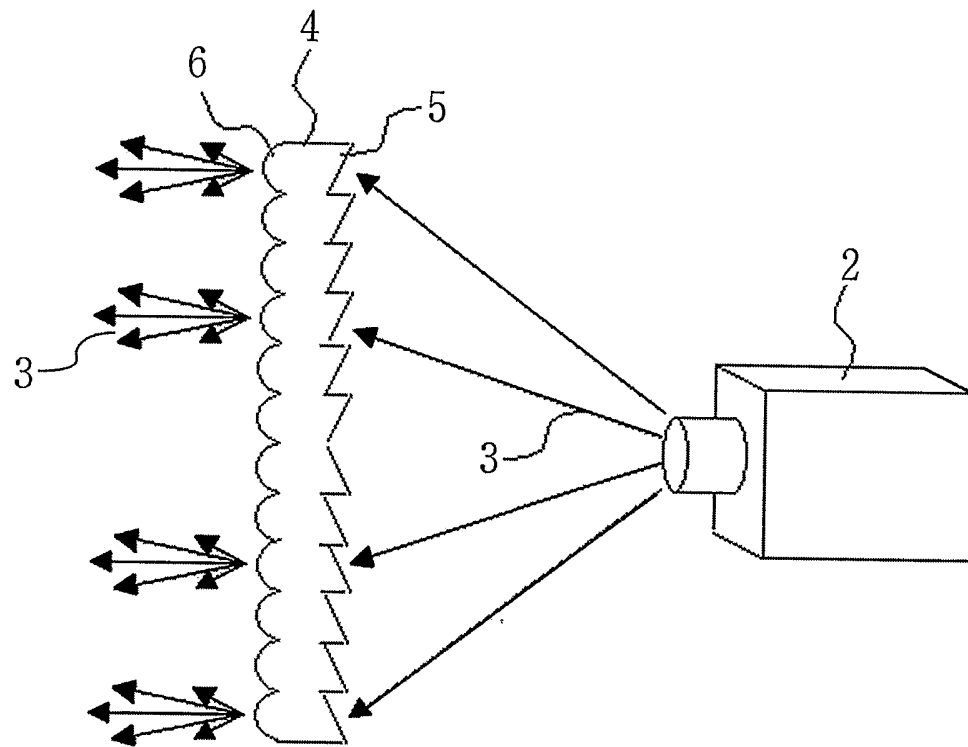
wherein the plate support frames are detachably inserted into the partitions of the screen support frame.

10

28. The optical fiber display screen according to any one of claims 17, 25 to 27, wherein the adhesive contains carbon.

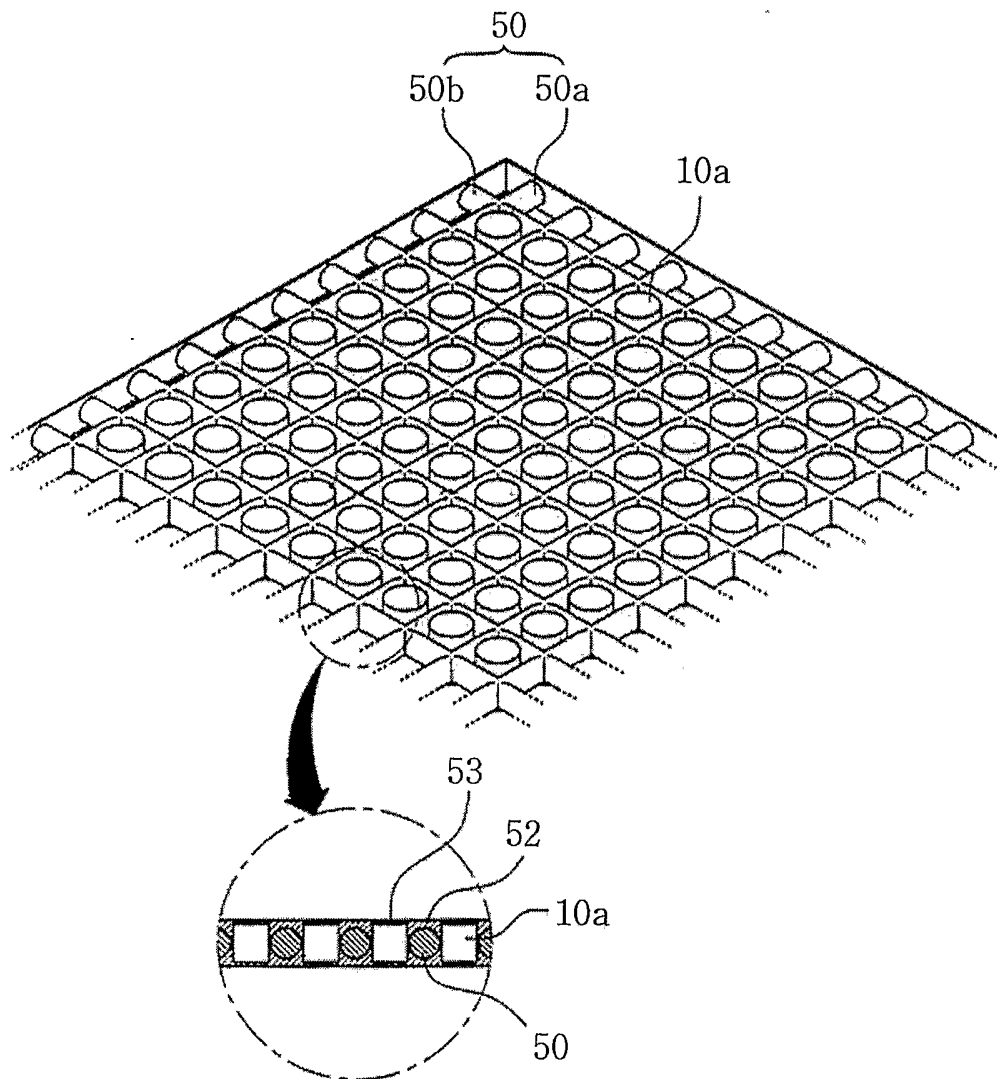
1/19

FIG.1

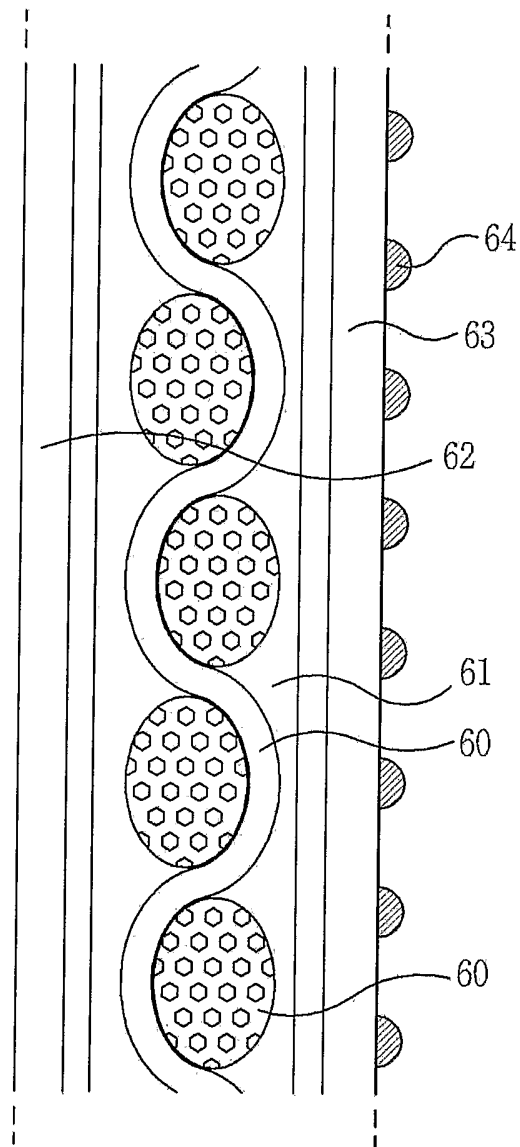


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FIG.2

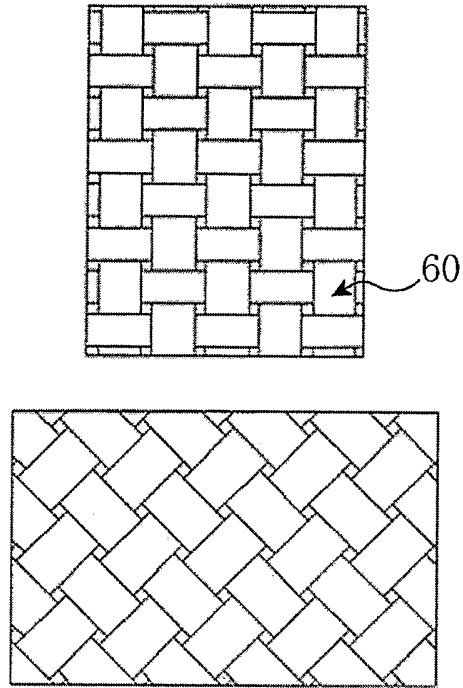


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FIG.3a



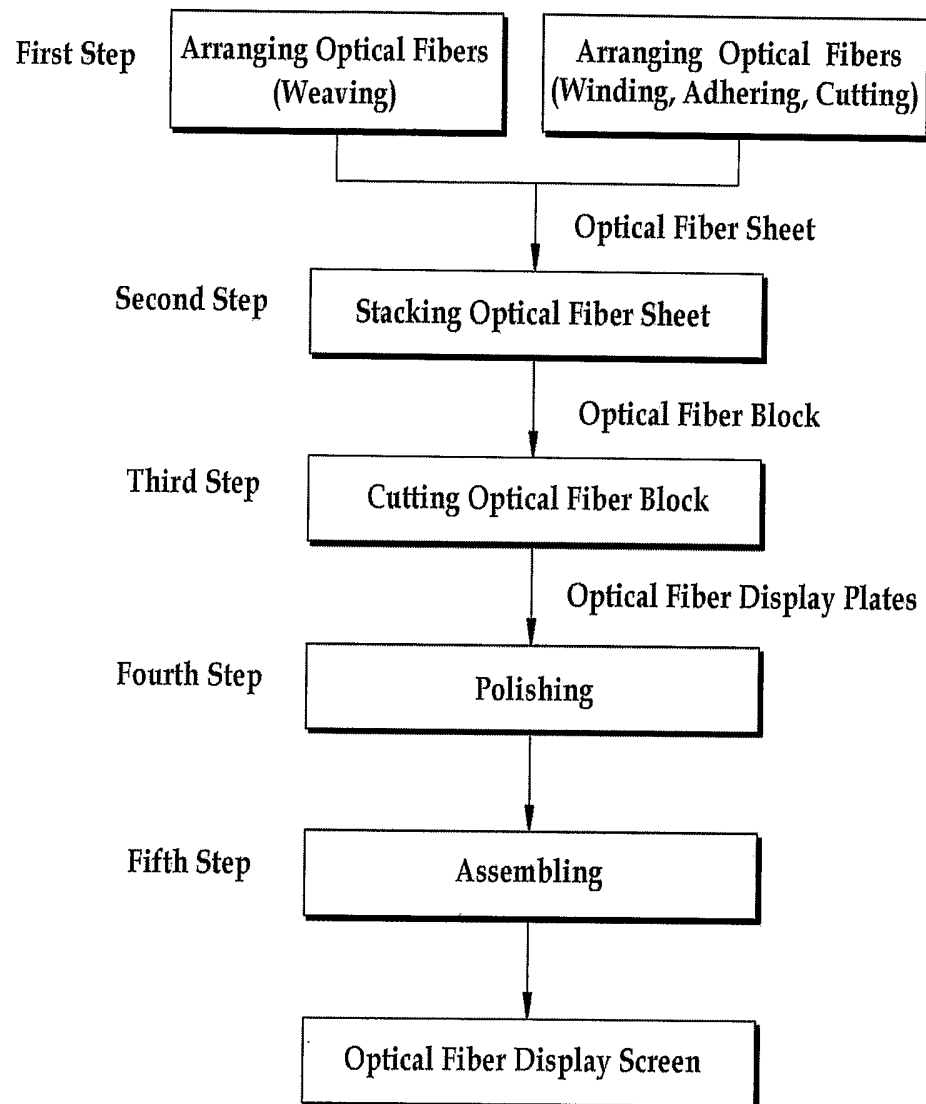
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FIG.3b



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FIG.4



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FIG.5a

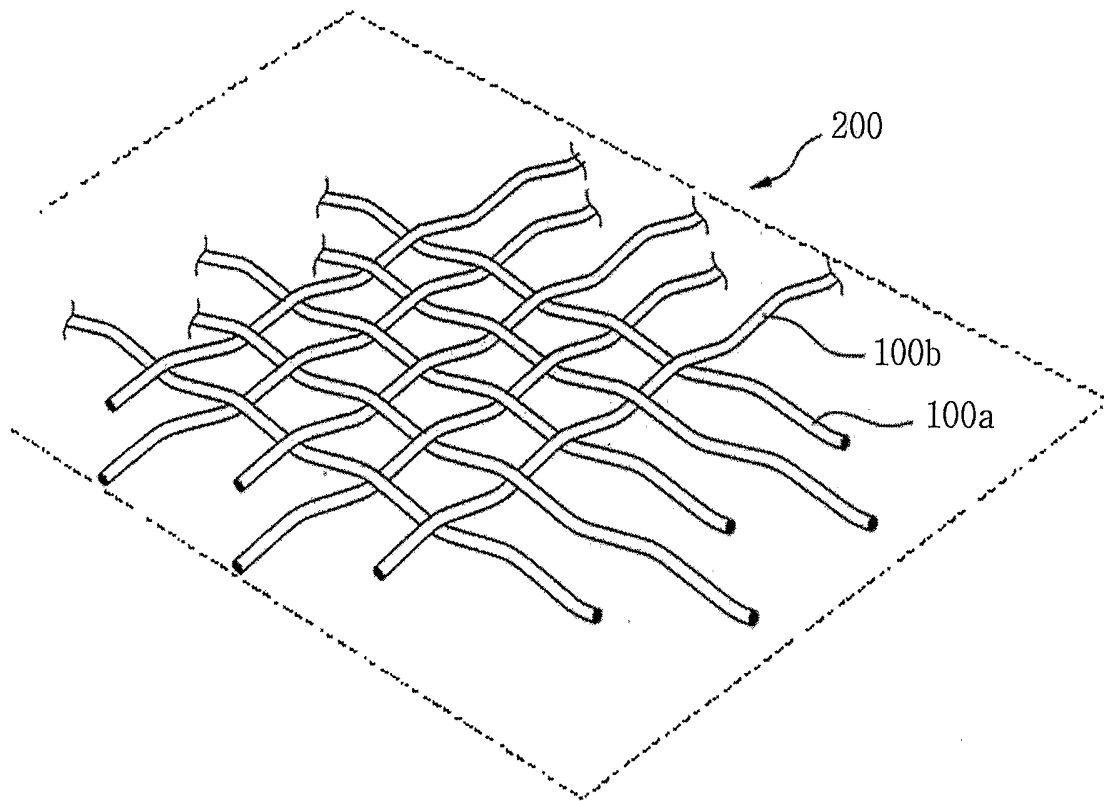
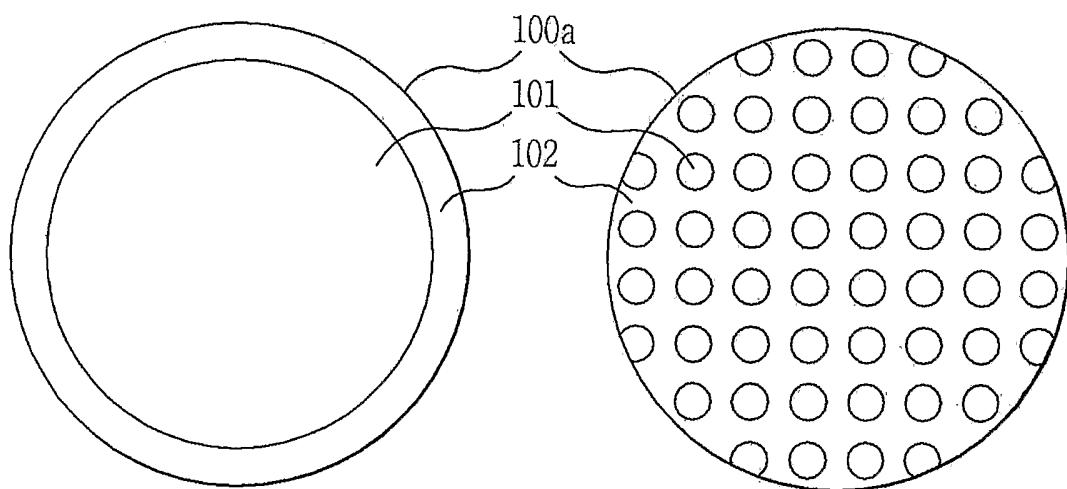
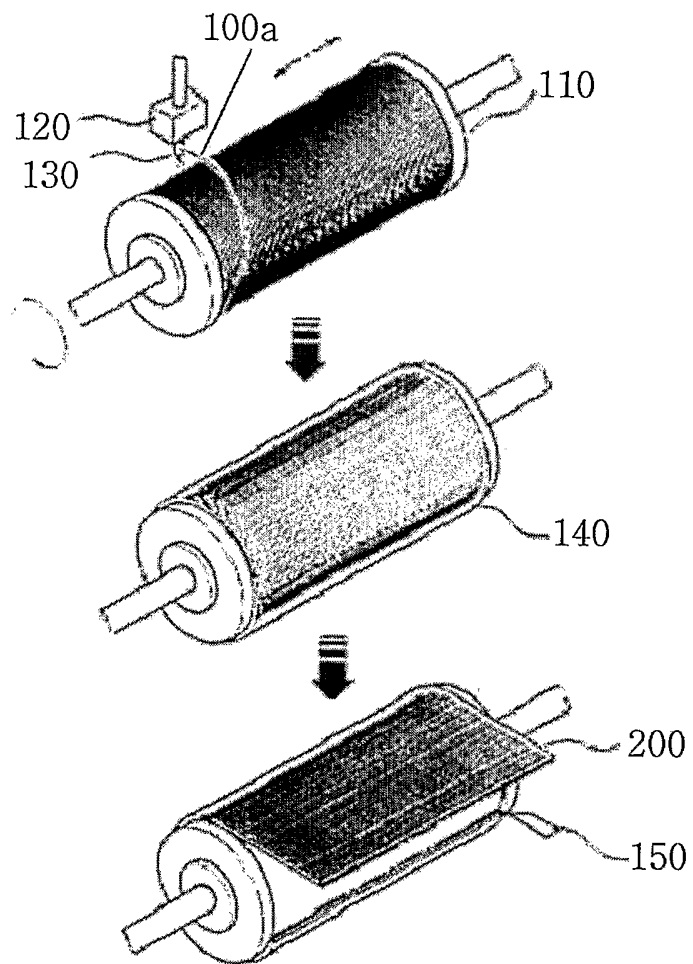


FIG.5b



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FIG.6



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FIG.7a

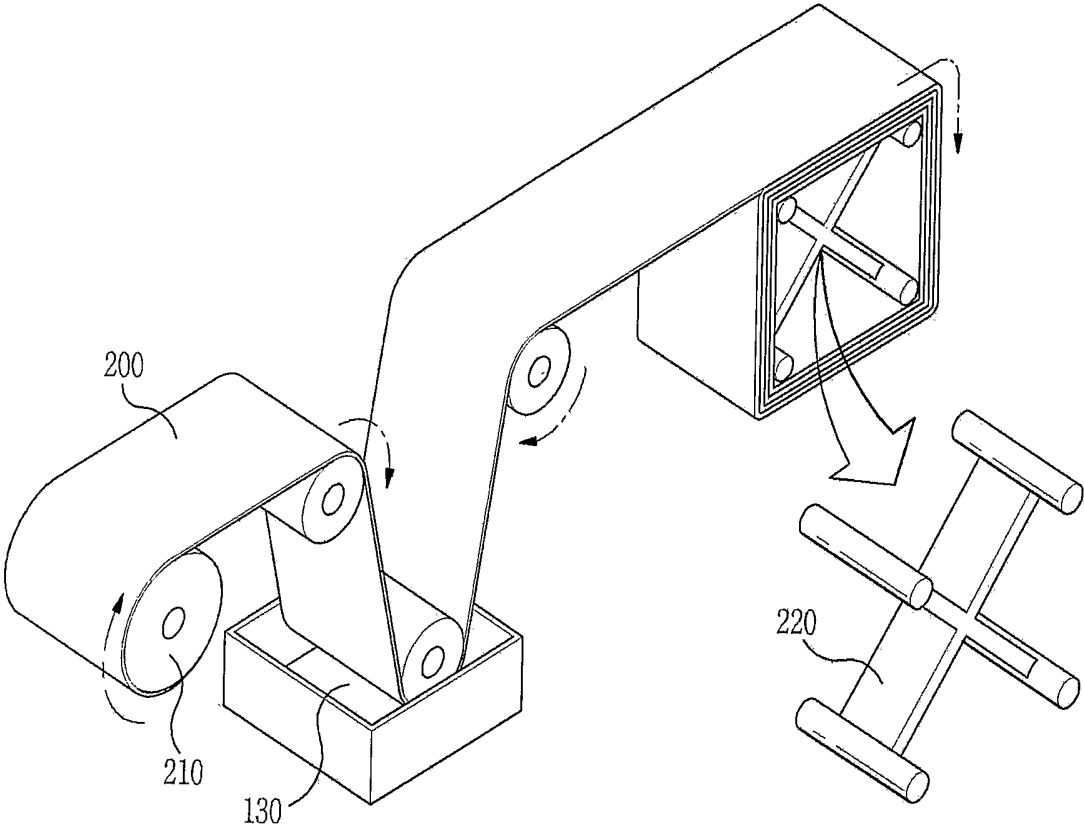
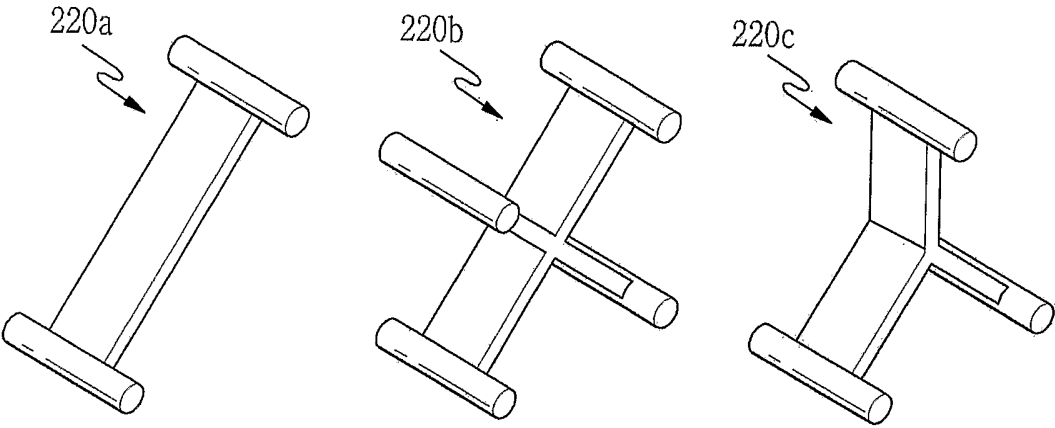


FIG.7b



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FIG.7c

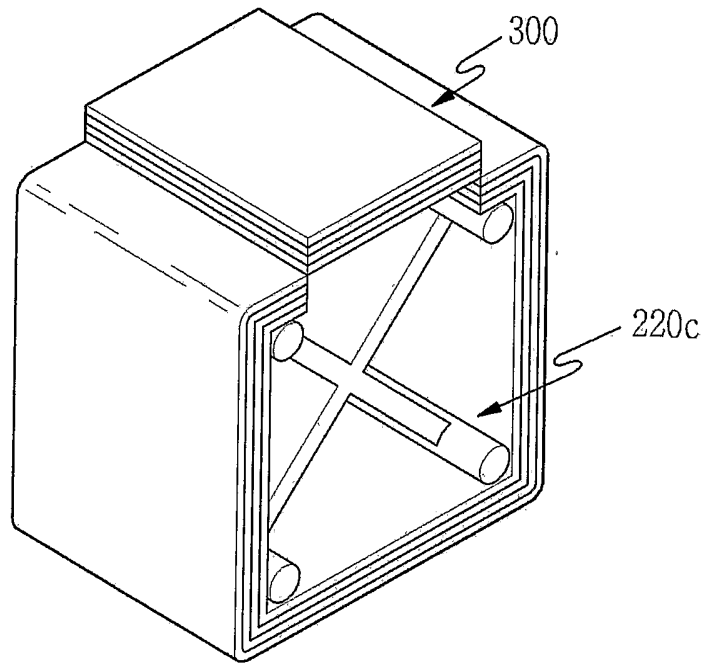
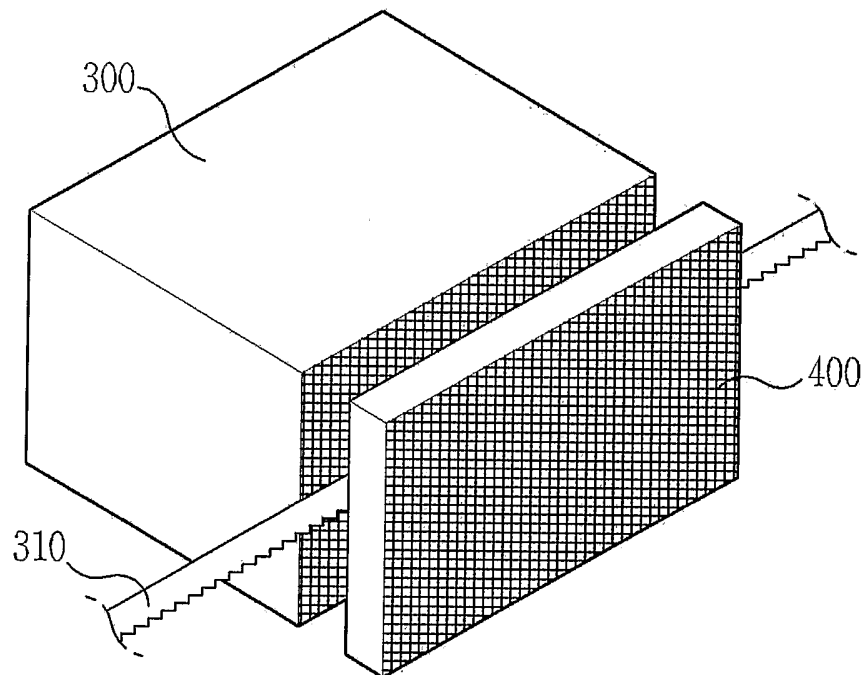
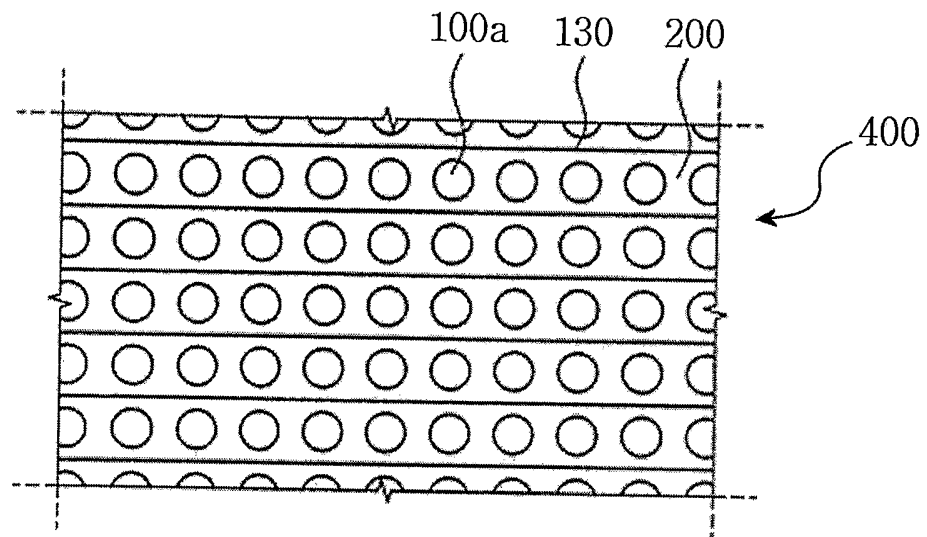


FIG.8a

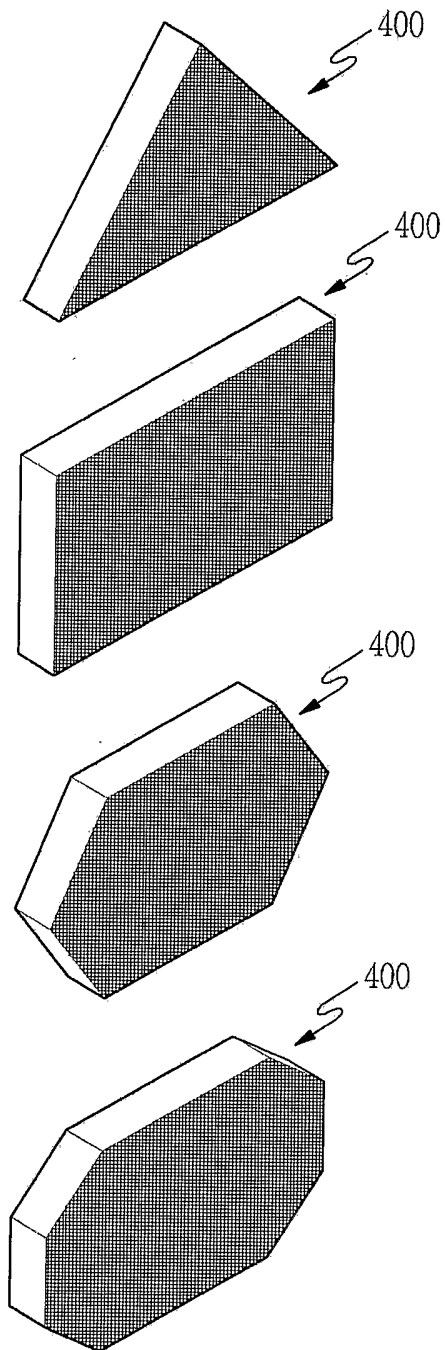


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FIG.8b

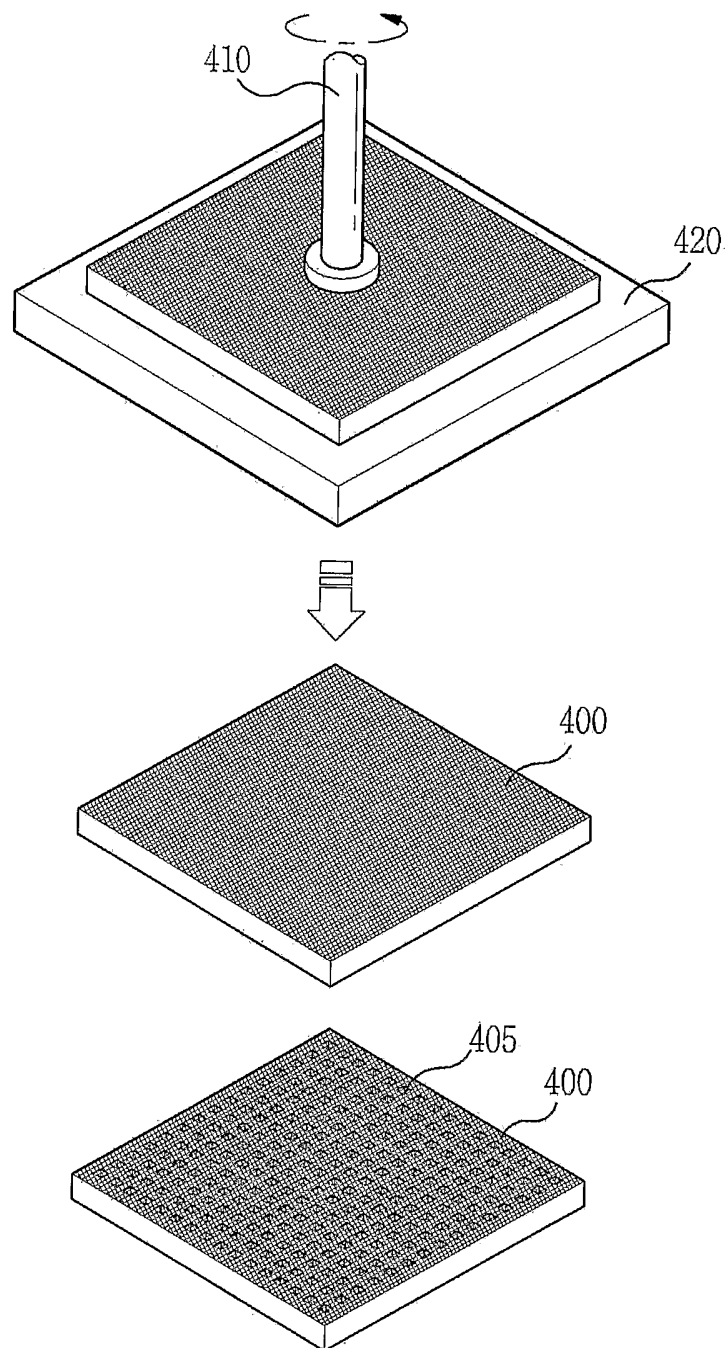


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FIG.8c



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FIG.9



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FIG.10a

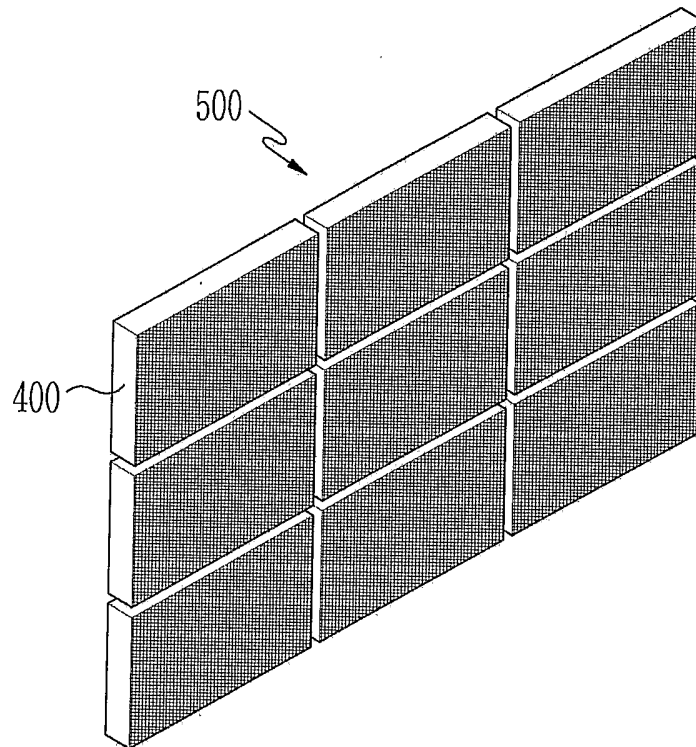
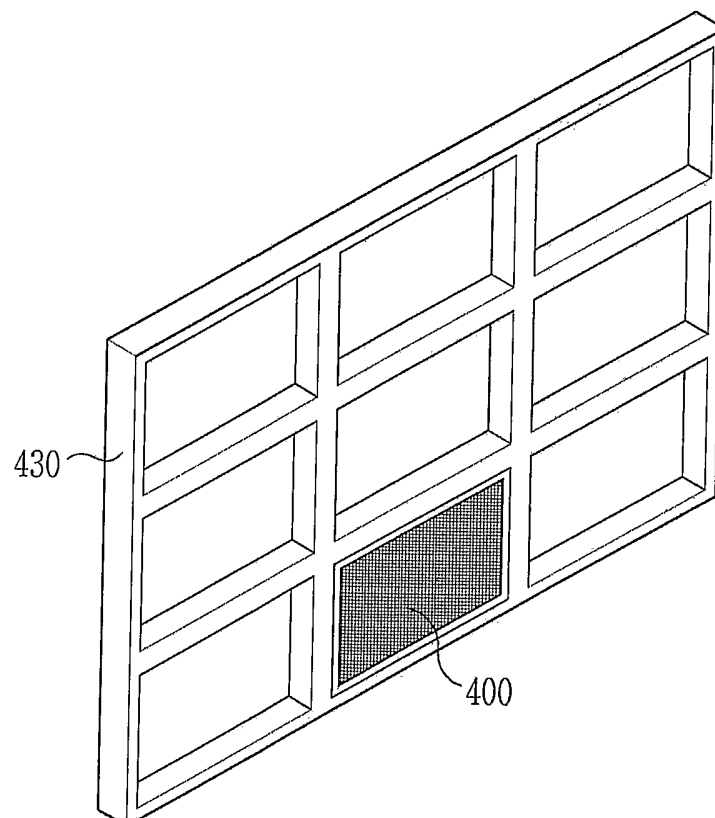
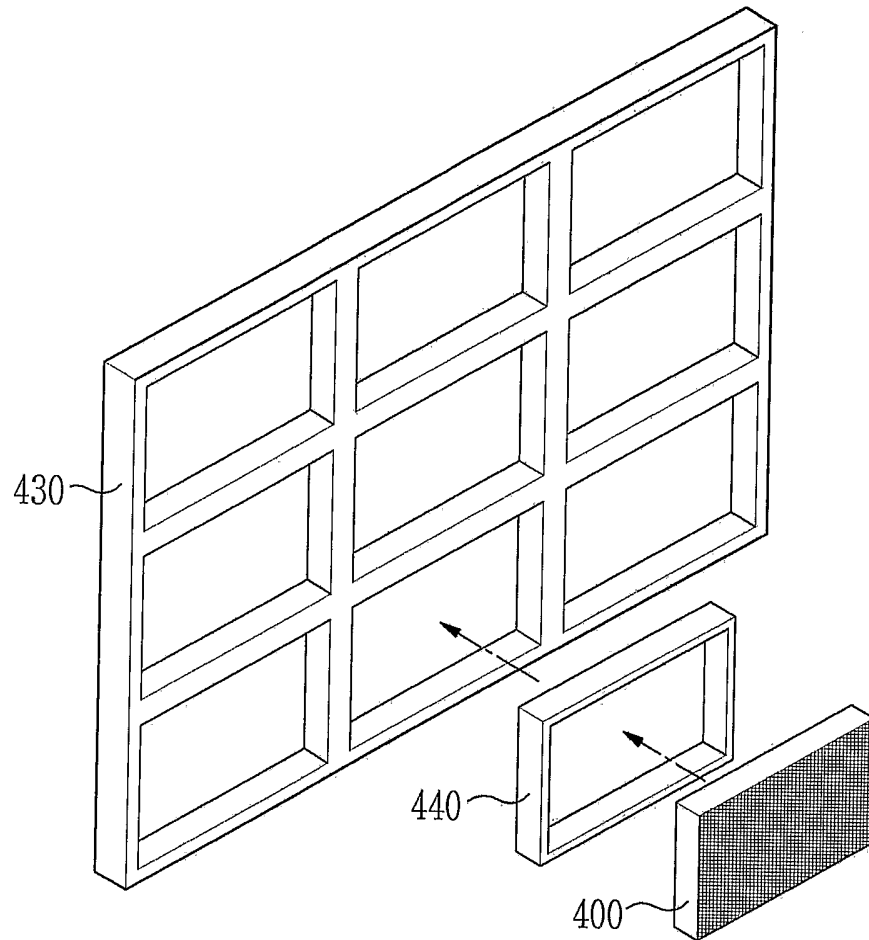


FIG.10b



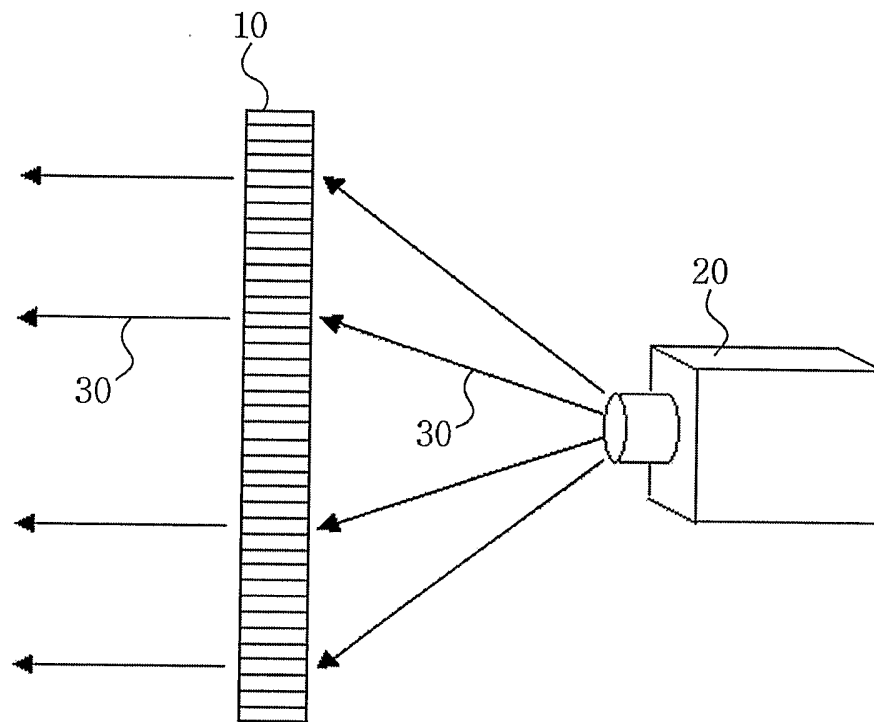
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FIG.10c



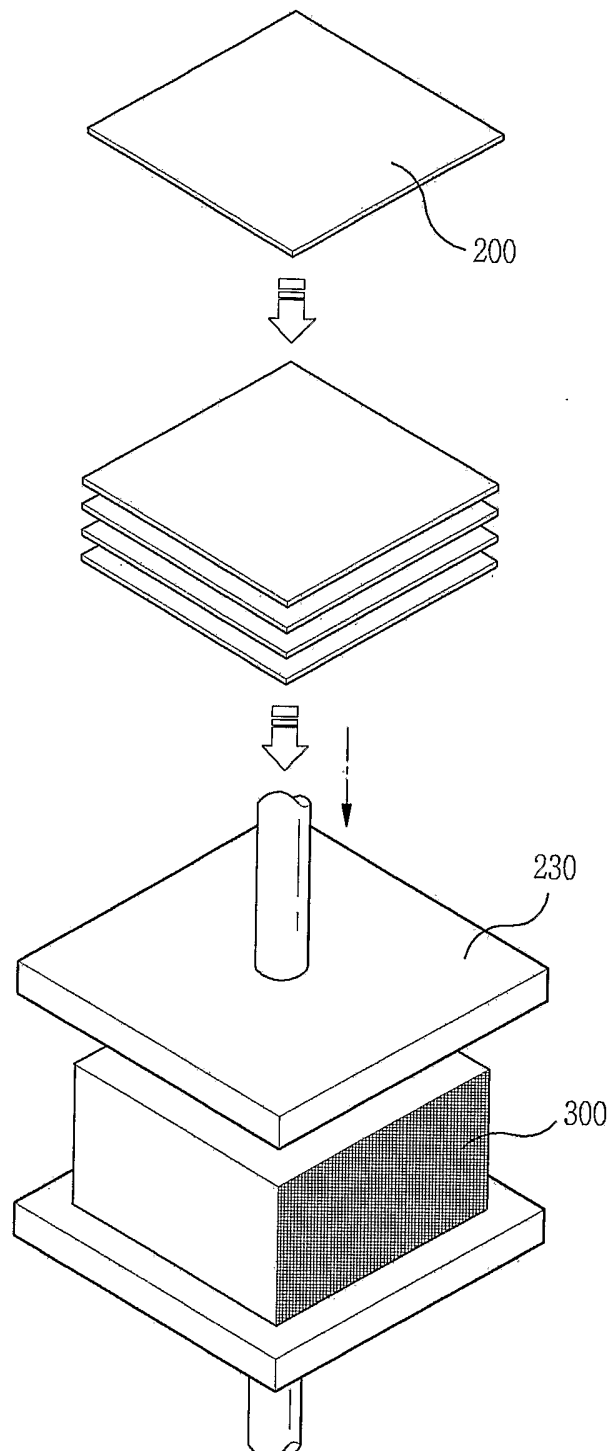
15/19

FIG.11



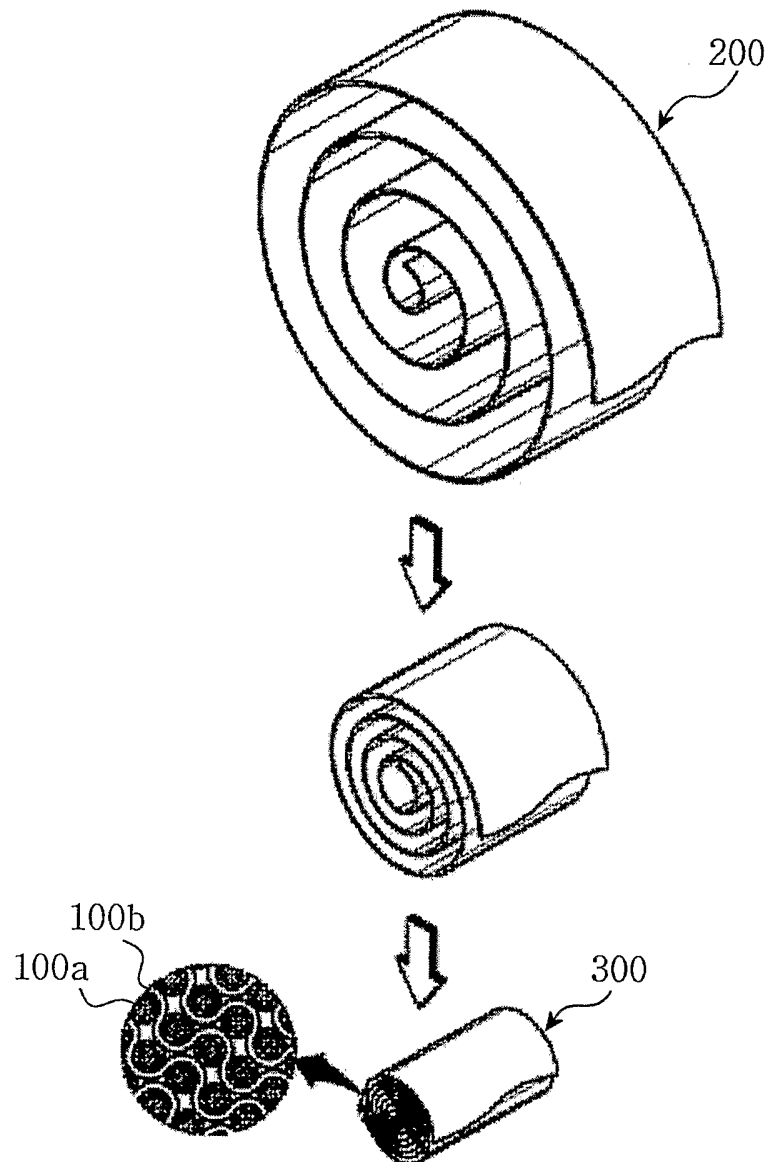
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FIG.12



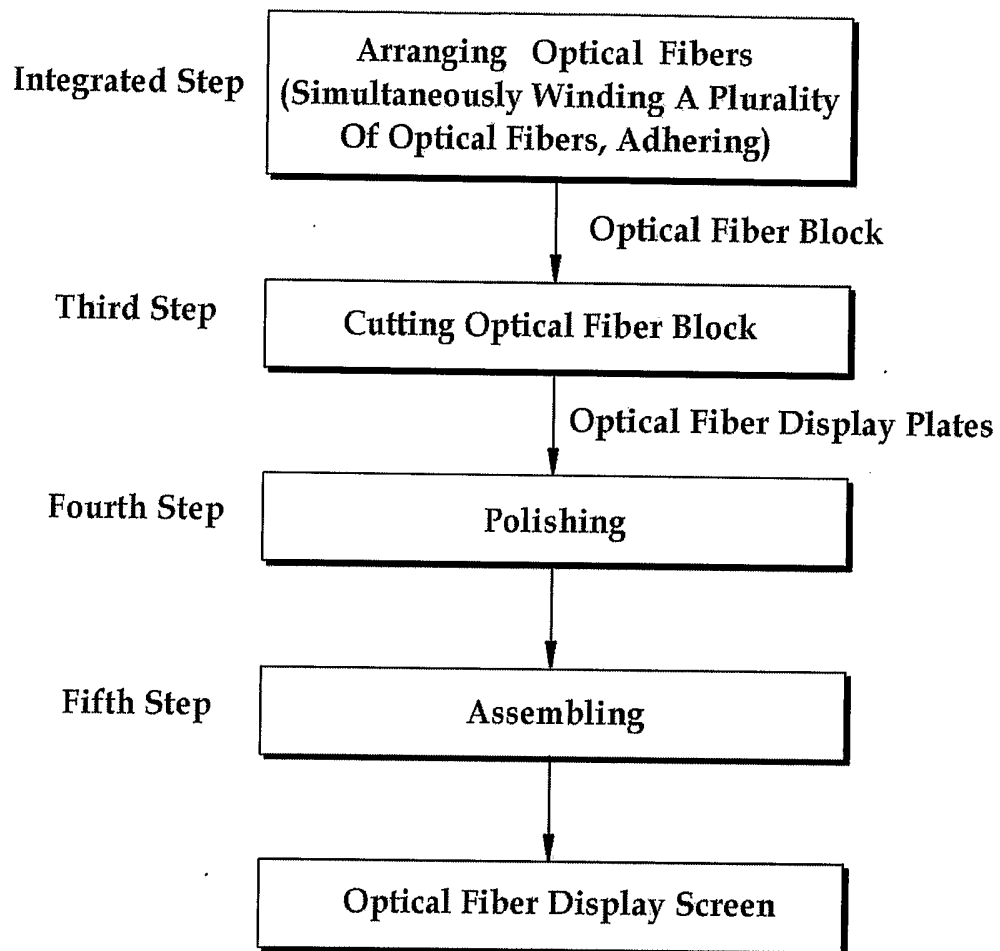
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FIG.13

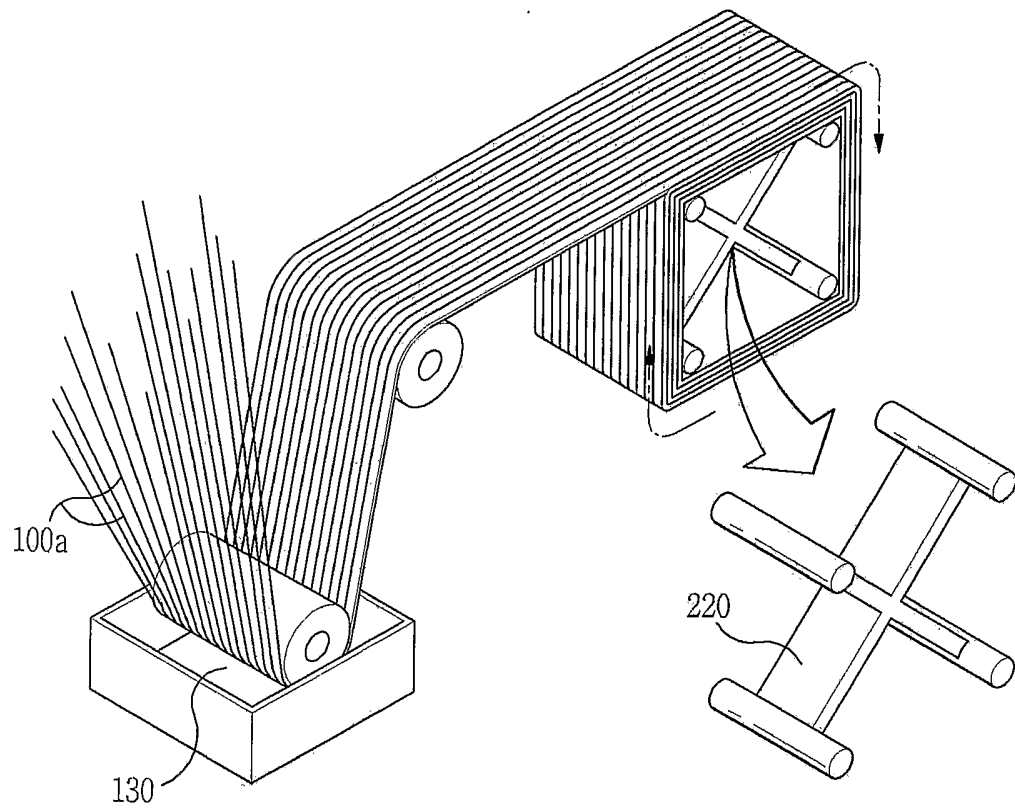


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FIG.14



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FIG.15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2004/000112

A. CLASSIFICATION OF SUBJECT MATTER IPC7 G02B 6/06 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) IPC7 G02B 6/06 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean Patents and applications for inventions since 1975 Korean Utility models and applications for Utility models since 1975 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)				
C. DOCUMENTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
A	US 5444570 (KURARAY CO., LTD.) 22 AUGUST 1995 See whole document	1		
A	US 5825543 (MINNESOTA MINING & MANUFACTURING CO.) 20 OCTOBER 1998 See whole document	1		
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.				
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Date of the actual completion of the international search 12 MAY 2004 (12.05.2004)		Date of mailing of the international search report 13 MAY 2004 (13.05.2004)		
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