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WO 2005/091258 A1 **DE 003633565 A1**
US 20090322651 A1

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Other: **EPODOC, WPI, TXTE.**

(54) Title of the Invention: **Tiled Display and method for assembling same**
Abstract Title: **Tiled display and method for assembly**

(57) Tiled display and method for assemblyA tiled display comprising discrete luminous sources distributed over at least two adjacent flexible display tiles 30, 40, each being configured to drive the discrete luminous sources on it when connected to a power supply and when receiving data and control signals. The power, data and control signals are provided to the tiles trough conducting tracks (20, figure 2B) formed on a carrier substrate (10, figure 2B), wherein at least one of the conducting tracks extends from one edge of the carrier substrate to the opposite edge of the carrier substrate.

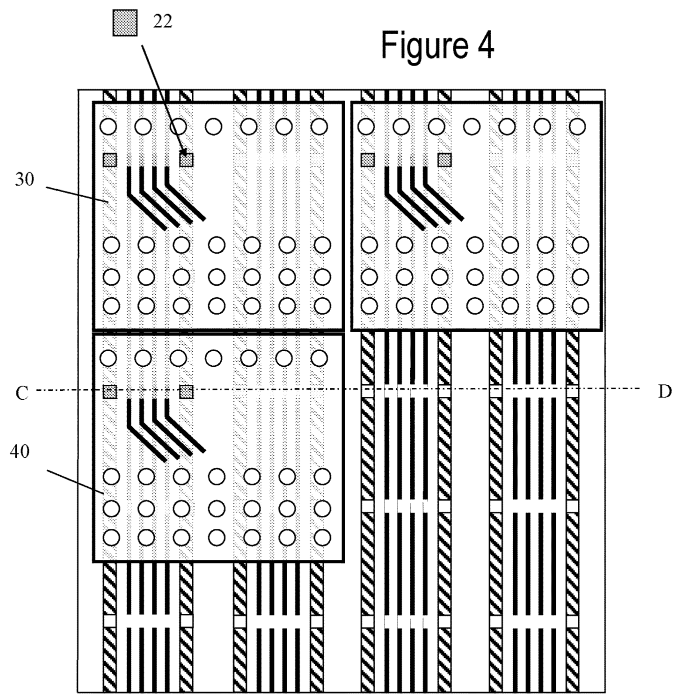

Figure 4

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

06 01 15

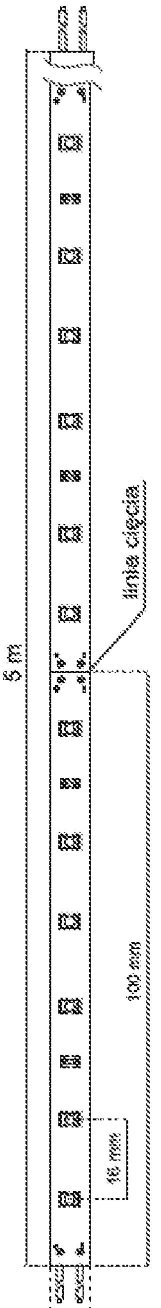

Figure 1a

06 01 15

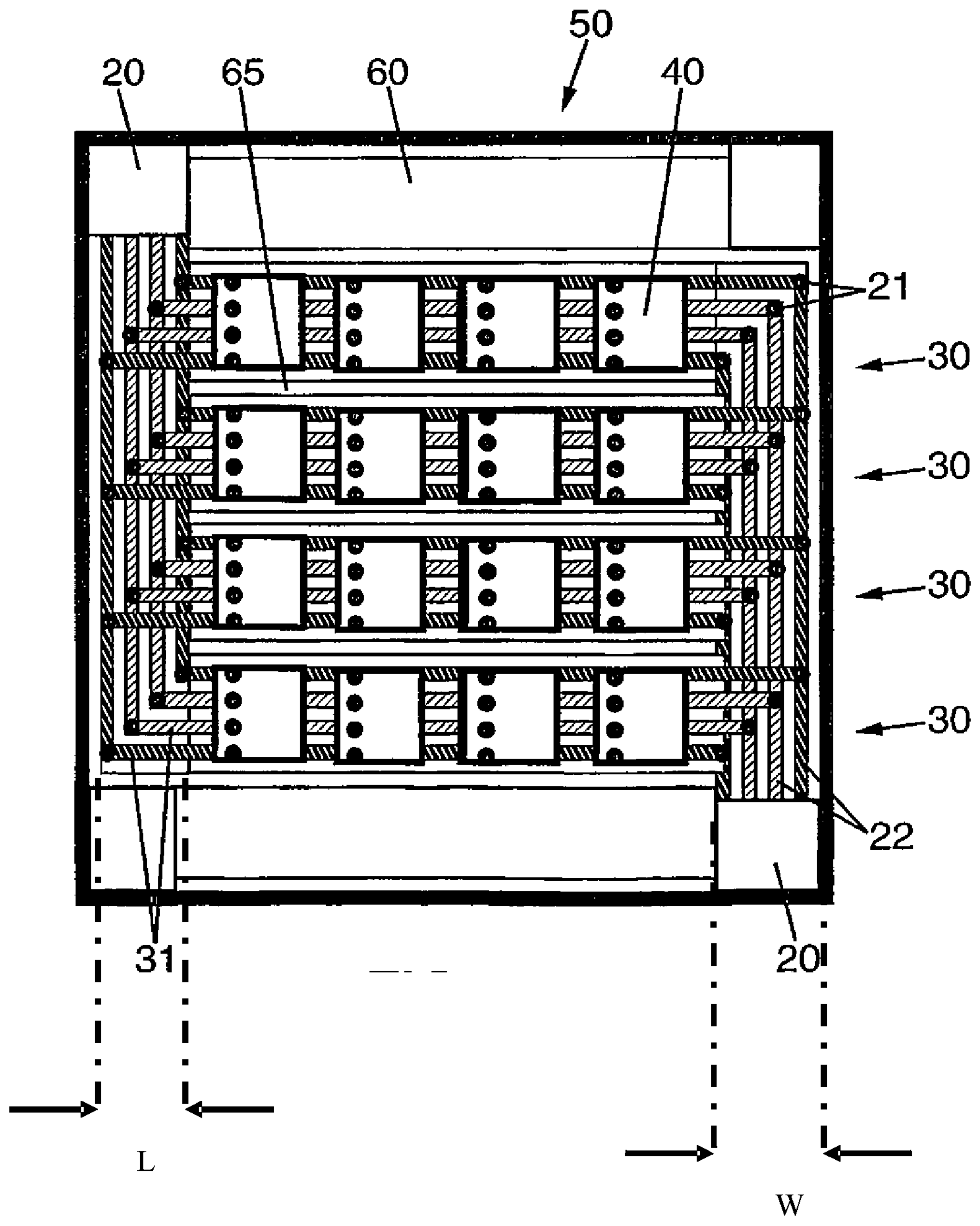

Figure 1b

06 01 15

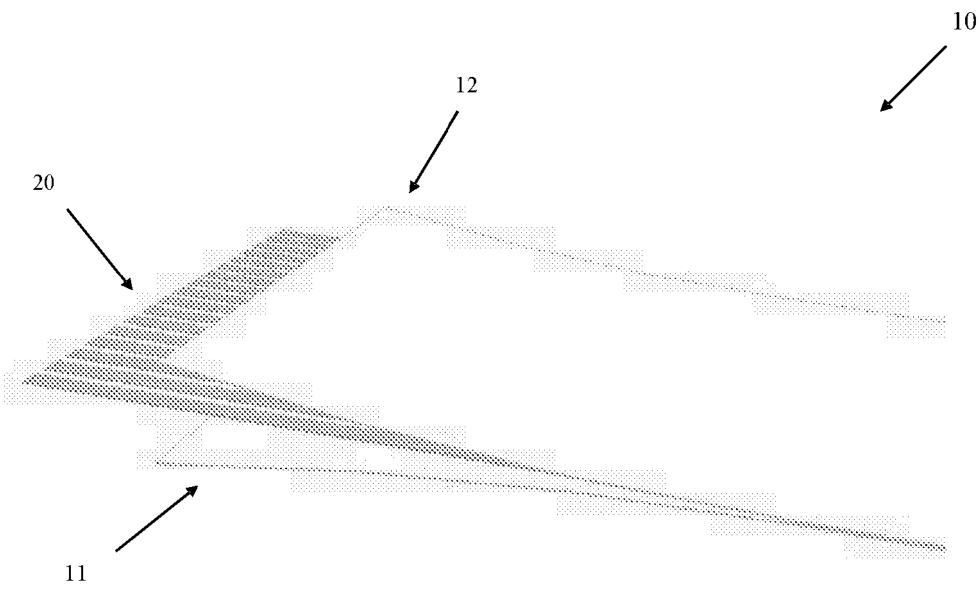

Figure 2a

06 01 15

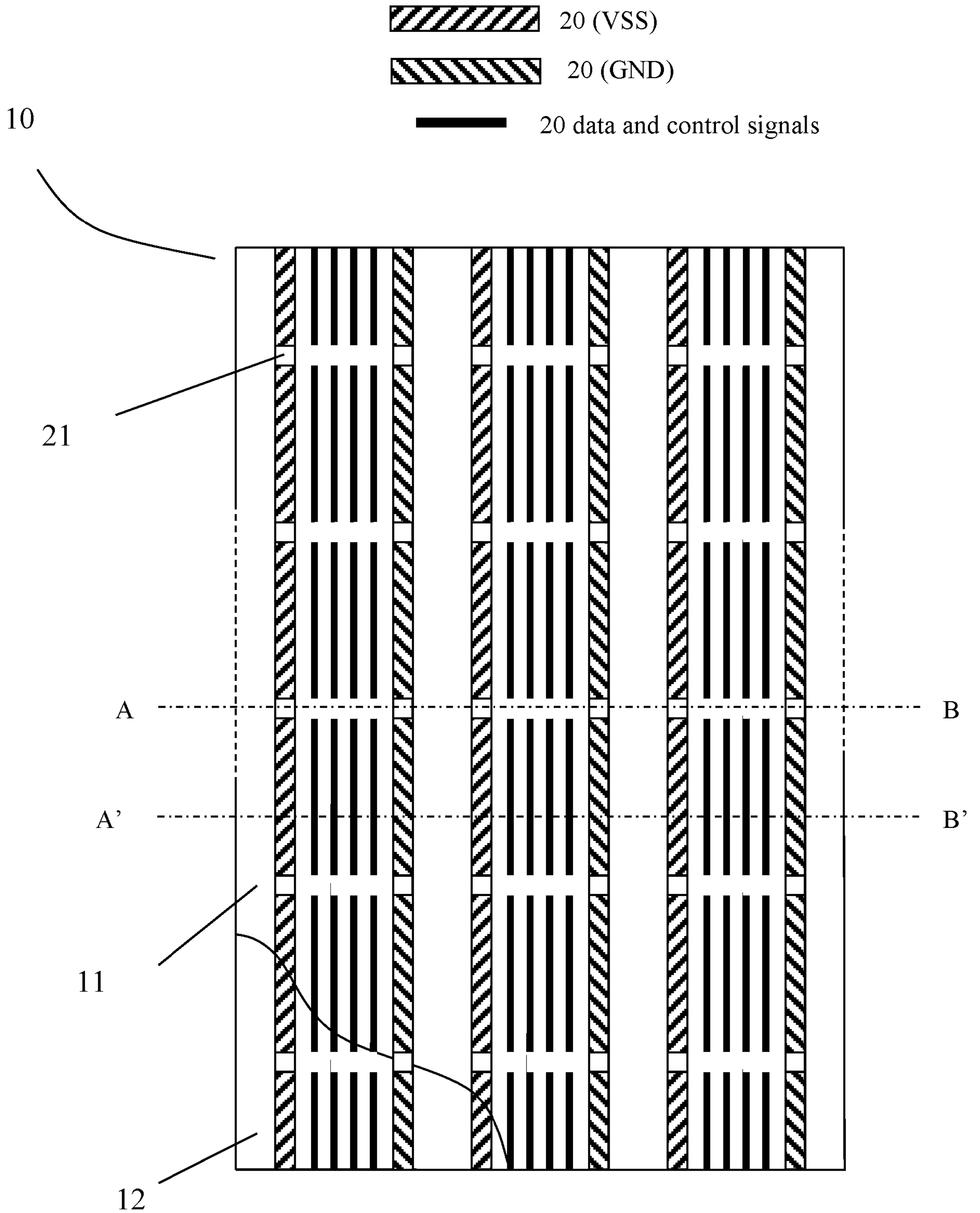

Figure 2b

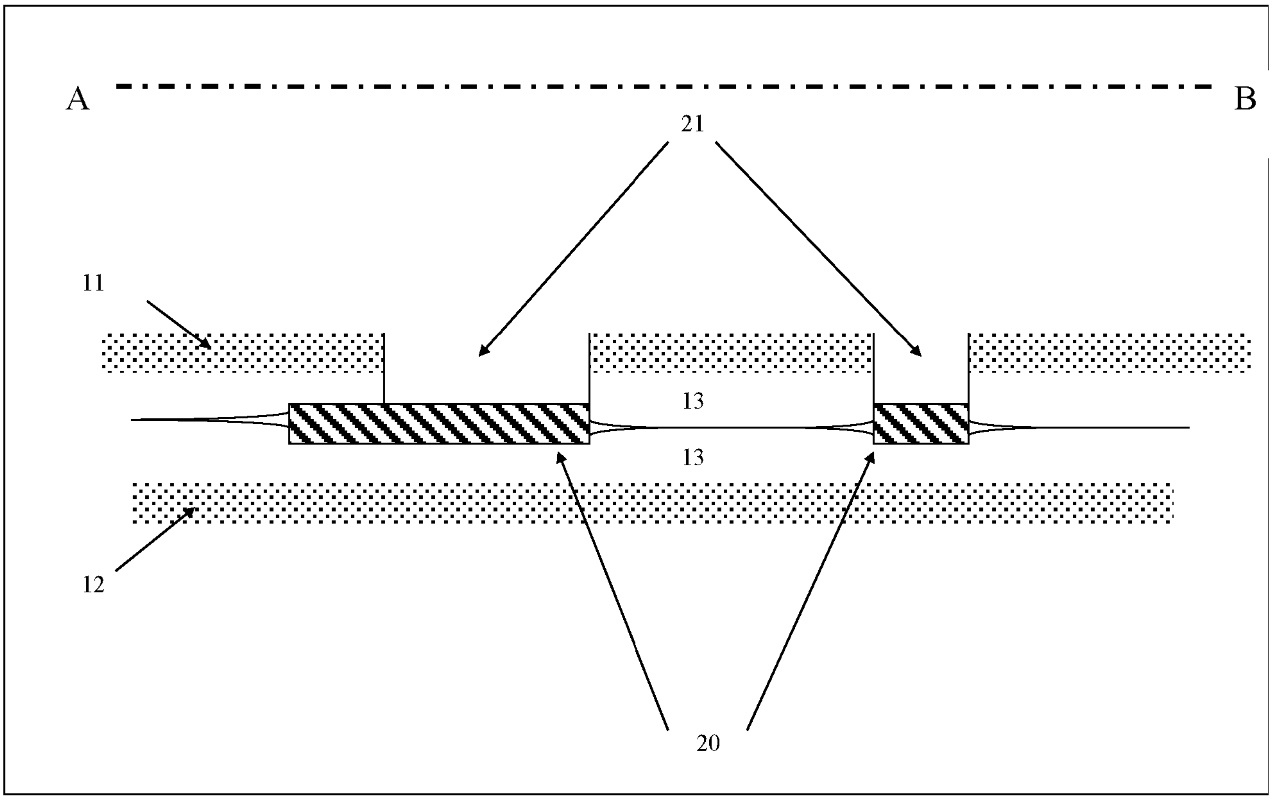

Figure 3a

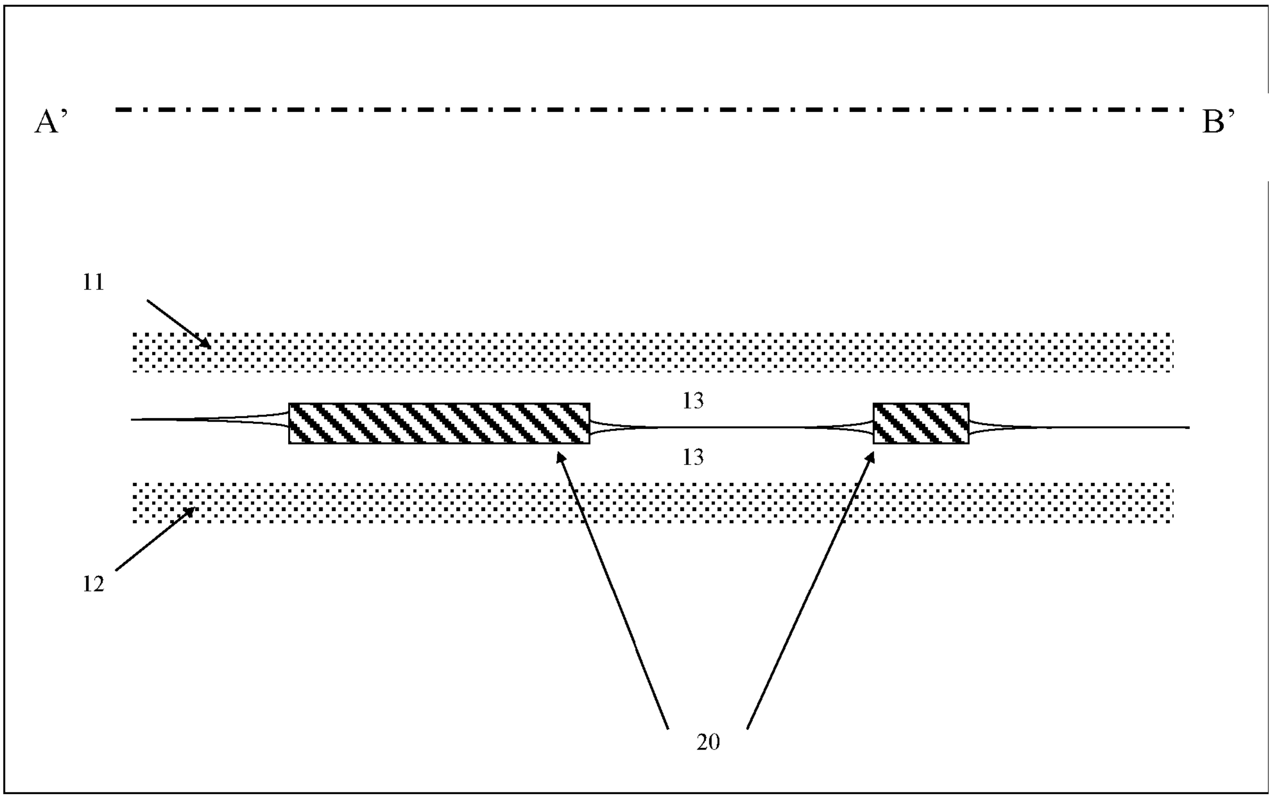

Figure 3b

Figure 3

06 01 15

06 01 15

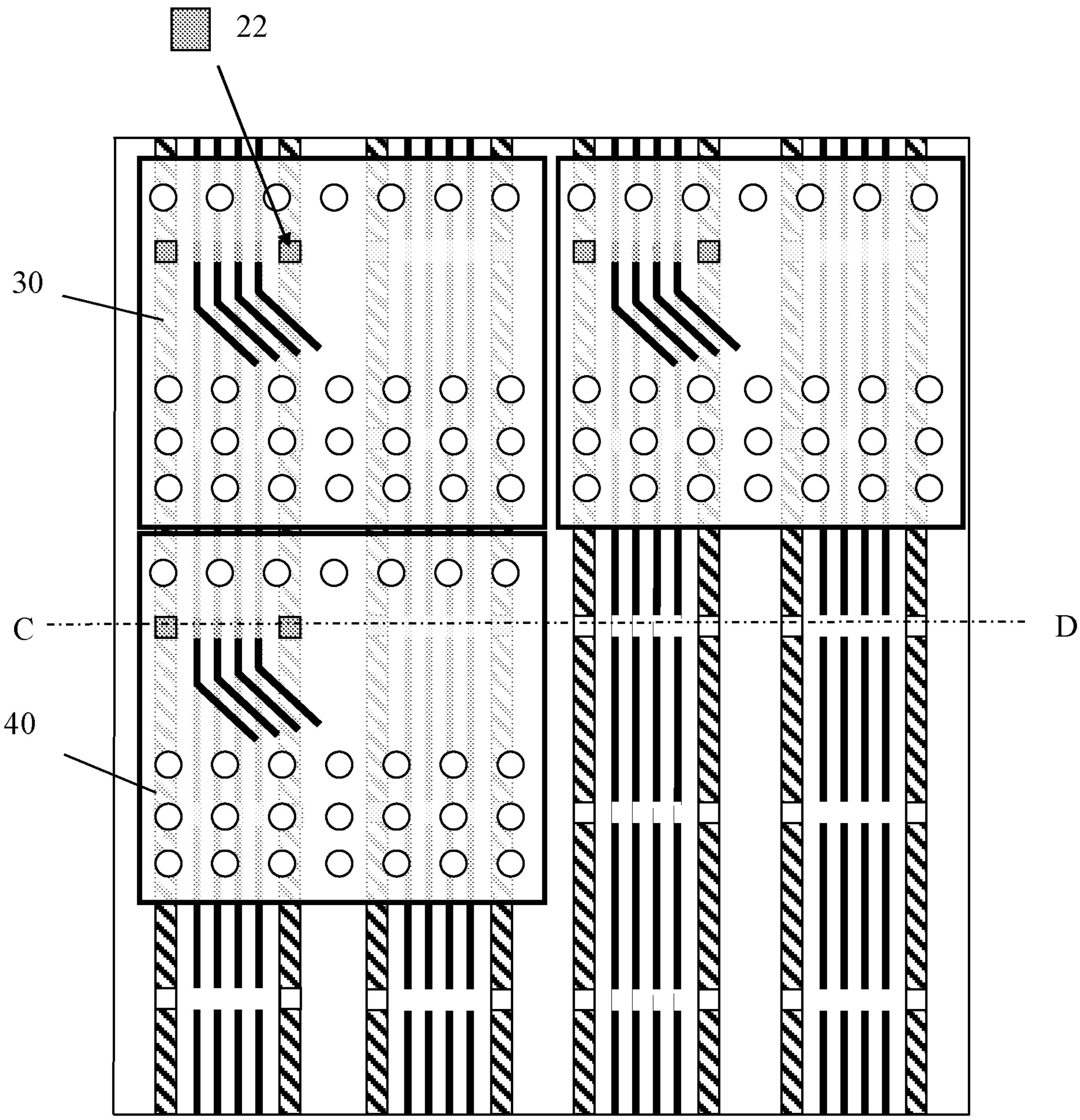

Figure 4

06 01 15

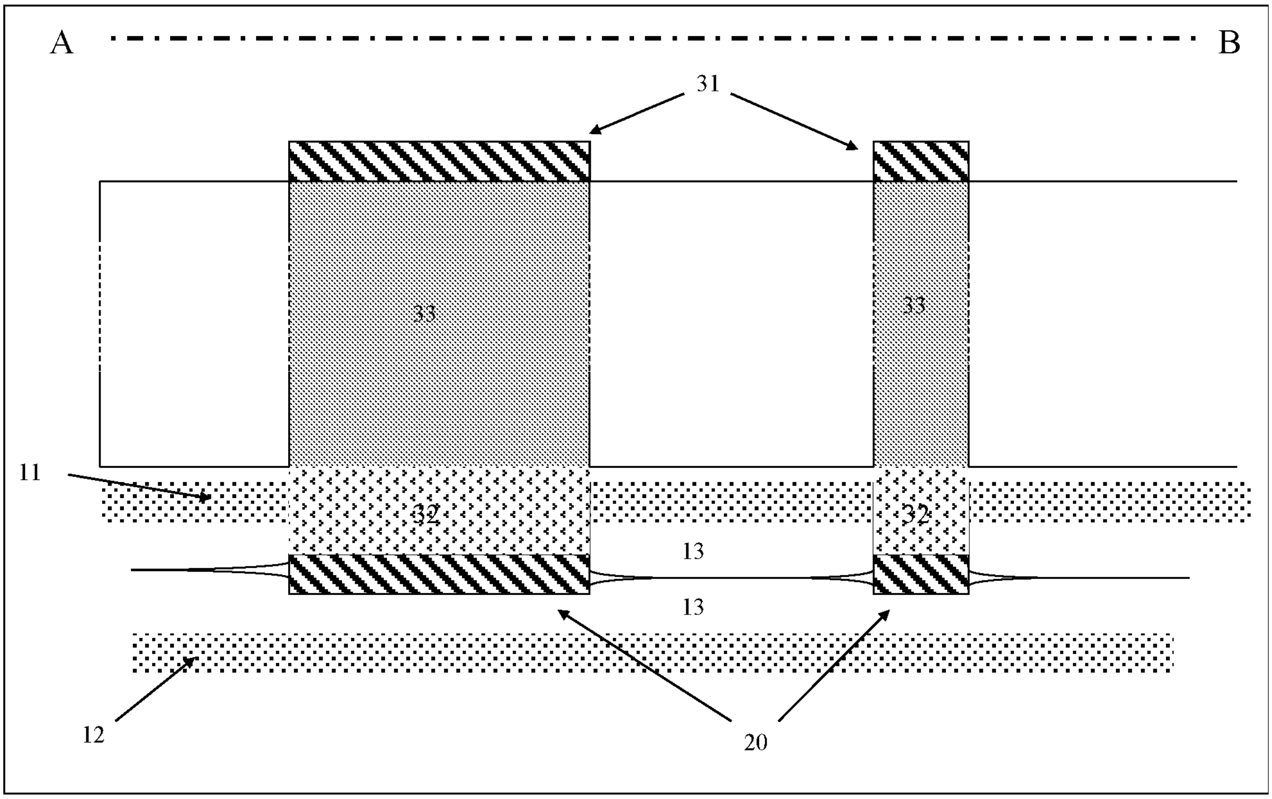

Figure 5

Figure 5

06 01 15

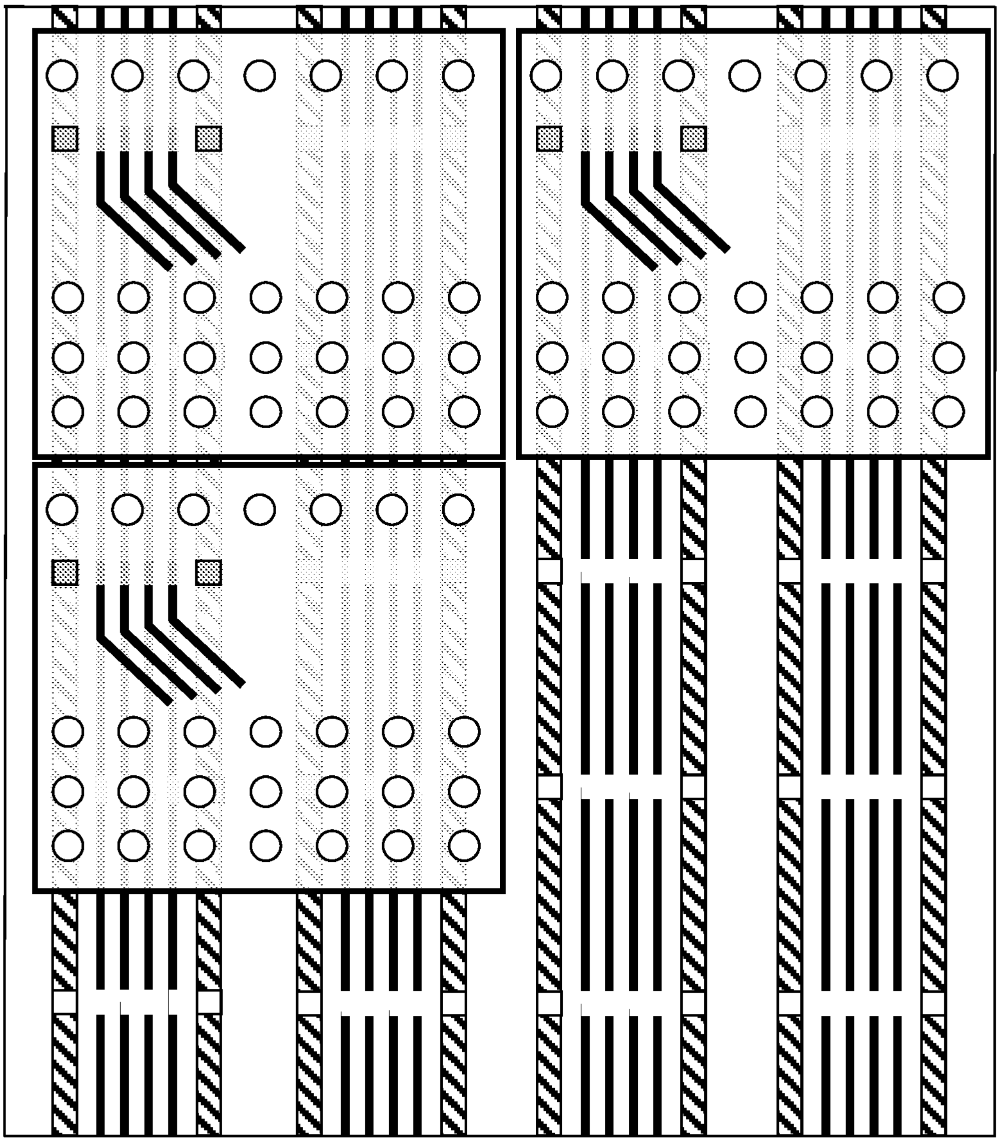

Figure 6a

06 01 15

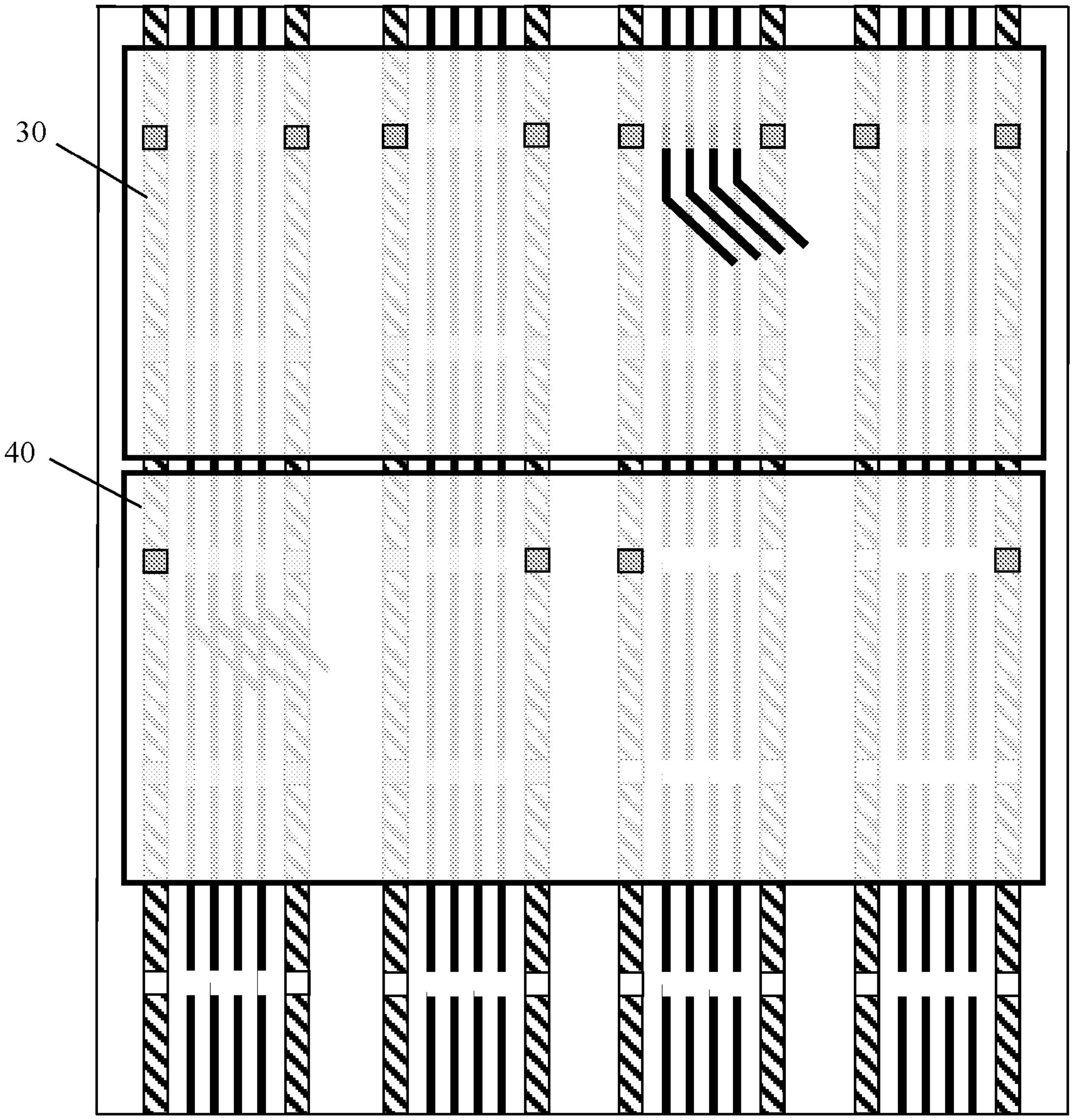

Figure 6b

06 01 15

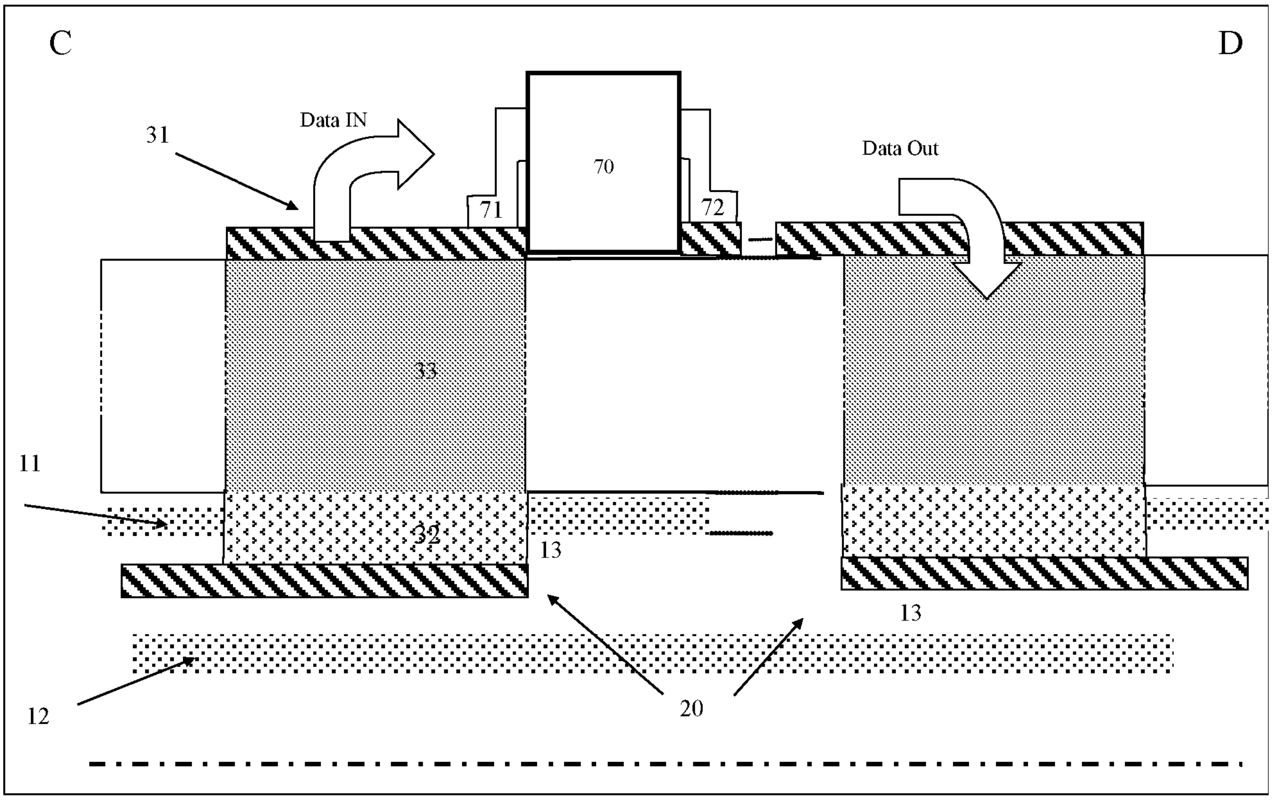

Figure 6c

Figure 6c

06 01 15

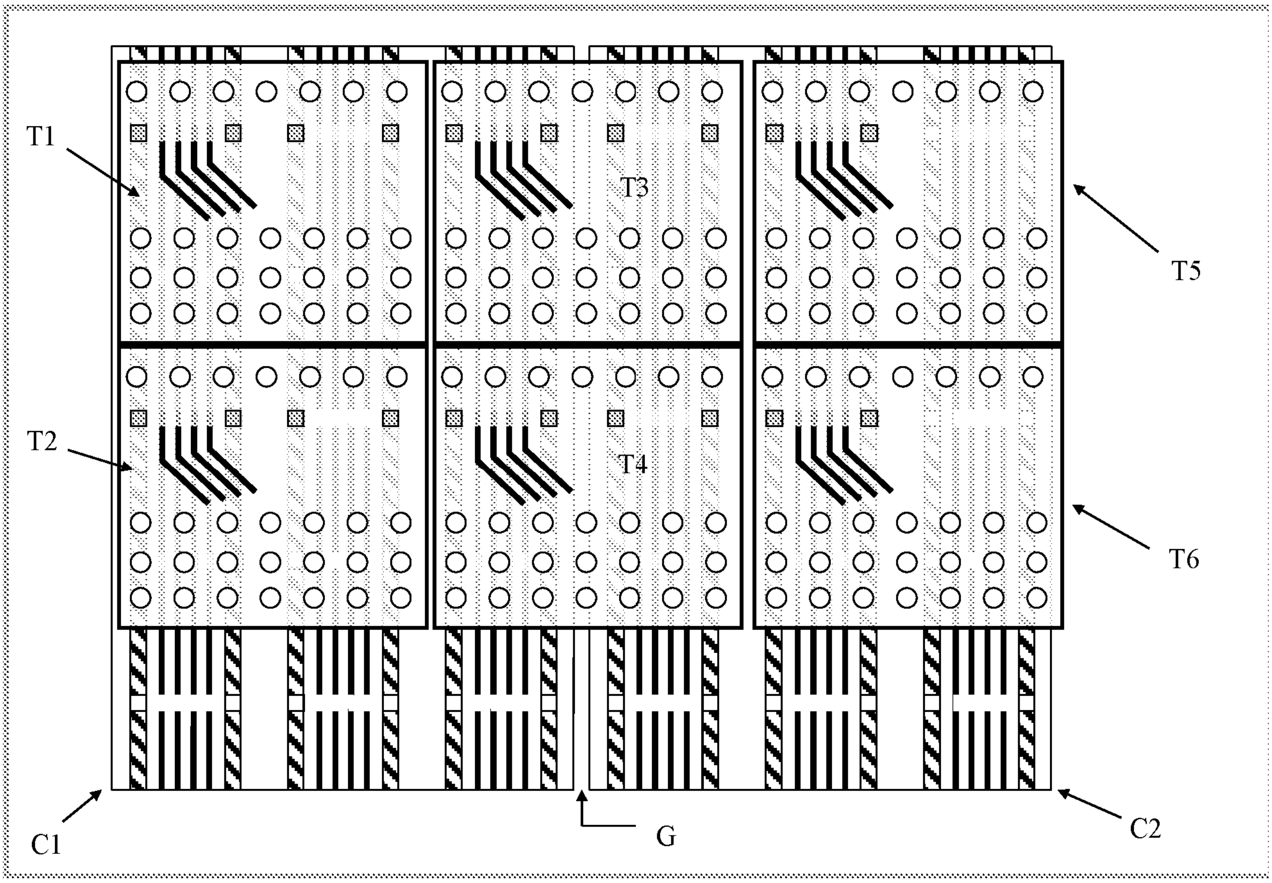

Figure 7

Tiled Display and Method for Assembling Same

Field of the Invention

The present invention pertains to the field of displays, in particular to the field of tiled displays.

Background

As exemplified by the LED display described in the prior art and in particular US 5,900,850, typical large tiled display devices require bulky structures to support the display tiles and keep them aligned.

US 8,434,963, assigned to ORBUS, and EP 2 459 888 A1, in the name of the present applicant, give other examples of metallic support structure made of pultruded beams. Both documents describe solutions to problems such as axial and planar alignment of display tiles and illustrate problems such as assembly and disassembly of the support structure and concealment of the support structure.

US 2010/0135032 and US 2007/0218751, both assigned to Element Labs, Inc., are more particularly concerned by hanging tiled displays. They offer solutions to simplify assembly and maintenance of such displays but these solutions still present challenges at the time of assembly and disassembly.

EP 1 650 731 A1, in the name of the present applicant, discusses the mounting and fastening of one display element or tile to a display structure. EP 2 110 801 A2, in the name of Element Labs, Inc., is concerned with the fastening of the display element or tiles to a support structure and the alignment of the display tiles. While the solutions proposed in both documents simplify the assembly and servicing of the display element, both the fastening means and the support structure remain cumbersome.

One of the disadvantages of conventional LED display screens is that they are large, thick and heavy. For example, a 1 m^2 8x8 LED display module 8 (2088AEG) weighs about 24.6 kg. Strong and heavy frames or supports are needed to support these LED display screens to ensure safety in the assembling process. The thickness of a conventional LED display screen is in the range of 5 cm to 50 cm. These conventional LED display screens are made of rigid PCB and can only be mounted on flat surfaces.

In one embodiment of EP 2 023 391 A2, a flexible LED screen may include a fixation layer coupled to a rear surface of the flexible printed circuit board to facilitate the fixing of the flexible LED screen to a support structure.

The fixation layer includes a plurality of openings sized and shaped to allow the integrated circuits to be situated therein. The fixation layer may be made of magnetic rubber and may have a thickness of about 1.5 mm. The fixation layer serves to fix the flexible printed circuit board on a wall or any supporting structure.

If fixed on a wall, connection means to power, data, and control signals must be provided.

If the flexible LED screens described in EP 2 023 391 A2 are tiles of a larger tiled LED display, the number of power and signal conducting cables and connectors increases rapidly. The number of cables may make the resulting structure very cumbersome. The cables may have to be hidden behind the display for aesthetic reasons, in which case a solution has to be found to guarantee that cables snaking between wall and the fixation layer will not affect the stability of the structure (e.g., by weakening adhesion to the wall) and will not introduce visual artefacts (by local bending of the tiles at those places where cables and tiles are in contact).

The cables may have to be routed between the tiles, in which case the dimensions of the cables will impose a minimum pixel pitch and resolution to avoid visual artefacts caused by pixel pitch variation between the outer pixels of adjacent tiles.

A screen of large dimensions is usually realized by combining several identical screen units of smaller dimensions. In most cases, a seam will be visible at the border between two adjacent units or tiles. Those seams have to be kept as discrete as possible and are often painted in black. To make things worse, thermal expansion can cause the seams to evolve differently across the screen with serious consequences for the visual perception of the displayed image. One of the main specifications of display quality is uniformity in colour and brightness. For a tiled display, obtaining colour and brightness uniformity is often even more difficult, because the tiles and their seams form a regular structure, which is very easily detected by the human eye. It is known that if a human eye observes a uniform plane, even the smallest local non-uniformities, such as a small variance on the mechanical seams, become visible.

Flexible LED strips are now available off-the-shelf (see figure 1a). They consist of a flexible substrate with adhesive tape on one side and LEDs and conducting tracks on the other side. The strips can be glued even to irregular surfaces. The flexible substrate is of the type commonly found in electronic appliances. The strips are available as 5 meter rolls. Realizing a display with $N > 1$ rows of $M > 1$ LEDs can be considered easy if there is a wall or surface available to glue the strips. Each strip will also have to be connected to a controller or the strips will have to be daisy-chained with ad-hoc cabling that is likely to be as cumbersome as that of the solutions previously described. The control of the pixel pitch between two parallel strips can be difficult to guarantee, which means that visual artefacts are likely to affect the display synthesized with the $N > 1$ parallel strips.

EP 1 716 553 A1 discloses a flexible tiled display **50** (see Fig. 1b) that solves some of the problems encountered with the LED strips. Flexible strips **30** comprising Light Emitting Diodes (LED) are cut so that each comprises a given number of LED modules **40** and/or has the required length for the flexible display **50.** The strips are placed parallel to each other on a peripheral flexible circuit **60.** The flexible circuit **60** consists of a flexible substrate (made of e.g. polyimide or PVC) on which electrically conducting tracks **22** have been formed. The tracks **22** connect the flexible strips **30** to supply and control circuits **20** via solder point **21** between tracks **22** on the substrate **60** and tracks **31** on the flexible strips **30.** The tracks **22** are located on the periphery of the flexible substrate **60** and the flexible display **50.** In essence, the display **50** consists of several tiles **30** spread over a single substrate **60.**

The problems with the display proposed in EP 1 716 553 A1 are:

(a) The length L of the portions of conductor strips **31** on both extremities of flexible strips **30** must be at least as long as the width W of the bundle of tracks **22** to allow connections between all tracks **31** and tracks **22.** The ribbons being produced continuously and cut to length to fit on the circuit **60,** this means that the distance between pixel modules **40** on the flexible strips **30** will have to be equal or larger than W. The achievable resolution is therefore limited by the width of the tracks **22.** Indeed, if two tiles **50** were assembled side by side to realize a larger tiled display, L and W have to be equal in order not to introduce visual artefacts caused by variation in the distance between pixels on the adjacent edges of the two tiles.

(b) The flexible strips **30** must be almost as long as the display **50** itself. For large displays **50** this may be a problem. Indeed, flexible LED strips are available as rolls of e.g. 5 meter or 10 meter long. A display with dimensions larger than 5 or 10 m would therefore require the tiling of at least two displays **50** as described in EP 1 716 553 A1, leading to the assembly problems discussed earlier. There would also be a problem between tiles. The distance between tiles would be at least twice the width W of the bundle of conductor strips at the periphery of the displays **50**. The pixel pitch across the tiled display would therefore not be constant and lead to undesirable visual artifacts.

(c) If one LED module is defect, on-site servicing will require the replacement of the entire tile **30** on which the defect LED is located as is usually the case for tiled displays (see e.g. US RE 41,603 E). The dimension of the tile **30** being always as large as either the length or width of the display **50**, this is not practical for displays several meters across, in particular if the replacement has to be done on site.

(d) The tracks **31** on tile **30** have to conduct power to all the LEDs on that tile. This will either require increasing the thickness of the tracks **31** or change the material of which they are made (impacting flexibility and/or cost) or their width (which may require increasing the width of the flexible strip **30** and decrease the resolution).

(e) The connections (solder points) **21** between tracks **22** and **31** will have to conduct the current needed for all the LEDs on tile **30**. For large displays this may lead to reliability issues as current increases linearly with the number of LED on the tile **30**.

(f) Even if the strips **30** can be made long enough to extend form one end to another of a very large tiled display **50**, the substrate **60** still has to be of one piece. Any problem with the substrate **60** would then require a disassembly of the entire display. For very large displays, this can be too unpractical and/or costly.

It is a purpose of embodiments of the present invention to at least partially overcome one or more of the above disadvantages.

Summary of the Invention

What is needed is a tiled display requiring a minimum of ad-hoc cabling, with as little perceptible discontinuity as possible at the seams (the region of a tiled display between two adjacent tiles), requiring as little support infrastructure as possible, with little or no impact on the reliability of the mounted display (mechanical failure, degrading performances over time and in particular variations of the distance between adjacent tiles, easy maintenance …). The components of the display should be modular to allow the realization of displays with arbitrary numbers of rows and columns of LEDs (or more generally pixel or picture elements) with off-the-shelf components and parts. The display should preferably be flexible, or include flexible components so as to accommodate different geometrical deployments.

According to an aspect of the present invention, there is provided a tiled display comprising discrete luminous sources distributed over at least two adjacent flexible display tiles, each of the flexible display tiles being configured to drive the discrete luminous sources on it when connected to a power supply and when receiving data and control signals; wherein the power, data and control signals are provided to the tiles trough conducting tracks formed on a carrier substrate, wherein at least one of the conducting tracks extends from one edge of the carrier substrate to the opposite edge of the carrier substrate. The tiled display is preferably flexible.

For the purposes of the present description, terms such as “top” and “bottom” refer to the side of the panel on which the light emission takes place and the opposite side, respectively, and the term “vertical” refers to the direction perpendicular to the top and bottom planes.

Embodiments of the present invention solve some of the problems of the prior art by assembling a tiled display, which may be flexible. The display tiles themselves are advantageously made on a flexible substrate in order to accommodate the deformations, caused e.g. by wind when the setup is used outdoors, of the carrier substrate.

Modularity of the proposed system is enhanced when at least one of the conducting tracks providing the power, data and control signals extends from one edge of the carrier substrate to the opposite edge of the carrier substrate along the length of the carrier substrate, as shown in figure 2b. Modularity means that the same carrier substrate can be used to realize display tiles of different dimensions and/or accommodating tiles of different dimensions from one tiled display to the other as illustrated by figures 6a and 6b.

The modularity is further enhanced when at least one of the power, data or control signals is provided on at least two separate conductive tracks on the carrier substrate.

In another aspect of the invention, the modularity is further enhanced when the power, data and control signals are each provided on at least two separate conductive tracks on the carrier substrate. This aspect of the invention can be used to improve the reliability of the display panel. Indeed, let us consider a tiled display with each display tiles overlapping two sets of power, control and data signal tracks as illustrated on figure 6c. If the power were lost on e.g. one of the conductive tracks; the corresponding signal would still be provided to the tile by the other power track running under the tile. Depending on the design of the display tiles, the power will be available to those LEDs that draw power from the remaining track, thereby allowing a “graceful” degradation of the performance of the system versus all LEDs of the tile being unpowered or the power provided by the remaining track can be redistributed.

In another aspect of the invention, the modularity is further enhanced when the pattern of conductive tracks carrying the power, data and control signals is periodical as illustrated on figure 2b.

Ease of assembly is achieved by realizing the connections between the tiles and the conducting tracks right under the display tiles. By “right under a tile” is meant that a conductive element will make contact with a conductive track under the tile. This does not exclude that the conductive element can go through the thickness of the tile as is the case with e.g. vias that will conduct the signal on the conductive track on the carrier substrate to the side of the display tile were the LEDs are positioned. Instead of vias, an electrically conductive drawing pin, a.k.a. push pin or thumb pin, can be used. The push pin may comprise an elongate body and a substantially flat head in electrical contact with the body. The body of the push pin will pierce the tile and the substrate carrier at the vertical of a track and will contact the track while at the same time fastening the tile to the carrier substrate. The flat head is used to establish contact with the circuitry on the display tile. Fastening of the tile to the carrier substrate is enhanced by e.g. bending the body of the push pin behind the carrier substrate.

Assembly of the tiled display is made easier in that the electrical connections between a display tile and a conducting track on the carrier substrate are done through pre-existing openings in the carrier substrate at the vertical of the conducting track and pre-existing vias in the display tile. An opening is provided in a layer protecting the conductive track to facilitate the contact with the conductive track. The pattern of openings in the carrier substrate can be periodical. This will further enhance the modularity of a tiled display system according to this invention. Indeed, the dimension of a display tile and the places on the display tile where contact must be made between tile and tracks can be chosen so that identical display tiles can be assembled with a carrier substrate and fill the area of the tiled display with LEDS all spaced at regular intervals and minimize the impact of the inter-tiles seams.

The connection between a conductive track on the carrier substrate and a tile is advantageously made with a conductive glue or a conductive adhesive tape with a metallic conductive core e.g. a copper core as illustrated in figure 5. The use of glue facilitate the assembly of a tiled display “on site” i.e. at the place where the tiled display will be used. Using glue instead of rigid connectors or solder points is expected to contribute to an improved flexibility of the display and an improved reliability (glue being more resilient or ductile than most metals used to establish electrical connections).

The enhanced modularity of a tiled display system according to this invention is further illustrated by figure 7. A tiled display of arbitrary dimensions can be realized by juxtaposing carrier substrates. To avoid the “fly curtain effect” (e.g. carrier substrates and their tiles swinging independently of each other in the wind), the tiles can be used to fasten two adjacent carrier substrates together by fastening a tile to each of the carrier substrates and connecting it to the tracks on each of the carrier substrate. This may also improve the reliability of the tiled display: if power, data and or control signals were lost on e.g. the left carrier substrate **C1**, the tiles overlapping the two carriers (e.g. **T3** and **T4**) can, if designed accordingly, act as a bridge and provide the missing signal to the tiles (**T5** and **T6**) entirely connected to the tracks on the right carrier substrate **C2**.

The tiles can be connected to the tracks and in particular the control and data tracks in parallel or in series (e.g. the tiles can be daisy chained). Daisy chaining will require that the tracks be interrupted as illustrated on figure 6c.

In that case, it is advantageous (as explained for the contacts between tracks on the carrier substrate and the tiles) to have the tracks interrupted at regular intervals. Modularity of the proposed tiled display system will also be further improved if the distance between two consecutive interruptions is smaller or equal to the length of carrier substrate under any of the display tile connected to the conductive tracks.

The full advantage of the proposed invention is obtained when the tiles are identical to each other (at least those at the same level on the same and adjacent carrier substrate).

A further advantage of a tiled display system according to this invention is that a display tile can be cut along a line separating two sets of tracks carrying the power, control and data signals, thereby allowing the realization of a tiled display with a lateral dimension that is substantially equal to an integer number of times the width of a carrier substrate even if one or more of the tiles assembled on the carrier substrates extending over the edge of a carrier substrate. This further advantage is possible if the tiles are designed such that contacts on the tiles are available on the tiles for each sets of tracks on the carrier substrate that a tile can overlap.

With a tiled display system according to this invention, the pixel pitch (i.e. the distance between two adjacent light emitting elements or the distance between two adjacent light emitting elements of the same color in e.g. RGB LED display) does not depend any more on the width of the bundle of tracks **20** and substantial variation of pixel pitch between two adjacent LED tiles can be avoided.

When the tiles must be exposed to humidity (whether hot, humid tropical air or rain), it is known from the art to “pot” or encapsulate the LED modules in e.g. an epoxy resin, a polyurethane compound etc... In the prior art, the potting is done “en masse” i.e. as a single group. This is likely to increase the stiffness of a display tile. It is therefore advantageous to pot the LED module by group of e.g. two or in “lines”, the line being parallel to a direction in which the flexibility must not be decreased.

According to an aspect of the invention, there is provided a method of assembling the tiled display as described above, the tiled display including at least a first flexible display tile, a second flexible display tile, and a carrier substrate with at least one conducting track, the method comprising arranging the first flexible display tile and the second flexible display tile in an adjacent position, wherein the at least one conducting track of the carrier substrate connects to the first and second flexible display tiles.

According to an aspect of the invention, there is provided a method to assemble the tiled display according to any of the preceding claims, the method comprising: cutting at least one length of a flexible substrate carrier with at least one conducting track; contacting a first display tile to the at least one conducting track of the carrier substrate; and contacting a second display tile to the at least one conducting track of the carrier substrate. Cutting the substrate carrier (anywhere) is possible because the track extends end-to-end or is continuous on the carrier substrate. In an embodiment, the contact between each tile and the at least one conducting track is achieved by aligning a pattern of contacts on the display tile with a pattern of contacts on the carrier substrate.

According to an aspect of the invention, there is provided a flexible display tile for use in the tiled display described above. The tile comprises discrete luminous sources, such as LEDs, arranged to be driven as part of a display system by appropriate power, data, and control signals. The tile may be made on a flexible substrate.

Brief description of the figures

These and other features and advantages of embodiments of the present invention will now be described in more detail with reference to the accompanying drawings, in which:

Figure 1a illustrates a flexible LED strip;

Figure 1b illustrates a display disclosed in EP 1 716 553 A1;

Figures 2a and 2b illustrate a flexible substrate with electrically conducting tracks according to an embodiment of the invention;

Figures 3a and 3b represent cross-sections as indicated in Figures 2a and 2b;

Figure 4 illustrates an exemplary embodiment of a tiled display according to the invention;

Figure 5 represents a cross-section along axis CD as indicated in Figure 4;

Figures 6a and 6b illustrate the use of a same carrier substrate to accommodate tiles of different dimensions;

Figure 6c illustrates the interruption of the tracks to daisy chain two tiles with respect to the command and/or the data signals; and

Figure 7 illustrates an arrangement where tiles are used to fasten two adjacent carrier substrates together.

Description of preferred embodiment

Figure 2a and 2b show a flexible substrate **10** with electrically conducting tracks **20** according to an embodiment of the invention. Each one of the conducting tracks is meant to carry power, data or control signals to LED tiles. For instance, power is conducted through the GND and VSS tracks. The other tracks carry a DATA CLCK signal, DATA (or Video Signal) and COMMAND SIGNAL (the signals considered in e.g. US 7,102,601 to control a tiled LED display; US 7,102,601 is assigned to the present applicant, and its contents, including in particular the description of Fig. 2 therein, are incorporate herein by reference for the purpose of describing the cited signals). The tracks carrying DATA CLCK, DATA and COMMAND SIGNAL may be interrupted at regular intervals as will be discussed in more detail further below.

In a first preferred embodiment, the conducting tracks **20** are positioned between a first material layer **11** and a second material layer **12**. The first and second layers **11** and **12** can be made of the same material (e.g. a polyimide). Layers **11** and **12** are preferably made of an insulating material. Additional layers can come between the first or second layer and the conducting tracks. Both layers **11** and **12** can have the same or different thicknesses. While the description will mainly consider a polyimide for layers **11** and **12**, other materials including textiles and cloths may be used.

The conducting tracks can be made out of copper foil. A typical thickness for the conducting tracks is 10 to 100 µm, giving a lot of flexibility to the substrate **10** with low risk of mechanical fracture along the tracks **20**. Other conducting materials can be used like e.g. gold or aluminium. Indium Tin Oxide (ITO) may even be contemplated for low power tiled displays (e.g. reflective displays where electrophoretic elements, e-paper or even liquid crystal elements would replace the LEDs on the tiles) that do not require high drive current for prolonged periods of time.

The flexible substrate **10** or carrier substrate can be produced continuously as rolls of a fixed width.

The copper tracks **20** can be laminated between two polyimide foils **11** and **12** as schematized on figure 2a to form a flexible substrate **10**.

If the layers **11** and **12** are made out of a fabric or a cloth, the conductive tracks **20** can be electrical wires glued to, woven into or embroidered on one or both of the layers **11** and **12**. The conductive tracks can also be formed on one of the foils **11** or **12** by a usual deposition process followed by a selective etching process. The layers **11** and **12** are then glued or laminated together. In some cases, for displays operating in mild atmospheric conditions, it may even be sufficient to form the conducting tracks on a single polyimide foil and cover them with a varnish.

Openings **21** are made in one of the polyimide foils to allow access to the copper tracks. Those openings are made at regular intervals along the length of the substrate **10** as exemplified on figure 2b. Figure 3a and 3b show a partial cross section of the carrier along axis AB and A'B' respectively (the cross section is not given from one side to the other along axis AB but is limited to the first few copper tracks **20**). Each of the layers on figures 3a and 3b has a typical thickness of 25 µm to 100 µm.

The openings **21** can be made with any suitable mechanical or chemical process like but not limited to e.g. punching, laser … before or after assembly with the copper tracks. If the conductive tracks were merely covered with a varnish, the openings **21** may be obtained by masking the places where openings **21** are needed with e.g. a stencil. After the varnish has been sprayed, the masks are withdrawn, leaving an opening **21** on the conducting tracks for connection to other conductors and electronics as will be described later. When we will refer to conductive tracks being formed on the carrier substrate **10**, it will be understood that the conductive tracks can be either sandwiched between two foils, formed on a single layer or woven or knit as electric wires within the fabric of a cloth.

Electrical connection between the conductive tracks and the tiles is preferably done by means of a conductive adhesive with copper core **32**. The conductive adhesive **32** is in contact with tracks **31** on the other side of tile **30** preferably trough a conductive via **33.** An example of the structure resulting from the assembly of a tile **30** and a carrier **10** is given on Figure 4. A cross section along the axis CD on figure 4 of a tile and the supporting carrier is given on figure 5.

Table 1 gives examples of materials that can be used for the connections **22**, the tracks **20**, and the foils between which the tracks are sandwiched and the adhesive used to assemble the different materials.

TABLE 1

20	Copper foil
11, 12	Polyimide
13	acrylic adhesive
22, 32	Self adhesive conductive tape

The polyimide (**11, 12**) and the acrylic adhesive (**13**) are presently available off-the-shelf as laminate.

The conductive adhesive with copper core is presently available off-the-shelf as tape with a thickness of approximately 80µm.

Figure 4 shows an exemplary embodiment of a tiled display according to the invention. LED tiles **30** and **40** are assembled (e.g. glued) on the carrier substrate **10.** The carrier **10** is easily obtained by cutting the required length of carrier from a roll of carrier described earlier.

The tiles **30** and **40** are printed circuit boards on which LED modules and the associated electronics are assembled on a first side of each tile (by gluing, soldering or any other adequate technique). The printed circuit boards are advantageously flexible printed circuit boards. Connections **22** between the circuit on tiles **30** and **40** and the tracks on the carrier are made with patterned self-adhesive conductive tape **32** on the second side of each tile.

The pattern of connections **22** on the self adhesive conductive tape on a second side of the tiles **30** and **40** matches the pattern of openings **21** on the carrier substrate **10**.

The periodicity with which the openings **21** are made in the carrier **10** enables to use the same carrier substrate with tiles of different dimensions in function of the application as exemplified on figure 6a and 6b.

The data and control signal tracks on the carrier substrate **10** can be continuous as on figure 2b or interrupted at regular intervals as on figure 2c.

Continuous data and control signals tracks require that the tiles on the carrier be addressed in parallel (all tiles receive the signal at the same time).

When the data and control signal tracks are interrupted, the tiles are designed to transfer the data and control signals they receive to the next tile through the next portion of conducting tracks on the carrier. This is exemplified by figure 6c that gives a cross section along one of the data and control signal tracks. An example of daisy chained tiles in a tiled LED display is described in US 7,071,620 "Display pixel module for use in a configurable large-screen display application and display with such pixel modules", assigned to the present applicant. As described in US 7,071,620 and seen on figure 6c a resyncer unit **70** receives and re-transmits the serial video and serial control data directly from one LED module array **30** to a next LED module array **40** in a sequential string of LED module arrays **100**. More specifically, the resyncer unit **70** receives a DATABUS IN signal, which is representative of serial video and serial control data, and transmits this data to the next device in sequence via a DATABUS OUT signal. A detailed example of the electronics that can be found on a tile **30** is also given in US 7,071,620. The cited parts of US 7,071,620 are incorporated herein by reference.

How the signals are transmitted by daisy chaining from one tile at the border of the display to the next tile of an adjacent tile column (tiles at top of figure 6a and 6c) will be described further below.

Repetition of the power, control and data signals bus on the carrier **10** offers the possibility of fastening two adjacent carrier substrates **10** by means of tiles overlapping and fastened to those two adjacent carriers. This possibility is illustrated on figure 6. In figure 7 two carriers **C1** and **C2** are placed parallel to each other. A gap **G** exists between the carriers **C1** and **C2.** Tiles **T1** and **T2** are fastened and connected to the first carrier **C1.** Tiles **T5** and **T6** are fastened and connected to the second carrier **C2.** The tiles **T3** and **T4** overlap parts of the carriers **C1** and **C2.** The tiles **T3** and **T4** are fastened and connected to both **C1** and **C2;** thereby binding the two carriers together. The bridging of carrier substrates **C1** and **C2** by tiles **T3** and **T4** makes it possible to increase the robustness of the tiled display. If for instance, power was not distributed anymore by the conducting tracks on **C1,** bridges on **T3** and **T4** can bring power to the tiles **T1** and **T2** on **C1** by connecting them to the conducting tracks on **C2.** The same can be done for the data and control signals, especially if the data and control signal tracks on the carriers are continuous and the tiles of the display are addressed in parallel.

The invention thus enables the realization of arbitrarily large displays tiles that can vary in dimensions from one display to the other while using the same format of carrier substrate **10.**

Connection of the tracks (power, data and signal tracks) at a first end of a carrier track **10** to an external controller can be made by soldering the wires of a standard cable to the tracks **20** through the first set of openings **21.**

A more practical solution is to use a clamping connector as now described.

The clamping connector **80** comprises two main parts **81** and **82.** Parts **81** and **82** can be joined by a hinge but this is not strictly necessary. In their simplest form, **81** and **82** are two beams made of any suitable material and with dimensions sufficient to bear the weight of the flexible display **50.** The two beams are preferably longer than the carrier substrate is wide and preferably as long as N times the width of a carrier substrate **10** (N being an integer larger or equal to 1) to enable assembly of displays with an arbitrary number M of carrier substrate **10** in parallel with $1 \leq M \leq N$.

A circuit **83** with at least one set of tracks **84** can be inserted between the beams **81** and **82.** The ends of the tracks **84** have a pattern that corresponds to the pattern of openings **21** on the carrier substrate **10.** The circuit **83** can be flexible and manufactured similarly to the carrier substrate **10.** Openings **85** at the end of the tracks **84** give access to the conducting tracks **84.** The tracks **20** on the carrier substrate **10** and the tracks **84** on the flexible circuit **83** can be done e.g. with conductive glue, conductive tape or any other methods to bring the tracks in good electrical contact. This could be done e.g. by clamping the carrier substrate **10** and the flexible circuit **83** together by mean of the beams **81** and **82.**

The beams **81** and **82** are held together with any practical means. In particular they can be held together with bolts and nuts, the bolts going through both beams **81** and **82.** The openings for the bolts can be placed so that the bolts will pierce the carrier substrate **10.** This can enhance the fixation of the carrier **10** to the connector clamp **80.**

The circuit **83** is advantageously assembled to one of the beams **81** or **82.** The tracks **84** are connected to one or more connectors **85** integral to the beam **81** or **82** to which the flexible circuit **83** is assembled to.

Pressure is applied to the stack consisting of beam **81**, substrate carrier **10**, flexible circuit **83** and beam **82** in a controlled manner by means of the bolts **86** and nuts **87** e.g. with a dynamometric torque wrench.

Connection of the display **50** to an external controller circuit and to a power supply or the local electrical network is then easily done with any type of cable corresponding to the one or more integral connectors **85**.

Driver electronics to send or relay control and data signals to the display tiles and/or stabilized power supplies can be positioned in the clamp connector itself. There can be one driver units per set of tracks on a carrier substrate, one driver for one or more carrier substrate or a single driver for all of the carrier substrates.

A second clamp connector **90** can used at the second end of the carriers **10**. Clamp connector **90** differ from the clamp connector **80** mainly by the layout of conductive tracks **94** on a flexible circuit **93** that will connect to the conductive tracks **20** on the carrier substrate **10**. The tracks **94** can be adapted by e.g. a cutting operating of specific tracks **94** to tiles of different sizes. In its simplest form, the second clamp connector has no conductive tracks and acts only as ballast to keep the flexible displays under tension and avoid excessive displacement of the flexible display e.g. in the wind. In some instances the conducting tracks **94** are mere "jumpers" that connect two adjacent sets of tracks (on the same carrier substrate or on adjacent carrier substrates). When the tiles are operated in parallel, no tracks **94** are strictly necessary for the data and control signals.

The VSS and GND tracks on different substrate carriers **10** clamped by the clamp connector **90** are advantageously connected in parallel through the flexible circuit **93**. This is expected to enhance the reliability of the system: should one or more of the power tracks on a carrier substrate **10** be damaged by e.g. sectioning of a conductive track, connection to the power tracks will be assured on both sides of the section thanks to the connections to the corresponding power tracks on the same carrier substrate **10** or on parallel carrier substrates of the display.

A clamp connector can be equipped with ball bearings **100** and 101 and e.g. a toothed wheel **102.** Axles **10**3 and **104** part of a support structure **105** that can be fixed to a vertical surface **106** and the ball bearings fasten the clamp connector to the vertical surface **106.** A mechanism **107** that can be part of the support structure **105** can turn the clamp connector e.g. through the toothed wheel **102** thereby enrolling or unrolling the tiled flexible display around the beams **81** and **82.** Advantageously, beams **81** and **82** form a cylinder when assembled to ease rolling and unrolling of the flexible display. Rolling the flexible display at will can be advantageous to protect the flexible display when it is exposed to strong wind and/or rains.

The second and first connectors can also be used for mounting of the display to a vertical surface e.g. a wall. One of the connector can be fixed with reduced infrastructure to the wall, the other connector can be left hanging. The connector left hanging is weighed to provide tensioning to the flexible display thereby avoiding wild swings that can be caused by wind. The second connector can also be fixed to the wall just as the first one.

Interestingly, one of the connector can be assembled to the flexible display in the factory and the display rolled around that connector before shipment. Once on site, the connector is fixed to the wall at both ends and is used as the drum of a pulley to unroll the display in a controlled manner. When the display must be disassembled, it is used as a pulley to roll back the display.

While the invention has been described hereinabove with reference to a number of embodiments, this is done to illustrate and not to limit the invention, the scope of which is determined by the accompanying claims. The skilled person will appreciate that features disclosed herein in connection with individual embodiments may be combined with features from other embodiments to obtain the same technical effects and advantages, without departing from the scope of the invention.

<u>Claims</u>

1. A tiled display comprising discrete luminous sources distributed over at least two adjacent flexible display tiles (30, 40), each of said flexible display tiles being configured to drive the discrete luminous sources on it when connected to a power supply and when receiving data and control signals; wherein the power, data and control signals are provided to the tiles trough conducting tracks (20) formed on a carrier substrate (10), wherein at least one of the conducting tracks extends from one edge of the carrier substrate to the opposite edge of the carrier substrate.

2. The tiled display according to claim 1, wherein the at least one conducting tracks extends from one edge of the carrier substrate to the opposite edge of the carrier substrate along the longest dimension of the carrier substrate.

3. The tiled display according to any of the preceding claims, wherein at least one of the power, data or control signals is provided on at least two separate conductive tracks on the carrier substrate.

4. The tiled display according to any of the preceding claims, wherein the power, data and control signals are each provided on at least two separate conductive tracks on the carrier substrate.

5. The tiled display according to any of the preceding claims, wherein the pattern of conductive tracks carrying the power, data and control signals is periodical.

6. The tiled display according to any of the preceding claims, wherein at least one of the conducting tracks passes under each of the at least two display tiles (30, 40).

7. The tiled display according to any of the preceding claims, wherein at least one of the electrical connections between at

least one display tile and one of the conducting tracks on the carrier substrate is done under the at least one display tile.

8. The tiled display according to any of the preceding claims, wherein the electrical connections between a display tile and a conducting track on the carrier substrate are done through opening in the carrier substrate at the vertical of the conducting track and a via through the display tile.

9. The tiled display according to claim 8, wherein the pattern of openings in the carrier substrate is periodical.

10. The tiled display according to claims 8 or 7, wherein the electrical connections between a display tile and a conducting track on the carrier substrate are done with one of a conductive glue or a conductive adhesive tape with a metallic conductive core.

11. The tiled display according to any of the preceding claims, wherein at least one of the at least two adjacent display tiles is connected to at least one of the conducting tracks formed on a first carrier substrate and at least one conducting tracks formed on a second carrier substrate.

12. The tiled display according to claim 7, wherein the second carrier substrate is adjacent to the first carrier substrate.

13. The tiled display according to any of the preceding claims, wherein at least one of the conducting tracks is interrupted at regular intervals.

14. The tiled display according to claim 9, wherein the distance between two consecutive interruptions is smaller or equal to the length of carrier substrate under any of the display tile (30, 40) connected to the conductive tracks (20).

15. A method of assembling the tiled display according to any of the preceding claims, the tiled display including at least a first flexible display tile, a second flexible display tile, and a carrier substrate with at least one conducting track, the method comprising arranging said first flexible display tile and said second flexible display tile in an adjacent position, wherein said at least one conducting track of said carrier substrate connects to said first and second flexible display tiles.

16. A method to assemble the tiled display according to any of the preceding claims, the method comprising:
cutting at least one length of a flexible substrate carrier with at least one conducting track;
contacting a first display tile to the at least one conducting track of the carrier substrate; and
contacting a second display tile to the at least one conducting track of the carrier substrate.

17. The method according to claim 16, wherein the contact between each tile and the at least one conducting track is achieved by aligning a pattern of contacts on the display tile with a pattern of contacts on the carrier substrate.

18. A flexible display tile for use in the flexible tiled display of any of claim 1-15.

Application No:	GB1318963.4	**Examiner:**	Mr Anthony Haslam
Claims searched:	1-18	**Date of search:**	16 April 2014

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-4, 6-8 & 13-17	US 2009/322651 A1 (TENNAGELS) See figures and abstract.
X	1-9 & 14-17	DE 3633565 A1 (LICENTIA GMBH) See figures and WPI Abstract Accession No: 1988-099446.
A	-	WO 2005/091258 A1 (FRANCE TELECOM) See whole document.

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X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G09F; H04N

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, TXTE.

International Classification:

Subclass	Subgroup	Valid From
G09F	0009/30	01/01/2006