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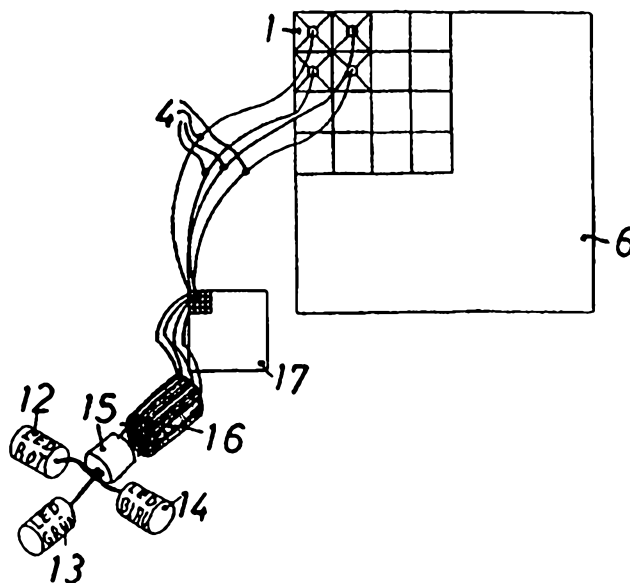
(51) Internationale Patentklassifikation ⁶ : G09F 9/30	A1	(11) Internationale Veröffentlichungsnummer: WO 99/63508 (43) Internationales Veröffentlichungsdatum: 9. Dezember 1999 (09.12.99)
(21) Internationales Aktenzeichen: PCT/EP99/03796 (22) Internationales Anmeldedatum: 1. Juni 1999 (01.06.99) (30) Prioritätsdaten: 198 24 618.8 2. Juni 1998 (02.06.98) DE 199 05 599.8 11. Februar 1999 (11.02.99) DE (71)(72) Anmelder und Erfinder: GLÄTZER, Rainer [DE/DE]; Nikolaus-Gross-Strasse 11a, D-45886 Gelsenkirchen (DE). (72) Erfinder; und (75) Erfinder/Anmelder (nur für US): GLÄTZER, Maik [DE/DE]; Nikolaus-Gross-Strasse 11a, D-45886 Gelsenkirchen (DE). (74) Anwalt: SCHNEIDERS & BEHRENDT; Huestrasse 23, D-44787 Bochum (DE).		(81) Bestimmungsstaaten: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO Patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), eurasisches Patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI Patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Veröffentlicht <i>Mit internationalem Recherchenbericht.</i>

(54) Title: FLAT DISPLAY SCREEN**(54) Bezeichnung:** FLACHBILDSCHIRM**(57) Abstract**

The invention relates to a flat display screen for displaying an image using a plurality of pixels which are arranged in a matrix-shaped manner and which are supplied with light from semiconductor light sources (12, 13, 14) via optical waveguides (4, 16), whereby the light can be modulated between the light sources (12, 13, 14) and the pixels (1) for generating an image. In order to provide such a flat display screen whose construction is versatile and variable, the invention provides that the end viewing surface of the display screen is comprised of a plurality of display modules (6) which are similar to one another. A group of pixels (1) is combined in each of said display modules. The display modules (6) are each separately connected to semiconductor light sources (12, 13, 14), said sources separately belonging to each display module (6), via flexible or partially flexible light waveguides (4, 16). In addition, a light modulator device (17) is connected in the light waveguides (4, 16) which lead to each display module (6).

(57) Zusammenfassung

Die Erfindung betrifft einen Flachbildschirm zur Darstellung eines Bildes mittels einer Vielzahl von matrixförmig angeordneten Bildpunkten, die über optische Wellenleiter (4, 16) von Halbleiterlichtquellen (12, 13, 14) mit Licht versorgt werden, wobei das Licht zwischen den Lichtquellen (12, 13, 14) und den Bildpunkten (1) zur Erzeugung des Bildes modulierbar ist. Um einen solchen Flachbildschirm in seinem Aufbau vielseitig und variabel zu gestalten, schlägt die Erfindung vor, daß die Endbetrachtungsfläche des Bildschirmes aus einer Vielzahl von untereinander gleichartigen Anzeigemodulen (6) zusammengesetzt ist, in denen jeweils eine Gruppe von Bildpunkten (1) zusammengefaßt ist, wobei die Anzeigemodule (6) jeweils gesondert über flexible oder teilflexible Lichtwellenleiter (4, 16) mit gesondert zu jedem Anzeigemodul (6) gehörenden Halbleiterlichtquellen (12, 13, 14) verbunden sind und in die zu jedem Anzeigemodul (6) führende Lichtwellenleiter (4, 16) eine Lichtmodulorenanordnung (17) eingeschaltet ist.



Abstract:

The invention relates to a flat display screen for displaying an image by means of a multitude of pixels arranged in the form of a matrix, said pixels being supplied with light by semiconductor light sources (12, 13, 14) via optical waveguides (4, 16), whereby the light can be modulated between the light sources (12, 13, 14) and the pixels (1) for generating the image. In order to provide such a flat display screen with a versatile and variable structure, the invention proposes that the end viewing surface of the display screen I assembled from a great number of display modules (6) that are similar among each other, said display modules each combining a group of pixels (1), whereby the display modules (6) each are separately connected via flexible or partially flexible light waveguides (4, 16) to semiconductor light sources (12, 13, 14) separately belonging to each display module (6), and whereby a light modulator device (17) is interconnected in the light waveguides (4, 16) leading to each display module (6).

FIG. 5



FLAT DISPLAY SCREEN

The invention relates to a flat display screen for displaying an image by means of a plurality of pixels which are arranged in the form of a matrix, in which groups of pixels are combined in display modules that are similar among each other. Said display modules jointly form the flat display screen and each are connected via flexible or partially flexible light wave guides to a light source belonging to each display module, whereby an arrangement of light modulators is interconnected in the light wave guides leading to each display module.

Such a flat display screen is known, for example from US-4,747,648 A. In connection with said known flat display screen, which is primarily conceived for large sized display boards for sports facilities, hotels or gas stations, the pixels combined in display modules, on the one hand, and the display modules on the other hand form a relatively rough matrix. This means that the individual pixels have a relatively large spacing from each other, so that said flat display screen is primarily suitable for the display of alphanumerical information and less so for the displaying images. A further drawback is that incandescent lamps are used as light sources, which have to be cooled. Furthermore, high losses occur in connection with the modulation of the continuous flux of



the light coming from the incandescent lamps especially when said flux of light frequently has to be wholly or partly interrupted, for example moving images. For said reason, it is possible only in a poor way in connection with said known flat display screen to make high light intensity available on each pixel. However, high light intensity per pixel is required if a largely flat image has to be produced with high contrasts and with a screen pattern that is hardly noticeable by the viewer. Obtaining high contrast is particularly important in a bright environment, for example at daylight.

Another flat display screen is known from DE-PS 195 40 363. With this known flat display screen, the optical wave guides are arranged in the form of a grid on the back side of the flat display screen, and have decoupling points arranged with uniform distribution along their longitudinal expanse. The decoupling points thus form a matrix-shaped array of pixels. One end of each wave guide is connected to a semiconductor light source. The light sources or the decoupling points can be controlled in such a way that they reflect light in one color or light in different colors. By rapidly lining up the light proportions in terms of time, said light components having different intensities that successively exit from the decoupling points into the viewing space, the impression of an image is created in the eye which, in case of color modulation, is varicolored. The required



modulation of the light takes place either in the semiconductor light sources themselves or by means of modulators that are associated with the individual decoupling points, i.e. which are therefore arranged distributed in the form of a matrix as well.

An important drawback of said known flat display screen lies in the fact that the optical wave guides are arranged in a stationary way in relation to each other and in relation to the display screen, so that the flat display screen necessarily has and must retain a fixed outer form that is not variable. A further important drawback lies in the fact that the multitude of decoupling points are arranged in series one after the other along each wave guide, so that either only a small fraction of the full amount of the incoming light can be reflected, or the reflection of the full amount of light is possible only at larger time intervals. Finally, another drawback consists in that the modulators modulating the light exiting from the decoupling sites have to be arranged in a narrow pattern in accordance with the narrow grid of the matrix, which ensues problems in view of the narrow arrangement of the control lines and in view of the dissipation of lost heat.

Finally, a flat display screen is known from EP-0 422 777 A1 in connection with which semiconductor light sources (LED's) are employed as the light sources. The



light of said light sources is guided via optical waveguides to the flat display screen consisting of a glass pane. The individual pixels are controlled on said flat display screen via optical demultiplexers whose operation is necessarily connected with high losses as well.

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The discussion of the background to the invention herein is included to explain the context of the invention. This is not to be taken as an admission that any of the material referred to was published, known or part of the common general knowledge in Australia as at the priority date of any of the claims.

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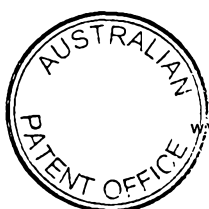
According to one aspect of the present invention there is provided a flat display screen for representing an image by means of a plurality of pixels arranged in matrix form, in which groups of pixels are combined to form display modules which are similar to each other and which jointly form the flat display screen and which are respectively connected by way of flexible or part-flexible optical waveguides to a light source belonging to each display module wherein a light modulator arrangement is connected into the optical waveguides leading to each display module wherein

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- the combined pixels which are disposed at the front side of the display modules respectively form a rimless end viewing surface of the display module,
- the individual display modules directly adjoin each other so as to afford an end viewing surface of the flat display screen, which is uninterrupted on the viewing side, and
- the light sources belonging to each display module are in the form of semiconductor light sources which emit pulsed light.

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Owing to the modular structure of the display screen built up from relatively small, edgeless display modules in which a group of pixels, for example 400 pixels are combined, it is possible to generate an image whose screen pattern is hardly noticeable by the viewer with the naked eye.

Owing to the fact that each display module has its own light source, and that the full light output of said light source can be made available to each display module in each case at the correct time because of the pulsed flux of light, an extraordinarily high output density is obtained as a result thereof over the entire flat display screen. Furthermore, owing to the pulsed flux of the light, the losses within the zone of the modulators can be kept very low. Finally, the light output can be substantially increased on the each semiconductor light source without having to depend on a correspondingly increased permanent line output on the power supply side.

Preferably LED or diode lasers are used as semiconductor light sources, whereby the semiconductor light sources for each display module have at least 3 LED



or 3 diode lasers in the colors red, green and blue. Such semiconductor light sources are characterized by very high luminous density and they can be controlled in a simple manner.

Different modulator devices of the known type can be employed for modulating the flux of light, for example such as LCD's, electrostatic, electroacoustic or mechanical modulators.

However, the invention makes it possible also to employ for said flat display screen for the first time optical ceramics as modulators, in connection with which the ratio between the active and the passive surfaces is poor because large spacings have to be maintained between the modulated surfaces. Therefore, provision is made according to a further development of the invention that the modulator devices each are realized in the form of a solid-state PLZT array with a multitude of modulation cells, and an ITO control. PLTZ is an electrooptical oxide ceramic material based on lead-lanthane-zirconate-titanate whose active surfaces can be controlled by means of ITO-electrodes. An ITO is an oxide semiconductor based on indium oxide and tin oxide. Such a solid-state PLTZ array with ITO control operates with low loss, efficiently and practically free of wear. The drawback of such solid-state modulators, which substantially lies in the fact that large spacings have to be maintained



between the active switching surfaces, plays no role in conjunction with the flat display screen as defined by the invention because of the movable and optional arrangement of the light waveguides.

If necessary, provision can be made for one solid-state PLZT array per display module, with the modulation cells of said array switching the colors red, green and blue offset in terms of time. In such an arrangement it is possible to make do with one single solid-state PLZT array per display module.

As an alternative, it is possible also to make provision for three solid-state PLZT arrays per display module. Said arrays can be controlled in parallel and of which each array switches a color red, green or blue. In such an arrangement, the required switching frequency is reduced by the factor 3.

Furthermore, provision is usefully made that the display modules are arranged in a display screen frame that has a great number of module receptacles arranged in the form of a matrix. Such a display screen frame makes it possible to assemble the individual display modules to form a flat display screen in a quick and simple manner.

The display modules usefully can be locked in the



module receptacles of the display screen frame. The individual display modules can be quickly mounted in this way and, if need be, also dismantled again, for example in order to be replaced or in order to change their location in the arrangement.

As an alternative, it is possible, of course, to join the display modules arranged in the display screen frame by gluing them together, and/or by gluing them to the display screen frame.

In order to obtain defined viewing effects it may be useful under certain circumstances to cover the individual pixels with an optical foil by which the light is reflected in a defined direction or at a defined angle.

According to a useful further development of the invention, provision is made that a multitude of pixels are glued next to each other to an optical foil made of deformable material in order to form a display module. In this way, the module remains deformable within itself, so that it is possible to produce flat display screens with surfaces shaped in any desired way.

If need be, the pixels of the display modules also can be formed directly by the end surfaces of the light-



conducting fibers, which remain movable. A display screen surface that can be designed in any desired way and that takes into account all sorts of different aspects is obtained in this way as well.

If necessary, the pixels also may consists of transparent solid bodies having the shape of a truncated pyramid, with the light waveguides feeding into said solid bodies from the one side, and with the opposite side being covered by a surface scattering the light. For the purpose of forming a display module under such aspects it is possible to assemble a great number of such solid bodies with the help of suitable auxiliary means.

Finally, it is possible also to arrange the pixels of a display module next to each other on a transparent board, whereby light waveguides feed into said board from one side and separately for each pixel, whereas the board is provided with a light-scattering surface on the opposite side. Said board with the connected light waveguides then forms the display module.

In order to make the flat display screen as defined by the invention additionally insensitive to mechanical damage or shocks, it is possible to wholly or partially embed the flexible or partially flexible light waveguides in a curing compound according to their association and



the three-dimensional arrangement.

Furthermore, within the zone of the semiconductor light sources and the light modulator devices, the light waveguides each can be formed by a solid
5 body that has a three-dimensional, light-conducting structure forming the light waveguides. Such solid bodies may consists of, for example transparent glass, a translucent polyester or similar materials, in whose volumes light-conducting structures serving as light waveguides are formed by a suitable physical treatment. If such solid bodies are employed, it is, of course, necessary to
10 previously define the spatial position of the semiconductor light sources accordingly, on the one hand, and of the light modulator arrays on the other.

According to a further aspect of the present invention there is provided a process for the production of a flat display screen as described above wherein
15 the flexible or part-flexible optical waveguides after their association and the three-dimensional arrangement thereof, are entirely or partially embedded into a hardening material.

Preferred embodiments of the invention are explained in greater detail in
20 the following with the help of the drawings, in which:

FIG. 1 shows a highly enlarged vertical section through a pixel.

FIG. 2 is a highly enlarged view of the end viewing surface of a display module, which is assembled from a multitude of pixels.

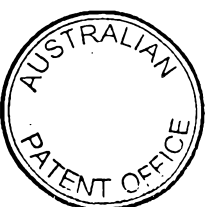


FIG. 3 is the same view as in FIG. 2, but shown in the original size.

FIG. 4 shows by a perspective/schematic view a display module and its arrangement in a frame surrounding the flat display screen.

FIG. 5 shows by a perspective/schematic view a first embodiment of the light supply and shape of a display module.

FIG. 6 shows by a perspective/schematic view a second embodiment of the light supply and shape of a display module.

FIG. 7 shows by a perspective/schematic view a third embodiment of the light supply and shape of a display module.

FIG. 8 shows by a perspective/schematic view a fourth embodiment of the light supply and shape of a display module.

FIG. 9 shows by a schematic sectional view a fifth embodiment of the shape and arrangement of a display module.



FIG. 10 shows by a schematic sectional view the shape of pixel in a modified form versus the one shown in FIG. 1; and

FIG. 11 shows by a schematic sectional view the further modified form of a display module.

In FIG. 1, the entity of as pixel is denoted by reference numeral 1. The pixel 1 has a pixel support body 2 which, on the sight side, is provided with a concave reflector 3. An optical waveguide in the form of a light-conducting fiber 4 ends at and feeds into said reflector at its lowest point. On the sight side, the reflector 3 is covered by an optical foil 5, with the help of which the outlet end of the light-conducting fiber 4 is reproduced with uniform distribution over the viewing surface. The optical foil 5 may have preferred angles of reflection in this connection.

The pixel support body 2 is designed tapering in the rearward direction in the form of a truncated pyramid, so that when the pixels are lined up next to each other and one on top of the other in the form of a matrix, free spaces remain available between the individual pixel support bodies 2. Said clear spaces widen in the rearward direction in the form of wedges and serve for receiving connecting means, for example in the form of a suitable



adhesive.

A large number, for example 400 of such pixels 1 arranged next to each and one on top of the other are assembled to form a display module 6 (see FIGS. 2 and 3). The assembled pixels 1 are located on the front side of the display module 6 and jointly form there the square, edgeless end viewing surface of the display module 6. Behind said end viewing surface 77 of the display module 6, the display module 6 has a module support body 8 that is tapering in the rearward direction in the form of a truncated pyramid, and which is provided in the zone of its side walls with the locking holes 9.

For assembling a large number (e.g. 1200) of the display modules 6 to form a flat display screen, provision is made for a display screen frame 10 that is provided with a corresponding number of the module receptacles 11, which are arranged in the form of a matrix. The individual modules 6 can be inserted and fixed in said module receptacles 11 directly bordering on each other, so that an uninterrupted end viewing surface is obtained on the sight side. The individual display modules 6 are fixed in the module receptacles 11 in that corresponding locking projections in the module receptacles 11 engage the wedge-shaped locking holes 9 of the module supports 8. Alternatively, the wedge-shaped



intermediate spaces between the adjacent module bodies 8 can be filled with a suitable adhesive. Also, the individual module bodies 8 can be glued to the module receptacles 11 of the display screen frame 10.

The pixels 1 are supplied with light by the semiconductor light sources 12 and 13 and 14 (see FIGS. 5 to 8). Said semiconductor light sources preferably are operated pulsed with a high frequency.

FIG. 5 shows that the light emitted by the semiconductor light sources 12, 13 and 14 is first supplied to an optics 155 for homogenizing the flux of the light, and from there fed into a flexible or semi-flexible light-conducting fiber bundle 16 with 400 individual fibers, and then supplied by the latter to a light modulator device 17. In all exemplified embodiments, said light modulator device 17 is realized in the form of a solid-state PLZT array with ITO control and has a total of 400 modulation cells. Each modulation cell of the light modulator device 17 is connected to a light-conducting fiber of the light-conducting fiber bundle 16. The light-conducting fibers 4 lead from each modulation cell of the light modulator device 17 to the individual pixels 1, whereby the individual light-conducting fibers 4 can be combined also here to form a flexible or partially flexible bundle of light-conducting



fibers at least over part of the length.

With such an embodiment of the display module 6 and of the light supply, the colors red, green and blue are successively modulated in terms of time.

The exemplified embodiment shown in FIG. 6 differs from the exemplified embodiment according to FIG. 5 in that a separate light modulator device 17 is used for each color. Accordingly, three light-conducting fiber bundles 16 are required in the present case. Furthermore, each pixel 1 is connected to three light-conducting fibers 4 which each are separately connected to the light modulator device 17 belonging to each color, namely extra for each color. It is possible in this way to control the three colors red, green and blue in a parallel manner, so that a switching frequency reduced by the factor three is required as compared to the embodiment according to FIG. 5. However, the present embodiment requires three times as many light-conducting fibers.

The exemplified embodiment according to FIG. 7 is different from the exemplified embodiment according to Fig. 6 in that in the present case, each pixel 1 is subdivided in the sub-pixels 1a, 1b and 1c, of which each one is responsible for a color red, blue or green, and is connected to the light modulator device 17 belonging to



said color via the light-conducting fibers 4.

The exemplified embodiment according to FIG. 8 corresponds with the exemplified embodiment according to the exemplified embodiment according to FIG. 5 with respect to the light supply; however, the individual pixels 1 are loosely arranged in the present case and are formed by the end surfaces of the individual light-conducting fibers 4. With the present exemplified embodiment, the format of the display modules 6 can be varied at any time in any desired way.

FIG. 9 shows that the individual pixels 1 can be glued also to an optical foil 18, if need be, said foil being elastically deformable. This results in a flexible viewing surface of the display module 6, which can be adapted to any desired spatial form.

It is important in connection with all embodiments that the light-conducting fibers 4 and the light-conducting fiber bundles 16 are designed flexible or partially flexible, so that the pixels 1 or the display modules 6 assembled from the pixels 1, and the modulator devices 17 or the semiconductor light sources 12, 13, 14 are decoupled from one another in terms of space.

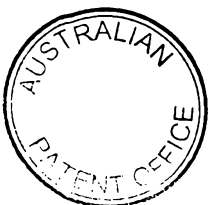
FIG. 10 shows that the pixel 1 may also consist of a



transparent solid body 20 in the form of a truncated pyramid, if need be, into which the light waveguide coming from the one side feeds in the form of a light-conducting fiber 4, and which is provided with a light-scattering surface 21 on the other side. The transparent material of such a solid body has a higher refractive index than air, so that total reflection occurs on the sides. A great number of such solid bodies 20 can be combined to form a display module, using suitable auxiliary means.

In connection with the display module shown in FIG. 11, the individual pixels 1 are located on a through-extending board 23 consisting of transparent material. Light waveguides in the form of the light-conducting fibers 4 feed into said board from one side, namely separately for each pixel 1. On the opposite side, the transparent board 23 is provided with a transparent light-scattering surface 24 that is transparent as well and serves as the end viewing surface. In the present case, the board 23 provides for the cohesion of the display module.

In connection with all exemplified embodiments, the flexible or partially flexible light waveguides 4, 16 can be wholly or partly embedded in a curing compound after they have been associated and arranged in the three-



dimensional manner. In this way, the flat display screen as defined by the invention is rendered more insensitive to mechanical damage and shocks.

Deviating from the exemplified embodiments shown, the light waveguides 16 each can be formed within the zone between the semiconductor light sources 12, 13, 14 and the light modulator devices 17 by a solid body having a three-dimensional, light-conducting structure that is forming the light waveguides.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A flat display screen for representing an image by means of a plurality of pixels arranged in matrix form, in which groups of pixels are combined to form display modules which are similar to each other and which jointly form the flat display screen and which are respectively connected by way of flexible or part-flexible optical waveguides to a light source belonging to each display module wherein a light modulator arrangement is connected into the optical waveguides leading to each display module wherein

- 10 - the combined pixels which are disposed at the front side of the display modules respectively form a rimless end viewing surface of the display module,
- the individual display modules directly adjoin each other so as to afford an end viewing surface of the flat display screen, which is uninterrupted on the viewing side, and
- 15 - the light sources belonging to each display module are in the form of semiconductor light sources which emit pulsed light.

2. A flat display screen according to claim 1 characterised in that the semiconductor sources for each display module have at least three LED- or diode lasers in the colours red, green and blue.

3. A flat display screen according to claim 1 or 2 characterised in that the modulator arrangement are respectively formed as PLZT solid-state arrays with a plurality of modulation cells and an ITO-actuation means.

4. A flat display screen according to claim 3 characterised in that there is provided for each display module a PLZT solid-state array whose modulation cells modulate the colours red, green and blue in time succession.

5. A flat display screen according to claim 3 characterised in that for each display module there are provided three PLZT solid-state arrays which modulate the colours red, green and blue in parallel in respect of time.



6. A flat display screen according to any one of the preceding claims characterised in that the display modules are arranged in a display screen frame having a plurality of module mountings arranged in matrix form.

5 7. A flat display screen according to claim 6 characterised in that the display modules are latchable into the module mountings of the display screen frame.

8. A flat display screen according to claim 6 characterised in that the
10 display modules which are fitted into the display screen frame are glued to each other and/or to the module mountings of the display screen frame.

9. A flat display screen according to any one of the preceding claims characterised in that the individual pixels are covered by an optical foil from
15 which the light is radiated in given directions or angles.

10. A flat display screen according to any one of claims 1 to 8 characterised in that a plurality of pixels for forming a display module are glued in mutually juxtaposed relationship on to an optical foil of deformable material.
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11. A flat display screen according to any one of the preceding claims characterised in that the pixels of the display module are formed directly by the end faces of the movable optical waveguides.

25 12. A flat display screen according to any one of claims 1 to 10 characterised in that the pixels respectively include transparent frustopyramidal solid-state bodies into which the optical waveguides open from one side and which are provided at the opposite side with a light-diffusing surface.

30 13. A flat display screen according to any one of claims 1 to 10 characterised in that the pixels of a display module are arranged in mutually juxtaposed relationship on a transparent plate, wherein optical waveguides open in said plate from one side and separately for each pixel while at the opposite side the plate is provided with a light-diffusing surface.



14. A flat display screen according to any one of the preceding claims characterised in that in the region between the semiconductor light sources and the light modulator arrangements, the optical waveguides are respectively
5 formed by a solid-state body having a three-dimensional light-guiding structure which forms the optical waveguides.

15. A flat display screen for representing an image by means of a plurality of pixels arranged in matrix form substantially as herein described with reference
10 to the accompanying drawings.

16. A process for the production of a flat display screen according to any one of the preceding claims wherein the flexible or part-flexible optical waveguides after their association and the three-dimensional arrangement thereof, are
15 entirely or partially embedded into a hardening material.

DATED: 4 July, 2001

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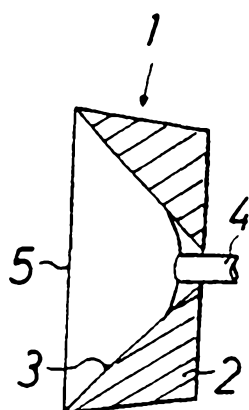


FIG. 1

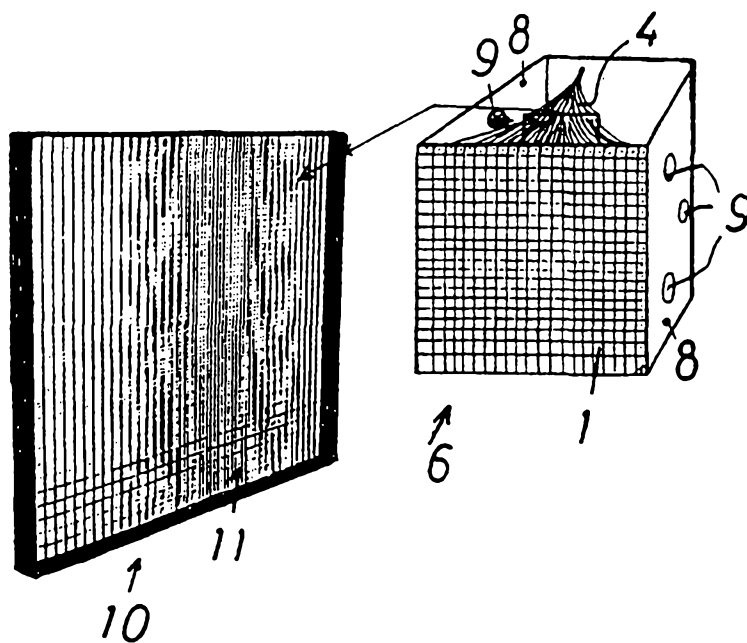
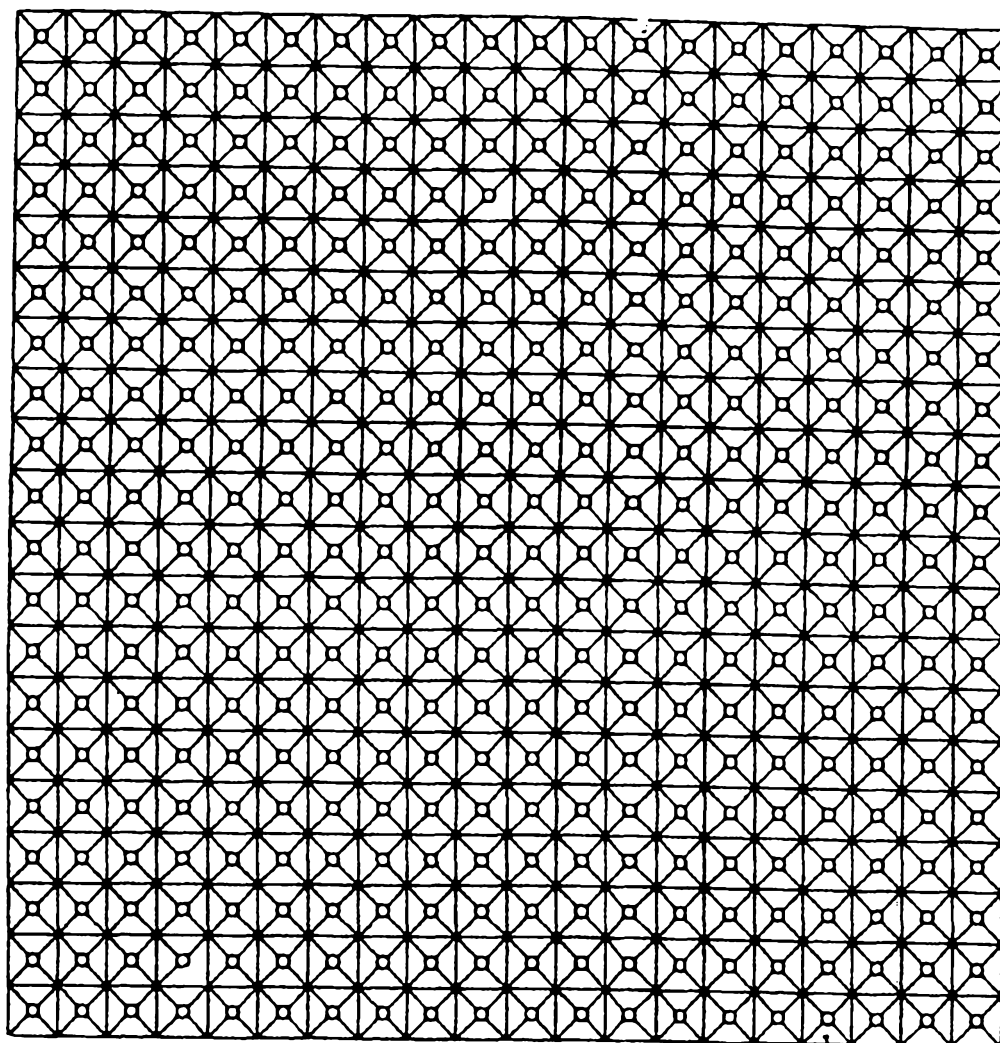


FIG. 4

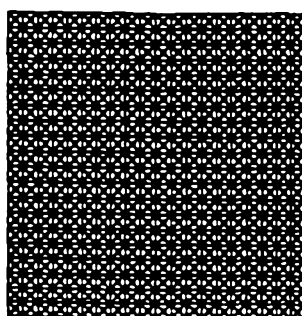
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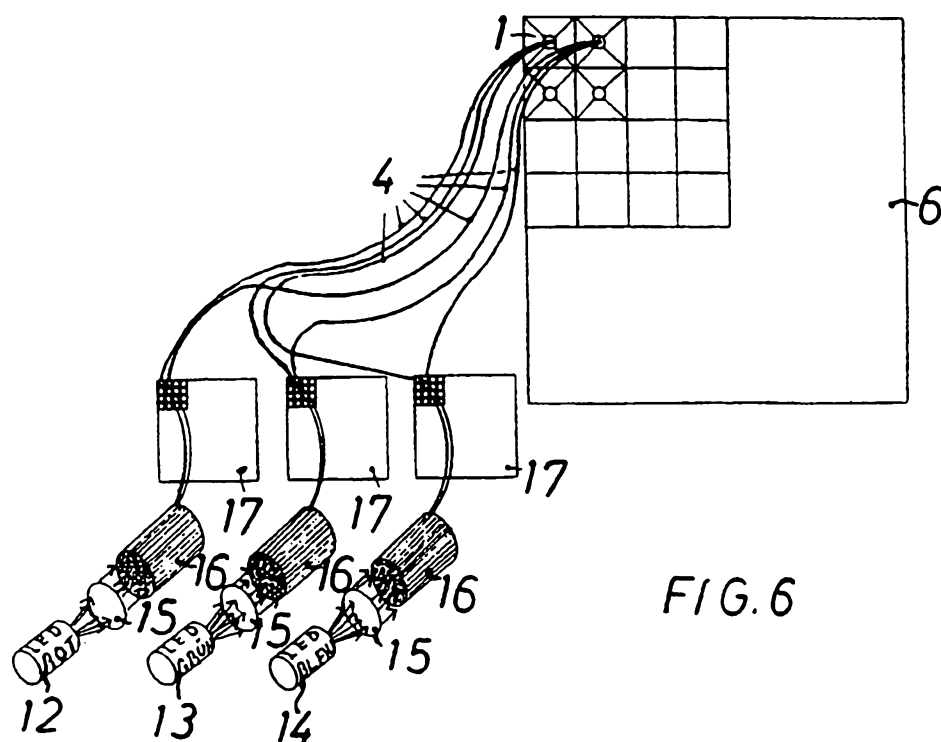
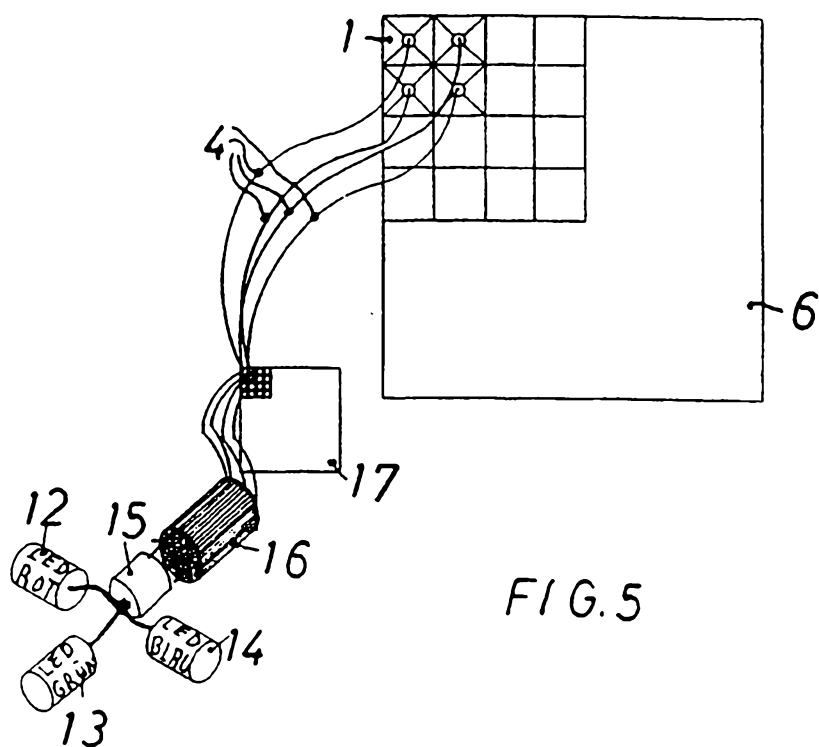
FIG. 2

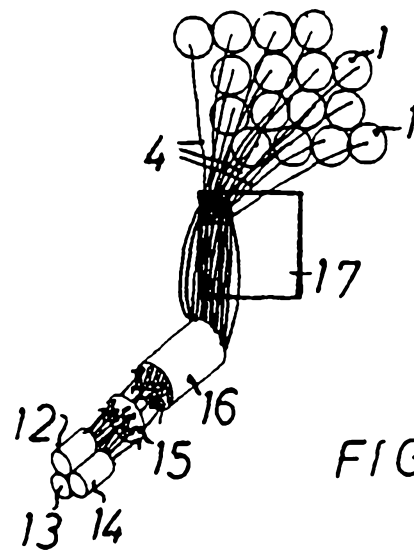
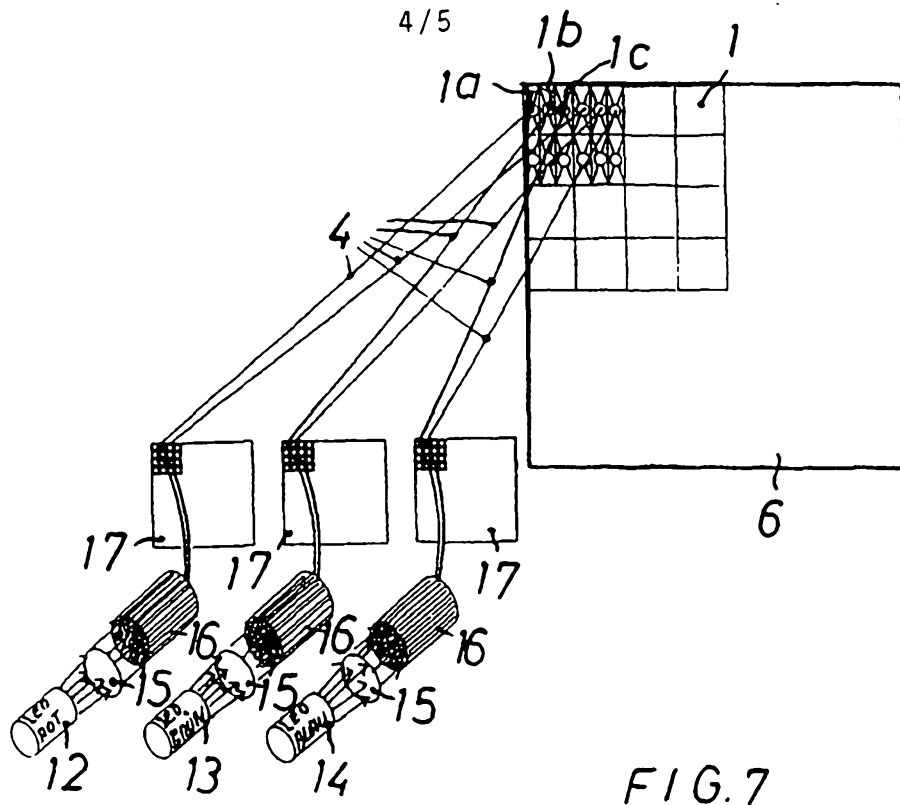


← 6

FIG. 3

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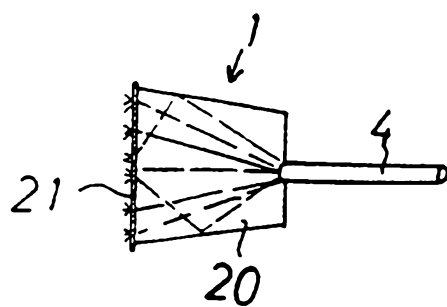
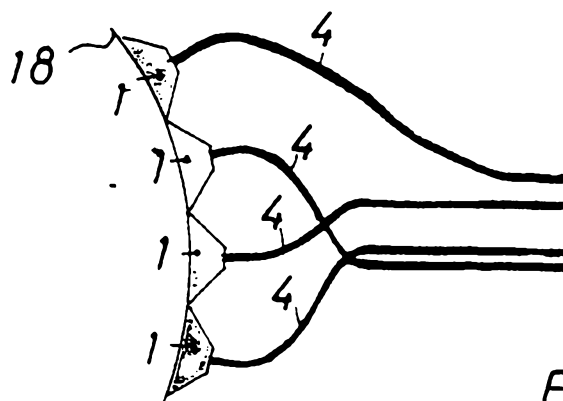


FIG.10

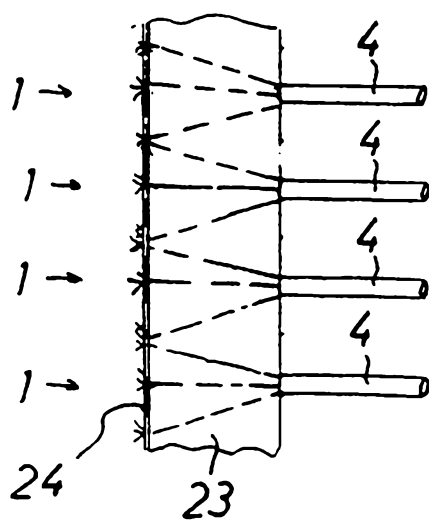


FIG.11