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(54) **Light panel**

(57) The invention relates to a device for the transmission and enlargement of images by means of optic fibres. The device comprises a first plate or plane in which first ends of optic fibres are fixed with an average mutual centre distance d_1 and such that light can be coupled in and out of the optic fibres and a second plate or plane in which the other ends of the optic fibres are fixed with an average mutual centre distance d_2 and such light can be coupled in and out of the optic fibres. Here is $d_1 < d_2$ and the optic fibres in the first plate or the first plane are coherently ordered with respect to the optic fibres in the second plate or the second plane. The optic fibres in the first plane or plate are moreover free from mutual contact.

The invention also relates to a method for obtaining said device.

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Description

[0001] The invention relates to a device for the transmission and enlargement of images by means of optic fibres, comprising a first plate or plane in which first ends of optic fibres are fixed with an average mutual centre distance d_1 and such that light can be coupled in and out of the optic fibres and a second plate or plane in which the other ends of the optic fibres are fixed with an average mutual centre distance d_2 and such that light can be coupled in and out of the optic fibres, in which $d_1 < d_2$ and the ends of the optic fibres in the first plate or the first plane are coherently ordered with respect to the ends of the optic fibres in the second plate or the second plane.

[0002] The invention also relates to a method for the manufacturing of a device as mentioned above.

[0003] Such a device and method are known from US patent specification 3.853.658. A disadvantage of said device is that the originals to be displayed have to be very small. Moreover crosstalk may arise between the optic fibres as a result of mutual contact between the optic fibres.

[0004] The invention intends to provide a device as well as a method for the manufacturing of such a device which overcomes the above-mentioned drawbacks. To that end a device of the above-mentioned kind is characterized in that the optic fibres in the first plane or plate are free from mutual contact, d_1 being larger than the diameter of the optic fibres, and the optic fibres in the first plane being kept at a mutual distance by spacers which spacers comprise strips that are situated substantially perpendicular to the axis of the optic fibres between the optic fibres in the first plate or plane.

[0005] Moreover is a method of the above-mentioned kind characterized in that the optic fibres are inserted through openings in a mould, the mould is filled with a curable mass and the mass after it has sufficiently cured is removed from the mould after which the optic fibres are joined together into a narrowed bundle and fixed in their position, the joining together taking place in such a manner that the optic fibres have a mutual centre distance d_1 and the mutual order is maintained.

[0006] An advantage of the device and the method according to the invention is that the pixels of the images that have to be displayed in an enlarged way need not be very small. As a result it is possible for instance to use a generally available crystalline display. Such a display in general namely has a pixel dimension of approximately 0.3 mm. Moreover because the optic fibres are free of mutual contact less crosstalk arises between the optic fibres in the first plane. Additionally it appeared that because the optic fibres are no longer pressed together, rupture of the optic fibres hardly ever occurs any more. Moreover, according to the method mass production of such devices according to the invention is easy to realize. Moreover an accurate positioning

of the fibres is possible as a result of the spacers.

[0007] For that matter a method is known from US patent specification 3.157.721 for gathering threads, in which various combs with teeth are inserted between the threads. The patent specification further does not relate to light panels according to the invention. The threads are after all not mutually fixed beforehand, prior to insertion of the combs, as is the case in the method according to the invention.

[0008] According to the invention the ends of the optic fibres in the first plane and the ends of the optic fibres in the second plane are coherent. This means that the optic fibres run from the first plane to the second plane in such a manner that an image can be transmitted from the first plane to the second plane. This may mean that the optic fibre which, when the first plane is viewed from the front is positioned top left, in the second plane, when it is viewed from the front is top right. However it is also possible that the optic fibres of both planes are not mirrored with respect to each other, or are mirrored in the horizontal plane or both. In that case the image to be transmitted should be offered as a mirrored image. In short, in the widest sense the fact that the ends of the optic fibres in the first plane or plate and the second plane or plate are coherent means that it is known which end in the first plane corresponds to which end in the second plane. It is preferred, however, that the ends correspond such that an image on the first plane can be directly transmitted to the second plane, possibly horizontally or vertically mirrored.

[0009] The device according to the invention may be used in various apparatus in which images have to be transmitted and enlarged. Especially billboards, signposting, flexible road marking or road signs can be mentioned here. With the help of the device according to the invention it will be easy to change the image. It will even be possible to show moving images.

[0010] It is preferred that an intermediate space is present between optic fibres in the first plane, d_1 specifically being larger than the diameter of the optic fibres. As a result the crosstalk between the optic fibres is reduced.

[0011] Preferably the optic fibres in the first plane are kept at a mutual distance by spacers. Said spacers comprise strips which are situated substantially perpendicular to the axis of the optic fibres between the optic fibres. The strip may be divided into at least two series of strips. Here the strips of one series of strips are positioned substantially parallel with respect to each other in one plane, and the second series of strips are also positioned substantially parallel with respect to each other in one plane and the second series of strips is substantially perpendicular to the first series of strips, in which both planes in which both series of strips are positioned are substantially parallel with respect to each other. As a result it is easier to move the device during manufacturing and it is certain that the optic fibres in the first plane are coherent with respect to the optic fibres in a

second plane.

[0012] It is preferred that the spacers comprise at least two combs in which the planes the combs separately define are positioned substantially perpendicular to the axis of the optic fibres and substantially parallel with respect to each other. It will be advantageous here when a first comb is inserted between the optic fibres in one direction and a second comb is inserted between the optic fibres in a direction perpendicular to the insertion direction of the first comb. As a result it is simple to quickly arrange spacers to maintain the mutual position and orientation of the optic fibres.

[0013] Additionally, the first plate or first plane of the device according to the invention may be provided with means for entirely or partially or for a particular part of the spectrum entirely or partially shutting off preselected optic fibres from incident light, at choice. It is preferred here that the means can be electronically driven. As a result the images can be shown in an enlarged way and moreover images can be switched quickly and flexibly.

[0014] The means for partially or entirely shutting off the optical fibres in the first plane or the first plate at choice, preferably comprise liquid crystalline shutters. This may for instance be in the shape of a liquid crystalline display (LCD). It is possible that the ends of the optic fibres are also provided with light sources such as light emitting diodes (LED).

[0015] Preferably the mutual centre distance between the optic fibres is $d_1 = 0.4 - 1.1$ mm and $d_2 = 10 - 15$ mm. Preferable is $d_1 = 0.9 - 1.0$ mm and $d_2 = 8 - 12$ mm. The diameter of the optic fibres being $0.4 - 1.0$ mm and preferably $0.5 - 0.8$ mm.

[0016] One possible embodiment of the method according to the invention is this one, in which the optic fibres run through a grid of wires, the optic fibres being separated from each other by the wires of the grid, after which the wires of the grid are brought towards each other as a result of which the mutual distance of the optic fibres is reduced.

[0017] Preferably however the position of the optic fibres is fixed with the help of spacers. Said spacers preferably are strips here which are inserted between the optic fibres perpendicular to each other in one plane perpendicular to the axis of the optic fibres. Preferably the strips are rigid, as a result of which they can be inserted between the optic fibres and are able to keep the optic fibres accurately positioned.

[0018] In connection with the speed in mass production it is preferred however that the strips are mutually connected. This is possible by connecting them such that a comb shape is realised. The teeth of the comb in that case are inserted between the optic fibres. Preferably at least two combs are inserted with their teeth between the optic fibres after the optic fibres are joined together. The best fixation of the mutual position is achieved when the second comb is inserted perpendicular to a first comb in the same plane as the first

comb. In that case the width of the teeth is smaller than or equal to the mutual centre distance d_1 between the optic fibres.

[0019] The joining together of optic fibres after insertion of the combs preferably takes place by sliding the teeth of the combs towards each other. Here combs can also be used in which each time two teeth are inserted between each optic fibre, or combs of which the width of the teeth can be reduced, or, which is preferred in connection with the simplicity and smallest chance of damage and the highest processing speed, combs of which the width of the teeth is smaller than or equal to the intermediate space between the optic fibres.

[0020] For gathering the combs comprise means for moving the teeth of the combs towards each other. i.e. reducing the intermediate space between the teeth of the combs. Preferably the means for moving the teeth of the combs towards each other are adjustable. The combs in fact form a divided grid of adjustable width of mesh.

[0021] Prior to gathering the distance between the teeth is approximately equal to the initial intermediate space between the optic fibres.

[0022] In order to prevent damaging the optic fibres and letting the gathering run smoothly, which is important in mass production, it is preferred when the teeth of the combs are rigid to such an extent that they nearly do not bend, preferably are even rigid.

[0023] Joining the optic fibres together may also take place by inserting means between the optic fibres, in which said means comprise strips, that are substantially situated in one plane perpendicular to the axis of the optic fibres, and are divided over at least two series of strips, in which the first series of strips are inserted between the optic fibres substantially perpendicular to a second series of strips.

[0024] In order to join the optic fibres the strips of a series are moved towards each other in order to join the optic fibres. In order to facilitate insertion the strips may initially be mutually fixed such that the strips form teeth of combs.

[0025] It is also possible to use a comb with teeth that near the end have a large intermediate space, and of which the intermediate space decreased as the distance to the end of the teeth increases. However this is not preferred when gathering very many fibres at the same time, i.e. over a thousand and even more, as the teeth then have to be very long, which among others causes more problems in connection with the rigidity.

[0026] After the spacers have been placed possibly a permanent fixation of the optic fibres and the spacers can take place with the help of a curable mass. Said curable mass in connection with the weight and simple processing preferably is a curable synthetic material, such as polyurethane, an epoxy or the like. Possibly a thermoplastic synthetic material can also be used. Preferably the curable mass is a polyurethane foam (PUR-

foam). Such a curable mass is light-weight after curing and moreover cures very quickly.

[0027] In order to make a fast mass production possible the mould is filled for a second time with a curable mass prior to joining the optic fibres together. After that the optic fibres are joined between the two cast plates, spacers are placed and the spacers can be fixed. After placing the spacers or after arranging the curable mass the optic fibres are cut through near the spacers and in principle two devices according to the invention are ready.

[0028] During joining or placing the spacers the manufactured light panel might be removed further from the mould so that the mould can be filled for another go.

[0029] The ends of the optic fibres could, if so desired, be provided with lens-shaped ends. This can be achieved by heating the ends. Possibly the cast plates of the first and/or second plane could be provided with a second, transparent cover layer covering the ends of the optic fibres. The lenses could possibly be formed in said cover layer, for instance by enclosing air between the ends of the optic fibres and the transparent cover layer.

[0030] Prior to joining, strips could also possibly be inserted between the optic fibres, which after joining might serve as spacers. To that end the width of the strips has to be smaller than or equal to the mutual centre distance d_1 between the optic fibres.

[0031] The invention further relates to a device for making light panels according to the invention. Such a device comprises holders for optic fibres, a passage device for passing optic fibres through a mould for forming the second plate, means for lifting the second plate formed from the mould, and gathering means for gathering the optic fibres between two formed plates, in which the gathering means comprise at least two substantially parallel combs situated exactly above one another, the direction of the teeth being substantially perpendicular to each other, of which combs the mutual distance of the teeth can be adjusted.

[0032] The invention and the various further embodiments are, by way of example, further elucidated in the figures 1-4.

In figure 1 a schematic view can be seen of the device according to the invention.

In figure 1A and 1B parts of figure 1 are shown in detail.

In figure 2 a continuous production process is shown for manufacturing devices according to the invention according to the method according to the invention.

In figure 3A-3D various stages are shown of joining together and fixing the optic fibres.

In figure 4 a device according to the invention is shown, in which the first plane is provided with means to couple in images in the first plane.

[0033] In figure 1 a device is shown for the transmission and enlargement of images by means of optic fibres (1) according to the invention. In a first plate or plane (2) the first ends of optic fibres are fixed with an average mutual centre distance d_1 and in such a way that light can be coupled in and out of the optic fibres. In a second plate or plane (3) the other ends of the optic fibres are fixed with an average mutual centre distance d_2 and such that light can be coupled in and out of the optic fibres. It can be seen that $d_1 < d_2$. It can be seen that the ends of the optic fibres in the first plate or the first plane are coherently ordered with respect to the ends of the optic fibres in the second plate or the second plane. A, B, C and D in the first plane correspond with a known position of A, B, C and D in the second plane. It can further be seen that the optic fibres in the first plane or plate are free from mutual contact. Preferably an intermediate space (4) is present between the optic fibres in the first plate or plane. By means of a light source 5 light can be transmitted from the first plane to the second plane.

[0034] In figure 1A a part of the first plane of figure 1 is shown in an enlarged way. In figure 1A it is shown that preferably d_1 is larger than the diameter of the optic fibres. It can further be seen that the optic fibres (1) in the first plane are kept at mutual distance by spacers. Said spacers comprise strips which are situated substantially perpendicular to the axis of the optic fibres between the optic fibres, as shown in the figure. One series of strips (10) are positioned substantially parallel with respect to each other in one plane, and a second series of strips (10') are also positioned substantially parallel with respect to each other in one plane and substantially perpendicular to the first series of strips, both planes in which both series of strips are positioned being substantially parallel with respect to each other.

[0035] In figure 1B as well a detail of figure 1 can be seen. It can be seen here that the optic fibres (1) are permanently fixed with the help of a curable mass (11). Said mass preferably is a synthetic material. This may be a thermoplast or thermoset. In connection with production speed and retaining of shape after curing an epoxy is preferred. Polyurethane foam however is preferred over epoxy in connection with an even quicker curing and lighter weight.

[0036] In figure 2 a possible production process for producing the device according to the invention is shown. Here the optic fibres (1) are inserted through the openings in a mould (20). The mould is subsequently filled with a curable mass (21) so that the second plane (3) is formed. After having sufficiently cured, the mass is removed from the mould by lifting the plate formed from the mould. Subsequently the mould is filled for a second time. After curing of second plate the optic fibres between the two plates are joined into a narrowed bundle (22) and fixed in their positions, the joining together taking place in such a way that the optic fibres have a mutual centre distance d_1 and the mutual order being

maintained.

[0037] In figure 3A-3D the method for joining the optic fibres together and the fixing after joining together or the placing of spacers is shown. In figure 3A it can be seen that the two second planes (3) have been formed and the optic fibres (1) are retained in them. Subsequently at least two combs (30, 31) wherein the planes, which are separately defined by the combs, are positioned substantially perpendicular to the axis of the optic fibres and are substantially parallel with respect to each other, are inserted between the optic fibres (1). Here a first comb (30) is inserted between the optic fibres in one direction A and a second comb (31) is inserted between the optic fibres in a direction B perpendicular to the first comb. As can be seen in the figure the combs are inserted with their teeth between the optic fibres. Subsequently the teeth of comb 31 are moved towards each other in direction C and simultaneously or afterwards (or of so desired firstly) the teeth of comb 30 are.

[0038] In figure 3B it can subsequently be seen how the optic fibres (1) are joined together with the help of combs (30, 31). Combs having teeth that can move towards each other can be used here. It is of course also possible that the optic fibres run through a grid of wires, the optic fibres being separated from each other by the wires of the grid, after which the wires of the grid are moved towards each other as a result of which the mutual distance of the optic fibres is reduced. It is of course also possible to manipulate the combs in such a way that as a result a joining of the wires arises.

[0039] In figure 3C it is shown how a second set of combs (40, 41) are inserted between the optic fibres (1) whereas the optic fibres are retained in the second plane (3). The width of the teeth of the combs and the distance between the combs is chosen such here that the width of a tooth plus the distance between two teeth is smaller than or equal to d_1 .

[0040] In figure 3D it can be seen that by inserting the second set of combs two planes (50, 51) are created, possibly having an intermediate space. The optic fibres between the two planes could now be permanently fixed with the help of a curable mass, for instance a plastic such as an epoxy or polyurethane foam. After that the optic fibres can be cut through between both planes 50 and 51, for instance by a laser beam, a hot wire, or other means known to the expert.

[0041] It may also be possible to remove the first set of combs (30, 31) and instead of them insert a set of combs identical to the combs 40 and 41 above or under the combs 40 and 41 after which the process will further run as discussed with figure 3D. It may also be possible to insert two series of parallel strips or rods between the optic fibres instead of the combs 30 and 31. Said strips can be moved towards each other whereas the strips remain parallel. As a result the optic fibres are joined together, whereas the mutual position stays the same.

[0042] In figure 4 a device according to the inven-

tion can be seen which is provided with means for, at choice, entirely or partially or for a particular part of the spectrum entirely or partially shutting off preselected fibres (1) from incident light. As already mentioned. Preferably said means are electronically driven. Specifically said means are an LCD (60). Said LCD is placed in front of the first plane (2). A light source (70) may also be provided. It can be seen that in the first plane or plate (2) spacers (10) and perpendicular to them (10') are permanently left behind between the optic fibres.

[0043] The device according to the method or the product of the method according to the invention is preferably suitable for use in a light panel for displaying advertisements or signposting or traffic information.

[0044] It may also be possible to have several devices according to the invention arranged with their first and second planes or plates next to each other their sides abutting and possibly fixed. As a result a device is created with very many fibres and thus pixels. For instance devices with 20 by 100 fibres can be gathered in plane of 20 by 3 such that first and second image planes of 400 by 300 pixels are created.

Claims

1. Device for the transmission and enlargement of images by means of optic fibres, comprising a first plate or plane in which first ends of the optic fibres are fixed with an average mutual centre distance d_1 and such that light can be coupled in and out of the optic fibres and a second plate or plane in which the other ends of the optic fibres are fixed with an average mutual centre distance d_2 and such light can be coupled in and out of the optic fibres, in which $d_1 < d_2$ and the ends of the optic fibres in the first plate or the first plane are coherently ordered with respect to the ends of the optic fibres in the second plate or the second plane **characterized in that** the optic fibres in the first plane or plate are free from mutual contact, d_1 being larger than the diameter of the optic fibres, and the optic fibres in the first plane being kept at a mutual distance by spacers which are situated substantially perpendicular to the axis of the optic fibres between the optic fibres in the plate or the plane.
2. Device according to claim 1, **characterized in that** the spacers comprise strips of which one series of strips are positioned substantially parallel with respect to each other in one first plane, and a second series of strips are also positioned substantially parallel with respect to each other in one second plane and substantially perpendicular to the first series of strips, both planes with strips being positioned substantially parallel with respect to each other.
3. Device according to claim 2, **characterized in that**

the second series of strips comprise two combs, wherein the planes, which are separately defined by the combs, are positioned substantially perpendicular to the axis of the optic fibres and substantially parallel with respect to each other, and a first comb being inserted between the optic fibres in one direction and a second comb being inserted between the optic fibres in a direction perpendicular to the first comb.

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4. Device according to any one of the preceding claims, **characterized in that** the first plate is provided with means for entirely or partially or for a particular part of the spectrum entirely or partially shutting off preselected fibres at choice from incident light, which means can preferably be electronically driven, and preferably are liquid crystalline shutters.

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5. Method for the manufacturing of a device according to any one of the preceding claims **characterized in that** the optic fibres are inserted through openings in a mould, the mould is filled with a curable mass and the mass after it has sufficiently cured is removed from the mould after which the optic fibres are joined together into a narrowed bundle and their position is fixed, the joining together taking place in such a manner that the optic fibres have a mutual centre distance d_1 and the mutual order is maintained.

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6. Method according to claim 5, **characterized in that** the combs are inserted with their teeth between the optic fibres, the first comb being inserted perpendicular to a second comb and into the same plane as the second comb.

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7. Method according to any one of the claims 5-6, **characterized in that** the width of the teeth of the combs is smaller than or equal to the mutual centre distance d_1 between the optic fibres.

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8. Method according to any one of the preceding claims 5-7, **characterized in that** the spacers are fixed by means of a curable mass.

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9. Method according to any one of the preceding claims 5-8, **characterized in that** prior to joining the optic fibres together the mould is filled for a second time with a curable mass.

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10. Light panel for displaying advertisements or signposting or traffic information comprising at least one device obtained in accordance with the method according to any one of the preceding claims 5-9.

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11. Apparatus for making light panels according to any one of the preceding claims, comprising holders for

optic fibres, a passage device for passing the optic fibres through a mould for forming the second plate, means for lifting the second plate formed from the mould, and gathering means for gathering the optic fibres between two consecutively formed plates, in which the gathering means comprise elongated strip-shaped elements and is provided with means for adjusting the distance between the strip-shaped elements.

12. Apparatus according to claim 11, in which the gathering means comprise at least two substantially parallel combs situated exactly above one another, the direction of the teeth being substantially perpendicular to each other, of which combs the mutual distance of the teeth can be adjusted.

13. Assembly for displaying images such as advertisements, signposting or traffic information comprising at least one device according to any one of the preceding claims, preferably having the sides of the respective first and second planes or plates linked.

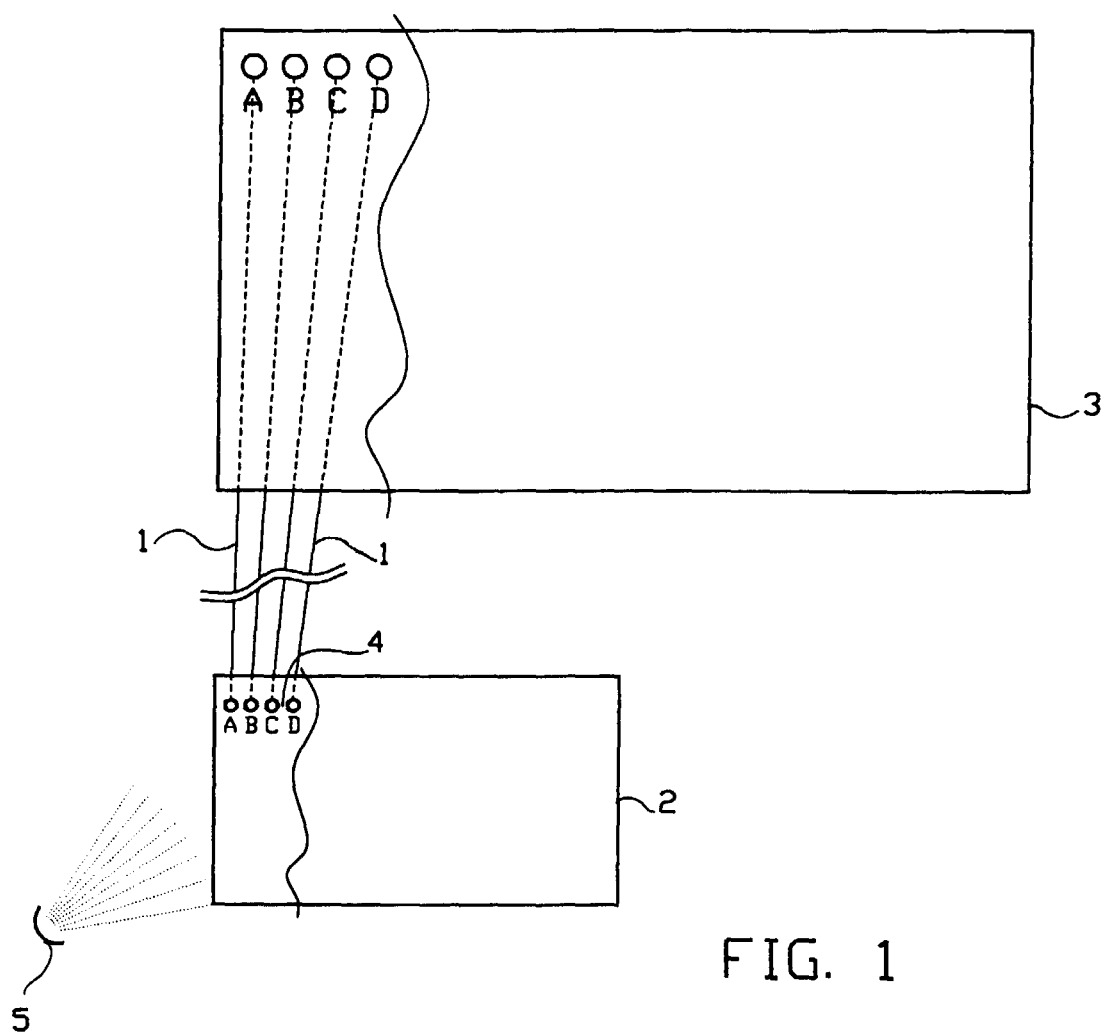


FIG. 1

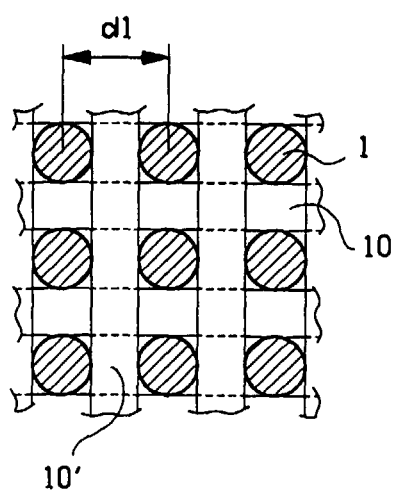


FIG. 1A

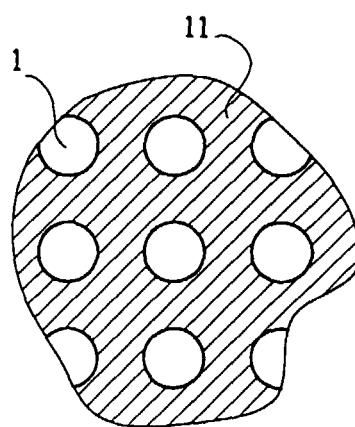


FIG. 1B

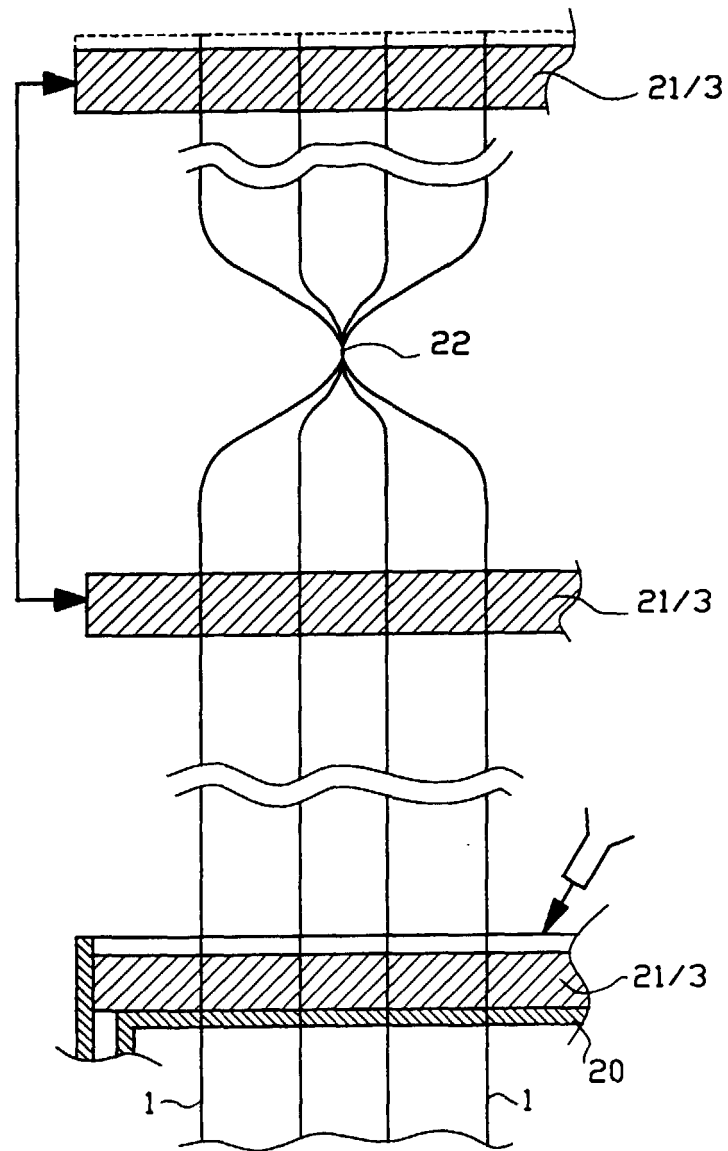


FIG. 2

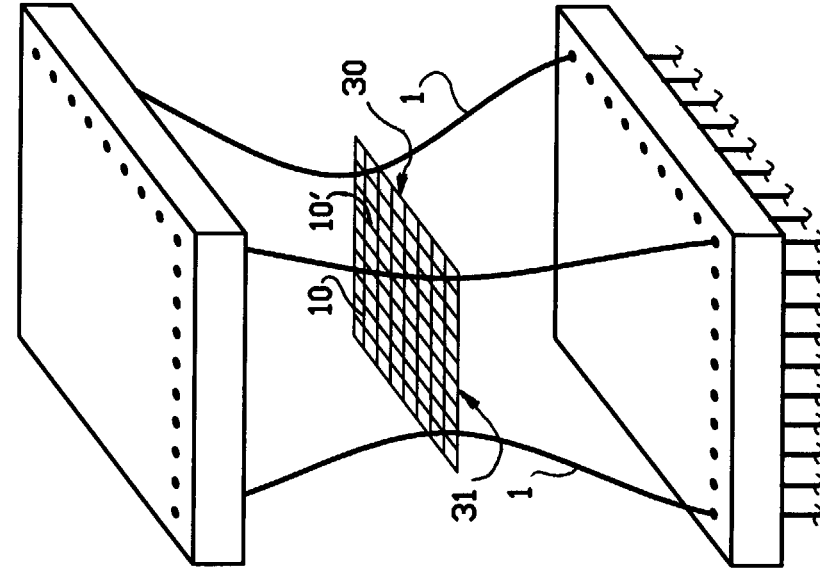


FIG. 3B

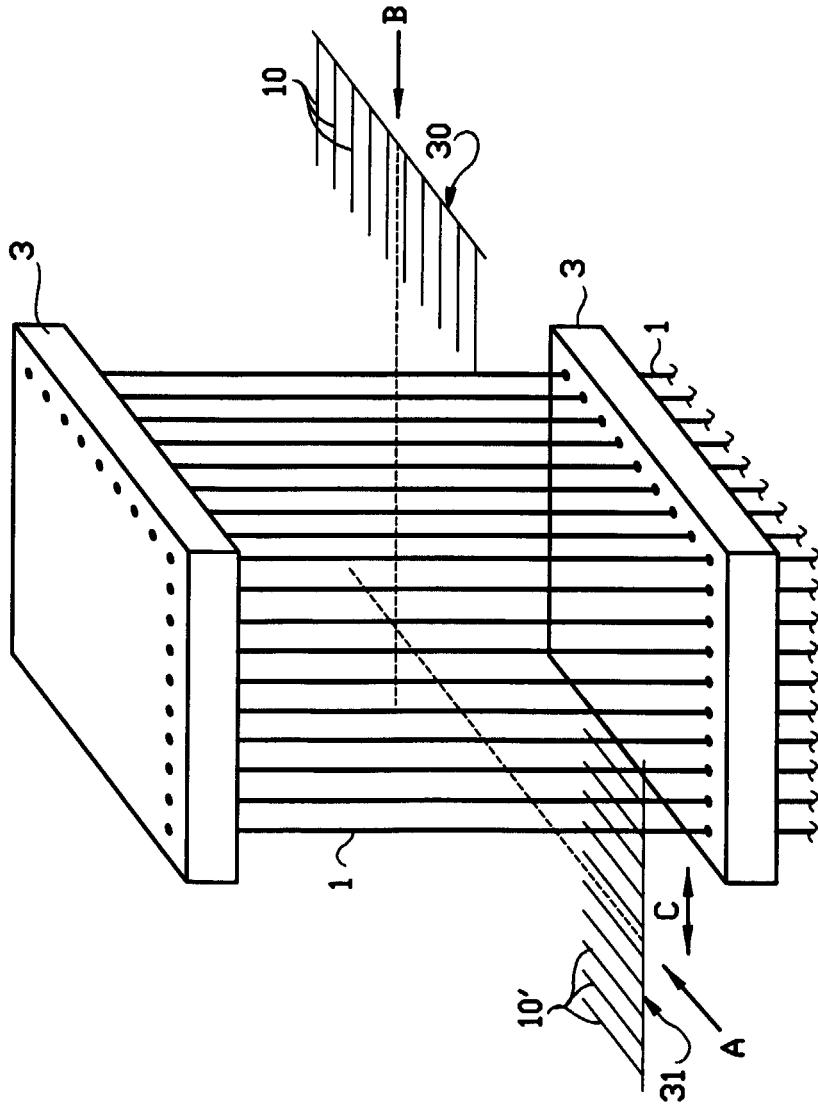


FIG. 3A

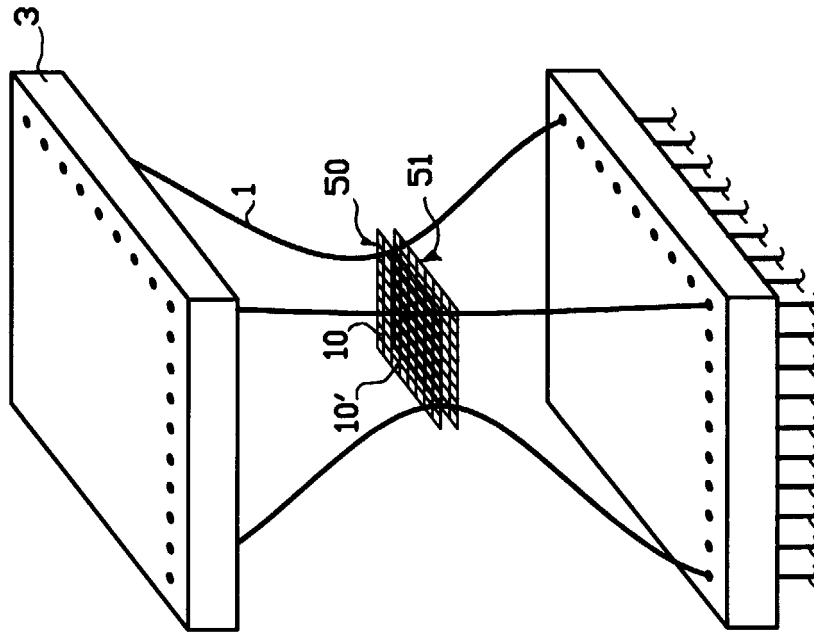


FIG. 3D

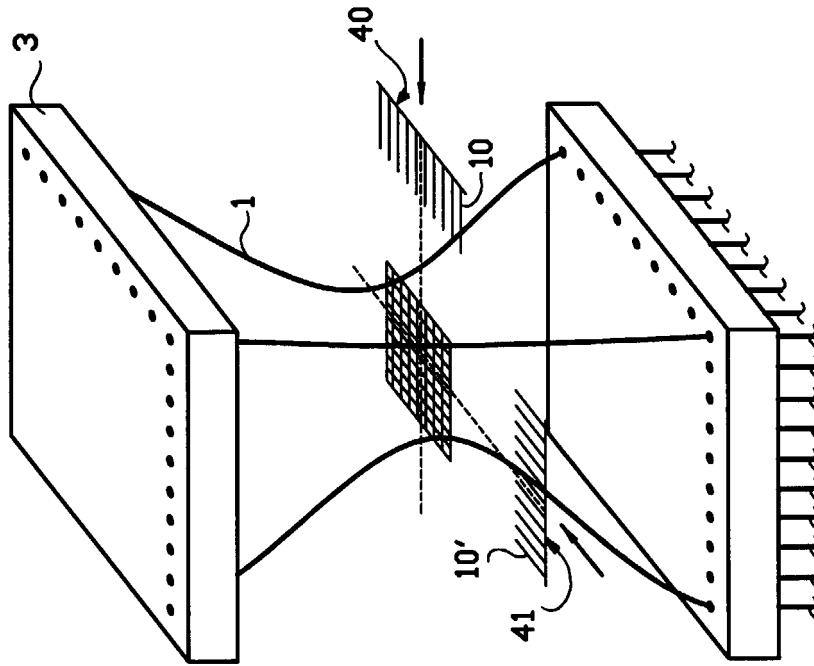


FIG. 3C

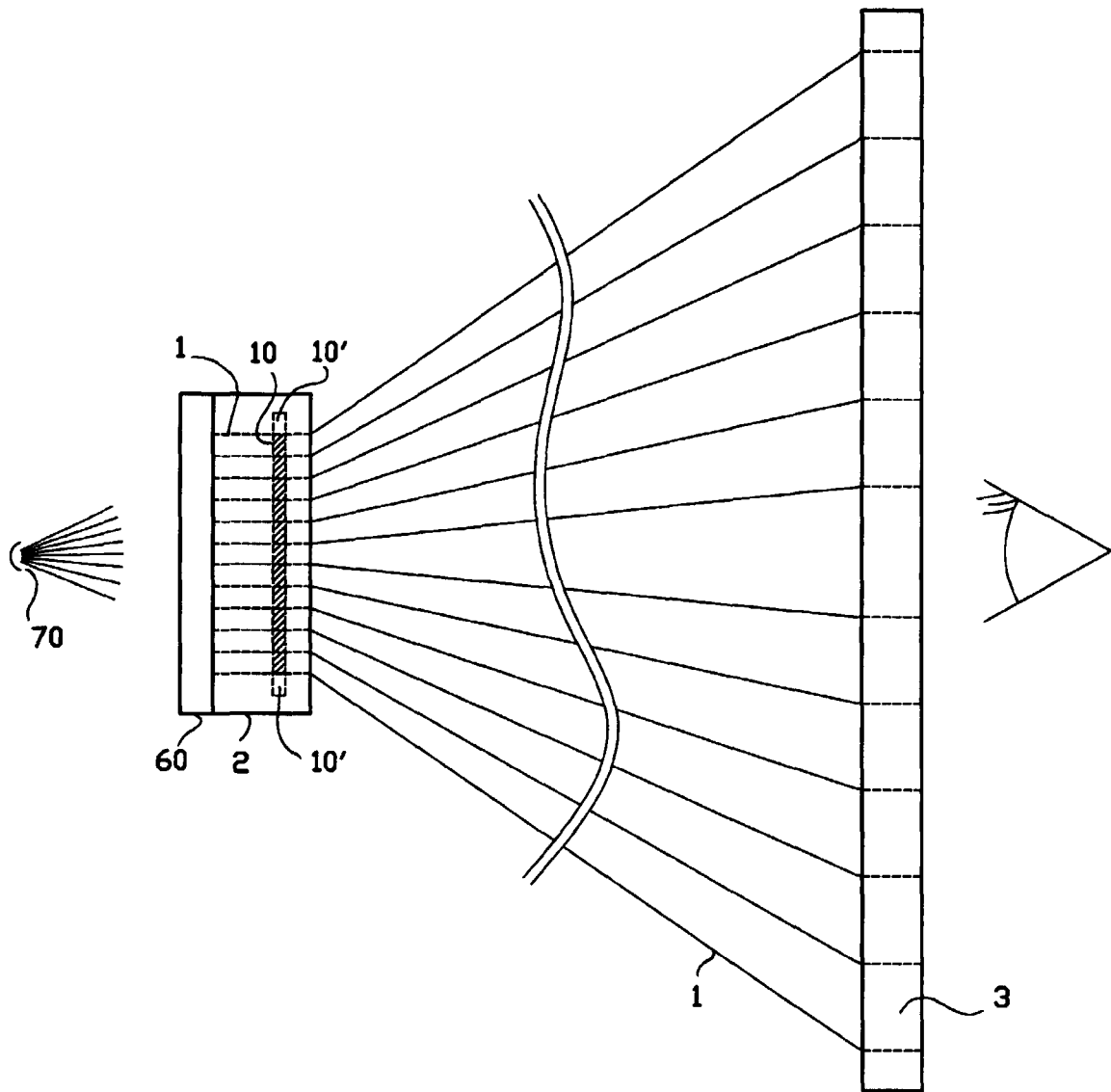


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 00 20 2399

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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Place of search		Date of completion of the search	Examiner
THE HAGUE		5 October 2000	Jandl, F
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 00 20 2399

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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