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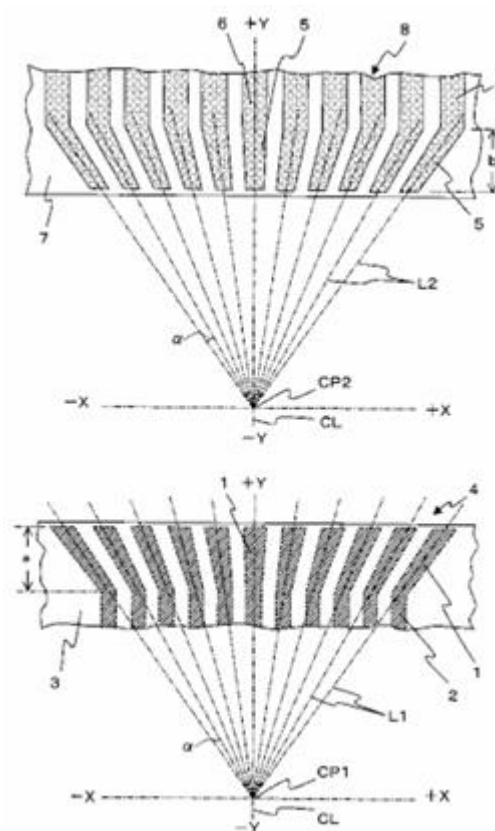
(54) [TITLE OF INVENTION] ELECTRONIC DEVICE AND METHOD OF CONNECTING TERMINALS THEREOF

(57) [ABSTRACT]

[Problem] To further reliably ensure electrical conduction between a connection terminal of a first electronic component and a connection terminal of a second electronic component, and to reduce electrical connection resistance between the connection terminals.

[Resolution Means] A first connection terminal 1 extending along a plurality of first straight lines L1 radially arranged, for example, at intervals of equal angles α , which pass through a first common intersection CP1, is formed in a first electronic component 4. A second connection terminal 5 extending along a plurality of second straight lines L2 radially arranged, for example, at intervals of equal angles α , which pass through a second common intersection CP2, is formed in a second electronic component 8. The first connection terminal 1 and the second connection terminal 5 overlaps with each other and are electrically connected. In such an electronic device, both the first connection terminal 1 and the second connection terminal 5 are formed so that the widths thereof increase as the first and second connection terminals 1 and 5 move away from the first and second common intersections CP1 and CP2, respectively.

[Selected figure] FIG. 1



[Scope of Patent Claims]

[Claim 1]

An electronic device wherein
 a first connection terminal extending along a plurality of first straight lines provided radially through the first common intersection is formed on a first electronic component;
 a second connection terminal extending along a plurality of second straight lines provided radially at angles corresponding to the respective angles between the plurality of first straight lines through a second common intersection is formed in a second electronic component;
 and in the electronic device wherein the first connection terminal and the second connection terminal overlap and are electrically connected,
 both the first connection terminal and the second connection terminal are formed so that the widths thereof increase as the first and second connection terminals move away from the first and second common intersections, respectively.

[Claim 2]

The electronic device according to claim 1, wherein
 either one or both of the first connection terminals and the second connection terminals is plated with any one of gold plating, gold plating with a nickel underlayer, tin plating, tin-lead alloy plating, or tin-bismuth alloy plating.

[Claim 3]

The electronic device according to claims 1 or 2, wherein
 the first connection terminal and the second connection terminal overlap and are electrically connected with conductive particles contained in an anisotropic conductive adhesive or conductive particles contained in an anisotropic conductive film sandwiched therebetween.

[Claim 4]

The electronic device according to claim 2, wherein
 the plating applied to both the first connection terminal and the second connection terminal is brought into contact with each other in a state in which pressure is always applied, and the first connection terminals and the second connection terminals overlap and are electrically connected.

[Claim 5]

A method of connecting terminals of an electronic device, wherein, when the plurality of first connection terminals and the plurality of second connection terminals in the electronic device according to claims 1 or 2 are electrically connected, after the first common intersection and the second common intersection are aligned, either or both of the first electronic component or the second electronic component are rotated, and the plurality of first connection terminals and the plurality of second connection terminals become overlapped.

[Detailed Description of Invention]

[Technical Field of Invention]

[0001]

The present invention relates to an electronic device formed in a first electronic component such as COF (Chip On Film), for example, a plurality of first connection terminals on an insulated substrate and a plurality of second connection terminals on a glass substrate formed on a second electronic component such as a liquid crystal panel are overlapped and electrically connected. The present invention also relates to a terminal connection method between a first connection terminal and a second connection terminal in such an electronic device.

[Conventional Art]

[0002]

Conventionally, as shown in FIG. 18, a plurality of first connection terminals 101 are formed on an insulated substrate 103 of a COF (Chip On Film) 104, while a plurality of second connection terminals 105 are formed on a glass substrate 107 of a liquid crystal panel 108, and a first connection region J1 of the first connection terminals 101 and a second connection region J2 of the second connection terminal 105 are overlapped and electrically connected as illustrated in FIG. 19. Reference numerals 102 and 106 in the figure denote a first wiring connected to the first connection terminal 101 and a second wiring connected to the second connection terminal 105, respectively.

[0003]

FIG. 20 shows a cross section of the arrow direction along line C-C when overlapped and electrically connected. The first connection terminal 101 and the second connection terminal 105 are subjected to heat and pressure with the anisotropic conductive adhesive 111 sandwiched therebetween. The anisotropic conductive adhesive 111 is composed of a resin 109 that exhibits insulating properties and adhesive properties, and conductive particles 110 that contribute to electrical

connection, and the first connection terminal 101 and the second connection terminal 105 are electrically connected via the conductive particles 110.

[0004]

Incidentally, the insulated substrate 103 of the COF 104 is generally composed of a thin film-like polyimide or the like, contracts when heat is applied in the stage of manufacturing the COF 104 and easily expands or contracts due to the subsequent temperature and humidity. In contrast, as liquid crystal screens are becoming increasingly smaller, the width and inter-terminal pitch of the first connection terminal 101 and the second connection terminal 105 are also becoming smaller. Due to this, as COF 104 expands or contracts, the pitch dimension between the terminals of the first connection terminal 101 changes, resulting in a problem wherein the alignment with the second connection terminal 105 becomes extremely difficult.

[0005]

Now, suppose the specified value of the inter-terminal pitch of the first connection terminal 101 formed in the COF 104 is defined as P and the specified value of the inter-terminal pitch of the second connection terminal 105 formed on the liquid crystal panel 108 is the same P , then suppose that the COF 104 contracts and the inter-terminal pitch of the first connection terminal 101 becomes $P - \alpha$.

[0006]

At this time, as shown in FIG. 21, when the first connection terminal 101 and the second connection terminal 105 provided at the center line CL are aligned so that the relative position deviation between the first connection terminal 101 and the second connection terminal 105 is as small as possible, the dimension of the outermost sides of the first connection terminal 101 becomes, due to the contraction of COF 104, $8P - 8\alpha$, which is the accumulation of the inter-terminal pitch $P - \alpha$ of the first connection terminal 101 as illustrated in FIG. 21. The relative positional deviation amount between the outermost first connection terminal 101 and the second connection terminal 105 becomes the largest.

[0007]

FIG. 22 shows a cross section of the arrow direction along line D-D in FIG. 21. As illustrated, the relative positional deviation amount between the first connection terminal 101 and the second connection terminal 105 increases as the distance from the center line CL increases. As the relative positional deviation amount increases, the number of conductive particles 110 contributing to the electrical connection decreases, the connection resistance increases, and the liquid crystal display becomes unstable. In addition, there was a problem in that liquid crystal display stopped functioning properly, such as the first connection terminal 101 short-circuiting due to the adjacent second connection terminal 105 and the conductive particles 110 therebetween, or the conductive particles 110 between the first connection terminal 101 and the second connection terminal 105 becoming unable to contact those terminals, resulting in a connection failure.

[0008]

To solve such problems, a conventional electronic device such as that described in Patent Document 1 has been proposed.

[0009]

That is, as shown in FIG. 23, a first connection terminal 211 extending along the first straight line L1 is formed in a first electronic component 210, a second connection terminal 221 extending along the second straight line L2 are formed in a second electronic component 220, a plurality of first straight lines L1 are radially provided passing through the first common intersection P1, and a plurality of second straight lines L2 are similarly radially provided in sequence at angles corresponding to each angle between the plurality of first straight lines L1 through the second common intersection P2. Furthermore, FIG. 23 shows a case wherein a plurality of first straight lines L1 and a plurality of second straight lines L2 are provided radially at intervals of equal angles α .

[0010]

In this way, even if the insulated substrate 214 of the first electronic component 210 expands or contracts, the position of the first connection terminal 211 is only shifted along the first straight line L1. Therefore, in a state where the first connection terminal 211 and the second connection terminal 221 are overlapped, the first connection terminal 211 and the second connection terminal 221 can be aligned and overlapped only by shifting the one or the other in a direction approaching to or separating from the first common intersection P1 or the second common intersection P2. Alternatively, as illustrated in FIG. 24, after aligning the first common intersection P1 and the second common intersection P2, the plurality of first connection terminals 211 and the plurality of second connection terminals 221 can be overlapped by rotating either or both of the first electronic component 210 or the second electronic component 220, thereby forming an electrical connection. Reference numeral 224 in the figure is a substrate such as a glass substrate or the like of the second electronic component 220.

[0011]

Therefore, even if the insulating substrate 214 expands or contracts, it is possible to accurately overlap the first connection terminal 211 and the second connection terminal 221. Then, as illustrated in FIG. 25, the plurality of first

terminals 211 and the plurality of second terminals 221 are connected by using conductive paste 225 composed of a resin 226 and conductive particles 227, thereby making it possible to form an electrical connection via conductive particles 227.

[Prior Art Documents]

[Patent Document]

[0012]

Patent Document 1: JP2007-242941 A

[Summary of Invention]

[Problems To Be Solved By the Invention]

[0013]

However, in recent years, there has been a trend toward further trying to further minimize liquid crystal displays, and as a result, the pitch of the connection terminals 211 and 221 have become small, and the width of these connection terminals 211 and 221 have also become narrower. As a result, even when using the method described in Patent Document 1, there is a problem that the number of conductive particles 227 contributing to electrical connection is insufficient, and the electrical connection resistance value cannot be reduced to the required level, leading to instability in the liquid crystal display.

[0014]

Therefore, the object of the present invention is to further reliably ensure electrical conduction between a first connection terminal of a first electronic component and a second connection terminal of a second electronic component, and to reduce electrical connection resistance between the connection terminals.

[Resolution Means]

[0015]

Therefore, in the electronic device according to a first aspect of the present invention:
a first connection terminal extending along a first connection terminals extending along a plurality of first straight lines are formed on a first electronic component such as COF (Chip On Film);
second connection terminals extending along a plurality of second straight lines are formed in a second electronic component such as a liquid crystal panel; and
and the first connection terminal and the second connection terminal overlap and are electrically connected.

Here, a plurality of first straight lines are provided radially through a first common intersection, and a plurality of second straight lines are provided radially at angles corresponding to the respective angles between the plurality of first straight lines through the second common intersection.

In addition, the present invention is characterized in that the first connection terminal is separated from the first common intersection and the second connection terminal is separated from the second common intersection, forming wide widths for each of them.

[0016]

Any one or both of the first connection terminals and the second connection terminals may be gold-plated, gold-plated on a nickel substrate, tin-plated, tin lead alloy-plated, or tin bismuth alloy-plated.

[0017]

The first connection terminals and the second connection terminals may overlap and be electrically-connected as a result of interposing conductive particles included in an anisotropic conductive adhesive or conductive particles included in an anisotropic conductive film.

[0018]

The plating applied to both the first connection terminals and the second connection terminals is brought into contact with each other in a state in which pressure is always applied, and the first connection terminals and the second connection terminals may overlap and be electrically-connected.

[0019]

The terminal connection method of the electronic device according to a second aspect of the present invention is characterized in that, when the plurality of first connection terminals and the plurality of second connection terminals in the electronic device according to the first aspect are electrically connected, after the first common intersection and the second common intersection are aligned, either or both of the first electronic component or the second electronic component are rotated, and the plurality of first connection terminals and the plurality of second connection terminals become overlapped.

[Effects of the Invention]

[0020]

According to the first aspect of the present invention, since both the first connection terminal are separated from the first common intersection and the second connection terminal is separated from the second common intersection, the connection area when the first connection terminal of the first electronic component and the second connection terminal of the second electronic component are overlapped and electrically connected is widened, allowing for the electrical conduction

of the connection terminals to be further reliably performed and for the electrical connection resistance between the connection terminals to be reduced.

[0021]

In the electronic device according to the first aspect, when any one of gold plating, gold plating on a nickel substrate, tin plating, tin lead alloy plating, or tin bismuth alloy plating is applied to either or both of the first connection terminal and the second connection terminal, this will provide a rust prevention effect and allow for electrical connection resistance to be reduced.

[0022]

Further, when the first connection terminal and the second connection terminal are overlapped and electrically connected across the conductive particles included in the anisotropic conductive adhesive or the conductive particles included in the anisotropic conductive film, the number of conductive particles contributing to the electrical connection can be increased, and the electrical connection resistance can be reduced by increasing the connection area.

[0023]

In addition, when the plating applied to both the first connection terminal and the second connection terminal is brought into contact with each other in a state in which the pressure is always applied, and the first connection terminal and the second connection terminal are overlapped and electrically connected, it is not necessary to use a member for a special connection device or connection, allow for an electrical connection to be performed inexpensively.

[0024]

According to the second aspect of the present invention, after the first common intersection and the second common intersection are aligned, because one or both of the first electronic component or the second electronic component are rotated, and the plurality of first connection terminals and the plurality of second connection terminals are overlapped and electrically connected, alignment will be performed in the widthwise direction only, eliminating the need for alignment of the first connection terminal and the second connection terminal in the lengthwise direction as well as simplifying the alignment.

[0025]

In addition, as the first connection terminal moves away from the first common intersection and the second connection terminal moves away from the second common intersection, both are formed with a larger width, thereby increasing the connection area when the first connection terminal of the first electronic component and the second connection terminal of the second electronic component overlap and are electrically connected, further ensuring the electrical conductivity between the connection terminals and reducing the electrical connection resistance between the connection terminals.

[Brief Description of Drawings]

[0026]

[FIG. 1] A partial planar view illustrating a first electronic component and a second electronic component used in an electronic device, which is an example of the present invention.

[FIG. 2] A planar view illustrating a part of a first connection terminal of the first electronic component in an enlarged manner.

[FIG. 3] A planar view illustrating a part of a second connection terminal of the second electronic component in an enlarged manner.

[FIG. 4] A planar view illustrating a state in which the first connection terminal and the second connection terminal are overlapped and electrically connected.

[FIG. 5] A planar view illustrating a second electronic component having a second matchmark on a glass substrate.

[FIG. 6] A planar view illustrating a first electronic component with a first matchmark on an insulating substrate.

[FIG. 7] A cross-sectional view in the direction of the arrow taken along line A-A in FIG. 4.

[FIG. 8] A cross-sectional view in the direction of the arrow taken along line B-B in FIG. 4.

[FIG. 9] An omitted planar view illustrating a case where a second alignment marking is provided in the vicinity of the second connection terminal.

[FIG. 10] An omitted planar view illustrating a case where a first alignment marking is provided in the vicinity of a first connection terminal.

[FIG. 11] A planar view illustrating a state in which a mask is superimposed on the first alignment marking shown in FIG. 10.

[FIG. 12] A planar view illustrating a state in which the positions of the first connection terminal and the second connection terminal are aligned.

[FIG. 13] A planar view showing a state in which a mask is superimposed on a first alignment marking provided in the vicinity of the first connection terminal when the first electronic component is expanded.

[FIG. 14] A planar view showing a state in which the positions of the first connection terminal provided with the first alignment marking and the second connection terminal illustrated in FIG. 9 are aligned.

[FIG. 15] A planar view showing a state in which a first alignment marking of another example is provided in the vicinity of a first connection terminal and a mask is superimposed on the first alignment marking.

[FIG. 16] A cross-sectional view showing a state in which connection terminals are overlapped and electrically connected to each other by adding pressure.

[FIG. 17] A cross-sectional view illustrating a state in which connection terminals are overlapped and electrically connected using an UV-curable adhesive.

[FIG. 18] A partial planar view of a first electronic component and a second electronic component illustrating a terminal shape of a first connection terminal and a second connection terminal of a conventional electronic device.

[FIG. 19] A planar view of a state in which the first connection terminal and the second connection terminal of the electronic device illustrated in FIG. 18 are overlapped and electrically connected.

[FIG. 20] A cross-sectional view in the direction of the arrow taken along line C-C of FIG. 19.

[FIG. 21] A planar view illustrating a state in which the positions of the first connection terminal and the second connection terminal of the electronic device shown in FIG. 18 are aligned when the first electronic component contracts.

[FIG. 22] A cross-sectional view in the direction of the arrow taken along line D-D in FIG. 21.

[FIG. 23] A partial planar view of a first electronic component and a second electronic component illustrating a terminal shape of a first connection terminal and a second connection terminal of another conventional electronic device.

[FIG. 24] A planar view of a state in which the positions of the first connection terminal and the second connection terminal of the electronic device illustrated in FIG. 23 are aligned.

[FIG. 25] A vertical cross-sectional view of FIG. 24.

[Embodiments for Carrying Out the Invention]

[0027]

Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

FIG. 1 illustrates a first electronic component 4 and a second electronic component 8 used in an electronic device, which is an example of the present invention.

[0028]

In this example, the first electronic component 4 is a chip on film (COF), and a plurality of first connection terminals 1 and a first wiring 2 connected thereto are formed on the insulating substrate 3. Each of the plurality of first connection terminals 1 extends along a first straight line L1 provided radially through a first common intersection CP1, and is connected to the first wiring 2 as is. The first connection terminal 1 and the first wiring 2 are formed by etching copper foil or the like, and it is preferable that any one of gold plating, gold plating of a nickel substrate, tin plating, tin lead alloy plating, or tin bismuth alloy plating is applied on the first connection terminal 1 and the first wiring 2 in order to enhance the anti-rust effect and enhance the effectiveness of the electrical connection to be performed later. Additionally, the region of the reference symbol an is defined as the connection region of the plurality of first connection terminals 1. The length of each first connection terminal 1 is determined by the connection region a.

[0029]

Each first connection terminal 1 is formed so that the first straight line L1 passes through the center of the terminal width, and as it moves away from the first common intersection CP1 with the first straight line L1 as the center line, it is formed in a stepped or gradual manner, or continuously curved, or as in this example, in a tapered shape with a thicker tip so that it follows a straight line with a wider width. Specifically, as can be understood from FIG. 2 which illustrates a magnified portion of this area, the center dimension IG1 between the first connection terminals necessary for securing electrical insulation characteristics or the like so as not to cause a short-circuit, for example, is set as wide as possible to reduce the electrical connection resistance when the anisotropic conductive adhesive is used to facilitate alignment with the plurality of second connection terminals 5 described later.

[0030]

On the other hand, the outer dimension OW1 of the first connection terminal width is preferably set as wide as possible to reduce the electrical connection resistance similarly to the above, and is set to a value larger than the center dimension IW1 of the first connection terminal width ($OW1 > IW1$). The outer dimension OG1 between the first connection terminals is set ($OG1 \geq IG1$) so as to be equal to or larger than the center dimension IG1 between the first connection terminals. Note that the first wiring 2 extends at a constant width with the dimension IW1 close to the center of the first connection terminal width.

[0031]

On the other hand, in this example, a second electronic component 8 is a liquid crystal panel, and as illustrated in FIG. 1, a plurality of second connection terminals 5 and second wiring 6 connected thereto are formed on the glass substrate 7. Each of the plurality of second connection terminals 5 extends along a second straight line L2 provided radially in the same manner at an angle corresponding to each angle between the plurality of first straight lines L1 through the second common intersection CP2, and is connected to the second wiring 6 as is. For example, when the disposed angle of the first

connection terminal 1 is $A^\circ, B^\circ, C^\circ, A^\circ, B^\circ, C^\circ \dots$ the disposed angle of the second connection terminal is also $A^\circ, B^\circ, C^\circ, A^\circ, B^\circ, C^\circ \dots$ and the corresponding arrangement angles of the plurality of first connection terminals 1 and the plurality of second connection terminals 5 are all equal.

[0032]

In this example, the plurality of first connection terminals 1 and the plurality of second connection terminals 5 are provided radially at intervals of equal angles α . The second connection terminal 5 and the second wiring 6 are formed of a metal oxide film such as an ITO film (InO_3), and it is preferable that any one of gold plating, gold plating on a nickel substrate, tin plating, tin lead alloy plating, or tin bismuth alloy plating is applied thereon in order to enhance the anti-rust effect and the enhance the effect of the electrical connection to be performed later. The gold plating or the like may be applied to either or both of the first connection terminal 1 and the second connection terminal 5. Additionally, the region of the reference symbol b is defined as the connection region of the plurality of second connection terminals 5. The length of the second connection terminal 5 is determined by the connection region b. The range in which it can be installed on the second electronic component 8 is preferably set as long as possible.

[0033]

Each second connection terminal 5 may be stepwise so that the second straight line L2 passes through the center of the terminal width, and the width becomes wider in stages or continuously as it moves away from the second common intersection CP2 with the second straight line L2 as the center line. However, as shown in this example, it is formed in a tapered shape with a thicker tip. Specifically, as can be understood from FIG. 3 which illustrates a magnified view of this portion, the center dimension IG2 between the second connection terminals, for example, which is necessary for securing electrical insulation characteristics or the like so as not to cause short-circuiting, is preferentially secured, and the center dimension IW2 of the second connection terminal width is set as wide as possible in order to simplify the alignment with the plurality of first connection terminals 1 to be performed later and to reduce the electrical connection resistance when connected using an anisotropic conductive adhesive. In this example, this is set as $IW1 = IW2$.

[0034]

On the other hand, the outer dimension OW2 of the second connection terminal width is preferably set as wide as possible in order to simplify the alignment with the plurality of first connection terminals 1 described later in order to secure electrical insulation characteristics, etc. and to reduce the electrical connection resistance when the connection is performed using the anisotropic conductive adhesive, and is preferably set to a value larger than the center dimension IW2 of the second connection terminal width ($OW2 > IW2$). The outer dimension OG2 between the second connection terminals is set to be equal to or larger than the center dimension IG2 between the second connection terminals ($OG2 \geq IG2$), and in particular, it is preferable to set the dimension $OG2 = IG2$.

[0035]

That is, because the pitch between the first connection terminal 1 and the second connection terminal 5 is smallest at the point closest to the first common intersection CP1 or the second common intersection CP2, the required predetermined interval (IG1 in FIG. 2, IG2 in FIG. 3) is ensured, and the width (IW1 in FIG. 2, IW2 in FIG. 3) of the first connection terminal 1 and the second connection terminal 5 at this portion is determined. The widths of the first connection terminal 1 and the second connection terminal 5 are formed continuously or stepwise as it goes away from the first common intersection CP1 or the second common intersection CP2 instead of a constant width as in conventional examples. If the conditions for the portion having the smallest pitch between the connection terminals is the same as that of the prior art, the IG1 in FIG. 2 and the IG2 in FIG. 3 can be made the same as the minimum gap of the prior art, and IW1 in FIG. 2 and IW2 in FIG. 3 will be the same as those of the first connection terminal 1 and the second connection terminal 5 of the prior art. Therefore, in the case of the present invention, because the width is formed to be wider as the distance from the first common intersection CP1 or the second common intersection CP2 increases based on the width, it can be said that "the connection area be made wider" in all cases compared with the prior art. At this time, the interval is not always equal to or less than the minimum gap. That is, it is set as $OG1 \geq IG1$ in FIG. 2 and $OG2 \geq IG2$ in FIG. 3. In this example, it is set as $OW1 = OW2$.

[0036]

The first electronic component 4 and the second electronic component 8 are aligned with the terminal surfaces facing each other, and the first connection terminal 1 and the second connection terminal 5 are overlapped and electrically connected. FIG. 4 illustrates this state while omitting the insulating substrate 3, the glass substrate 7, and the anisotropic conductive adhesive 11 described later. Here, as described above, because the plurality of radial lines L1 passing through the first common intersection CP1 and the plurality of second straight lines L2 passing through the second common intersection CP2 are provided radially at intervals of the same equal angle α through the first common intersection CP1 or the second common intersection CP2, respectively, it is possible to create a state in which the positions are aligned and overlap, and it is possible to create a state in which the positions of the plurality of first connection terminals 1 and the plurality of second connection terminals 5 on the radial lines L1, L2 are aligned and overlap.

[0037]

Here, a case in which the first electronic component 4 expands or contracts relative to the second electronic component 8 is considered. When the first connection terminal 1 expands or contracts in the X direction and the Y direction as illustrated in FIG. 1, the plurality of first connection terminals 1 are similarly present on the plurality of first straight lines L1, with only the distance from the first common intersection CP1 changing.

[0038]

Therefore, when the first electronic component 4 expands relative to the second electronic component 8, the plurality of first connection terminals 1 are only shifted in a direction away from the second common intersection CP2 along the plurality of radial lines L1, and thus the plurality of first connection terminals 1 can be precisely aligned with the second connection terminal 5.

[0039]

Conversely, when the first electronic component 4 contracts relative to the second electronic component 8, the plurality of first connection terminals 1 are only displaced in a direction approaching the second common intersection CP2 along the plurality of radial lines L1, and thus the plurality of first connection terminals 1 can be precisely aligned with the second connection terminal 5. As described above, when the alignment of the plurality of first connection terminals 1 and the plurality of second connection terminals 5 is precisely performed, the positions of the first common intersection CP1 and the second common intersection CP2 overlap each other as illustrated in FIG. 4.

[0040]

Thus, by aligning the positions of the first common intersection CP1 and the second common intersection CP2, the alignment of the plurality of first connection terminals 1 and the plurality of second connection terminals 5 can be easily performed. Therefore, for example, a marking for positioning is provided at the position of the first common intersection CP1 and the second common intersection CP2, and after the first common intersection CP1 and the second common intersection CP2 are aligned using the marking, either or both of the first electronic component 4 and the second electronic component 8 should be rotated so that the plurality of first connection terminals 1 and the plurality of second connection terminals 5 in the illustrated electronic device overlap and are electrically connected.

[0041]

Specifically, as illustrated in FIG. 5, when the second common intersection CP2 is on the glass substrate 7, for example, the center point of the round-shaped second matchmark 23 is made to coincide with the second common intersection CP2 and is formed using the same process as the second connection terminal 5. Furthermore, as illustrated in FIG. 6, when the first center point CP1 is on the insulating substrate 3, for example, the center point of the round-shaped first matchmark 22 is made to coincide with the first common intersection CP1 and is formed using the same process as the first connection terminal 1.

[0042]

Next, the formed second matchmark 23 and the first seal 22 are overlapped and aligned, and at the same time, the second connection terminal 5 formed on the Y axis shown in FIGS. 5 and 6 and the first connection terminal 1 formed on the Y axis are overlapped and aligned. In addition, the positions of the plurality of second connection terminals 5 and the plurality of first connection terminals 1 can also be precisely aligned.

[0043]

In the example illustrated in FIG. 1, the first common intersection CP1 is located on the insulating substrate 3 of the first electronic component 4, and a marking can be provided at that position, but since the position of the second common intersection CP2 is located outside the glass substrate 7 of the second electronic component 8 and is located in the space, a marking cannot be provided. Therefore, while it is difficult in the example illustrated in FIG. 1, but in another example, it is preferable to provide a marking at the positions of the first common intersection CP1 and the second common intersection CP2.

[0044]

Next, a case where the first electronic component 4 expands or contracts at different rates in the X direction and the Y direction as illustrated in FIG. 1 with respect to the second electronic component is considered.

[0045]

When the expansion rate or the contraction rate in the X direction and the Y direction is slightly different, even if the plurality of first connection terminals 1 and the plurality of second connection terminals 5 are aligned with each other by using the same method as described above, the generated alignment error is negligible, and is not problematic. However, when a large difference occurs in the expansion rate or the contraction rate in the X direction and the Y direction, if markings are provided at the positions of the first common intersection CP1 and the second common intersection CP2, and a method for performing alignment using the markings is used, sometimes the alignment error cannot be ignored. In such cases, a method for performing only alignment of the plurality of first connection terminals 1 and the plurality of second connection terminals 5 should be used without the use of markings, whereby it will be possible to reduce the alignment error to a negligible degree.

[0046]

After aligning the plurality of first connection terminals 1 and the plurality of second connection terminals 5, as shown in FIGS. 7 and 8, the anisotropic conductive adhesive 11, which is composed of the electrically-conductive particles 10 and the resin 9 exhibiting insulation properties and adhesiveness, is sandwiched between the first electronic component 4 and the second electronic component 8 to apply heat and pressure. In this case, the first connection terminal 1 and the second connection terminal 5 are electrically connected to each other by contact or pressure contact of the conductive particles 11. FIG. 7 shows a cross-section in the direction of the arrow along line A-A in FIG. 4, and FIG. 8 shows a cross-section in the direction of the arrow along line B-B in FIG. 4.

[0047]

As shown in FIGS. 7 and 8, the first connection terminal 1 and the second connection terminal 5 are fixed by a resin 9 constituting the anisotropic conductive adhesive 11, and are electrically connected by conductive particles 10 that are in contact with or pressed against both the first connection terminal 1 and the second connection terminal 5.

[0048]

The conductive particles 10 constituting the anisotropic conductive adhesive 11 are substantially uniformly dispersed in the resin 9 constituting the anisotropic conductive adhesive 11. Therefore, the total number of conductive particles 10 contributing to electrical connection is more probabilistically increased as the contact area between the first connection terminal 1 and the second connection terminal 5 widens. The larger the width of the first connection terminal 1 and the second connection terminal 5, the larger the contact area becomes and the larger the number of conductive particles 10 contributing to the electrical connection becomes.

[0049]

The distance from the first common intersection CP1 or the second common intersection CP2 is at a position farther from the cross-section portion of FIG. 8 than the cross-section portion of FIG. 7. Therefore, when comparing FIG. 7 and FIG. 8, the widths of the first connection terminal 1 and the second connection terminal 5 illustrated in FIG. 8 are wider, and the number of conductive particles 10 contributing to electrical connection is also larger in the cross-sectional portion of FIG. 8 than the cross-sectional portion of FIG. 7.

[0050]

As described above, since the widths of the plurality of first connection terminals 1 and the plurality of second connection terminals 5 are provided so as to be wider as they move away from the first common intersection CP1 or the second common intersection CP2, the total number of conductive particles 10 contributing to electrical connection can be increased, and the electrical connection resistance can be reduced. Therefore, it is possible to eliminate the problem of instability in the liquid crystal display of the second electronic component 8, which is a liquid crystal panel.

[0051]

Although the example above describes a case where the plurality of first connection terminals 1 and the plurality of second connection terminals 5 are electrically connected across the conductive particles 10 included in the anisotropic conductive adhesive 11, it is also possible to establish an electrical connection by interposing conductive particles contained in an anisotropic conductive film instead of using an anisotropic conductive adhesive.

[0052]

Next, in the electronic device according to the present invention, a method of positioning a plurality of first connection terminals 1 and a plurality of second connection terminals 5 by using a device combining an image recognition device and an automatic position control device will be described. As currently performed, for example, a positioning marking formed at both ends of a dry plate installed in the exposure machine in advance is recognized using an image recognition device, and the X-coordinate and the Y-coordinate are determined and pre-stored by performing arithmetic processing. Next, image recognition is performed on a sprocket hole used for conveyance to grasp the position of the sprocket hole formed at both ends of a product, and the X-coordinate and the Y-coordinate of the product are calculated and stored, and the X-coordinate and Y-coordinate of the dry plate and the product are positioned so as to coincide with each other by using an automatic positioning device.

[0053]

Here, since the substrate is formed of the glass substrate 7, the second electronic component 8, which is the liquid crystal panel, is less likely to be affected by humidity and heat, and trivial amounts of expansion and contraction can also be ignored. Therefore, since the amount of change in the dimension between the plurality of second connection terminals 5 is also trivial, it is possible to handle situations in which there are no dimensional changes when aligning the plurality of first connection terminals 1 and the plurality of second connection terminals 5.

[0054]

In contrast, the first electronic component 4, which is a COF, is generally formed of an insulating substrate 3 using a polyimide film, and the polyimide film is easily affected by humidity and heat, and expands and contracts more than the

glass substrate 7. Therefore, the dimension between the plurality of first connection terminals 1 formed on the insulating substrate 3 changes considerably more compared with the second connection terminal 5 formed on the glass substrate 7.

[0055]

Furthermore, as described in detail above, the first electronic component 4 is formed by the insulating substrate 3, but the insulating substrate 3 is generally formed using an organic material such as polyimide as described above, and it contracts due to heating in the processing step and extends (expands) due to moisture absorption by the finished product after processing. In contrast, the copper foil generally used as a material for forming the first connection terminal 1 and the first wiring 2 is substantially free from contraction due to heating in the processing step and does not expand due to moisture absorption after processing.

[0056]

As described above, since the first connection terminal 1 and the first wiring 2 are formed along the Y-axis direction (for example, in the case of FIG. 6), the first connection terminal 1 and the first wiring 2 act to restrict the expansion and contraction of the insulation substrate 3. Therefore, the extension rate (expansion rate) and the contraction rate of the first electronic component 4 tend to be larger in the X-axis direction in FIG. 6.

[0057]

For example, in a case where the first electronic component 4 contracts, since the X-axis direction illustrated in FIG. 6 due to this tendency to shrink (contract), when markings are provided at the positions of the first common intersection CP1 and the second common intersection CP2, and alignment is performed using the markings, the plurality of first connection terminals 1 provided on the first straight line L1 are brought into a closer state in the Y-axis direction illustrated in FIG. 6, and a relative deviation is generated relative to the plurality of second connection terminals 5, and vice versa when the first electronic component 4 is extended (expanded).

[0058]

Next, a method for aligning the plurality of first connection terminals 1 and the plurality of second connection terminals 5 will be described separately for a case in which the dimensions between the plurality of first connection terminals 1 have not changed and a case in which they have changed considerably. First, a case in which the dimensions between the plurality of first connection terminals 1 have not changed will be described.

[0059]

When the dimensions between the plurality of first connection terminals 1 have not changed, first, as illustrated in FIG. 9, for example, second alignment markings 13 are provided on the second straight line L2 passing through each of the left and right alignment markings 13 (two markings) and at the second common intersection CP2 near the second connection terminals 5 at both ends. The second alignment markings 13 are formed simultaneously by using the same formation method as that for the second connection terminal 5. In FIG. 9, only the second connection terminals 5 located at both ends and the center are shown, and the other second connection terminals 5 and the glass substrate 7 are omitted.

[0060]

Next, as illustrated in FIG. 10, for example, first alignment markings 12 are provided on the left and right sides (5 markings on each side; total of 10 markings) on the first straight line L1 passing through the first common intersection CP1 near the first connection terminal 1 at both ends. The first alignment markings 12 are formed simultaneously by using the same formation method as that for the first connection terminal 1. In FIG. 10, only the first connection terminals 1 located at both ends and the center are shown, and the other first connection terminals 1 and the insulation substrate 3 are omitted.

[0061]

Here, when aligning the plurality of first connection terminals 1 and the plurality of second connection terminals 5 while facing each other, the second straight line L2 that passing through the second alignment marking 13 and the first straight line L1 passing through the first alignment marking 12 are caused to overlap and coincide with each other. Furthermore, the first alignment markings 12 provided in each of the center areas on the left and right sides are formed by being designed to overlap and coincide with the second alignment markings 13.

[0062]

In order to align the plurality of first connection terminals 1 and the plurality of second connection terminals 5, the plurality of first connection terminals 1 and the plurality of second connection terminals 5 are set to predetermined positions in directions facing the plurality of second connection terminals 5.

[0063]

Thereafter, each of the second alignment markings 13 (total of 2 markings) formed on the right and left sides are recognized using the image recognition device to obtain the center position, and the distance between the center positions of the left and right second alignment markings 13 and the center between the distances are calculated by arithmetic processing, and stored as the X2-coordinate axis information and the Y2-coordinate axis information illustrated in FIG. 9. In order to make the image recognition device used here less likely to be affected by shape defects in the second alignment

markings 13, it is preferable to use a method to calculate the center of gravity based on area and then recognize the position of the center of gravity as the center position of the alignment markings.

[0064]

Next, as shown in FIG. 10, five of the left and right first alignment markings 12 are recognized and uploaded by the image recognition device, the center of gravity of the area is calculated by performing arithmetic processing, and the center of gravity position is recognized as the center position of the first alignment marking 12 groups. Using this method, the center of the position of each of the left and right first alignment marking 12 groups will coincide with the center position of a single first alignment marking 12 provided at the center. Incidentally, the image recognition device may be used to recognize the second alignment markings 13 or something else. However, for the same reason as described above, it is preferable to use a method in which: (a) center of gravity position is calculated based on area; and (b) the position of the center of gravity is recognized as the position of the alignment markings.

[0065]

Next, the distance between the center positions of the recognized left and right first alignment markings 12 groups and the center between the distances are obtained by arithmetic processing, and stored as the X1-coordinate axis information and the Y1-coordinate axis information illustrated in FIG. 10. Here, temporary positioning is performed by moving the first electronic component 4 using the automatic position control device so that the coordinate axes coincides with a preset position(s).

[0066]

Next, after the temporary positioning is performed, as illustrated in FIG. 11, the mask 14, which is in a state where the periphery of the mask slit 15 is shielded from light and is provided in advance in the image recognition device, is superimposed on the image of the image recognition device. However, although images are not recognized while the first alignment markings 12 and the first connection terminal 1 that overlap with the light-shielding unit are shielded from light, the first alignment marking 12 and the first connection terminal 1 are illustrated in FIG. 11 for explanation purposes. Then, the center position of this mask slit 15 is set so as to coincide with the center of the second alignment marking 13, and the width of the mask slit 15 is set to such a dimension that allows for a single first alignment marking 12 to enter therein.

[0067]

Because the above was a description of a case in which the dimension between the plurality of first connection terminals 1 has not changed, the first alignment markings 12 are formed according to the design values, and as illustrated in FIG. 11, a first alignment marking 12 is in a state coinciding with the center of the mask slit 15. Additionally, the first alignment marking 12 in the mask slit 15 in this state is recognized by the image recognition device, the center of gravity position is calculated based on area, and the position of the center of gravity thereof is determined as the alignment center point 16. Next, the distance between the right and left alignment center points 16 is calculated using arithmetic processing to determine the center, and as illustrated in FIG. 11, arithmetic processing is performed to calculate and store the X3-coordinate axis and the Y3-coordinate axis.

[0068]

Thereafter, position control is performed in such a way that the X3-coordinate axis, the Y3-coordinate axis, and the second alignment markings 13 will be calculated using the automatic position control device, and the stored X2-coordinate axis and the Y2-coordinate axis will coincide. Thus, as illustrated in FIG. 12, the plurality of second connection terminals 5 and the plurality of first connection terminals 1 can be precisely aligned with each other.

[0069]

As described above, the first electronic component 4 does not expand or contract, and the dimensions between the plurality of first connection terminals 1 can be formed according to the design values. Next, an alignment method for a case in which the first electronic component 4 expands and the dimension between the first connection terminal 1 becomes larger than the design value will be described.

[0070]

First, as illustrated in FIG. 9, each of the left and right second alignment markings 13 is recognized using the image recognition device to calculate the center position thereof, and the distance between the center positions of the left and right second alignment markings 13 and the center between the distances are calculated by arithmetic processing, and stored as the X2-coordinate axis information and the Y2-coordinate axis information illustrated in FIG. 9.

[0071]

Next, as illustrated in FIG. 10, each of the five left and five right first alignment markings 12 are recognized and uploaded by the image recognition device, the center of gravity of the area is calculated by performing arithmetic processing, and the center of gravity position thereof is recognized as the center position of the first alignment markings 12 group. According to this method, the center of the position of each of the five left and five right first alignment markings 12 coincide with the center position of one first alignment marking 12 provided at the center.

[0072]

Thereafter, the distance between the center positions of the recognized left and right first alignment marking 12 groups and the center between the distances are obtained by arithmetic processing, and stored as the X1-coordinate axis and the Y1-coordinate axis information illustrated in FIG. 10. Additionally, temporary positioning is performed by moving the first electronic component 4 using the automatic position control device so that the coordinate axes coincide with a preset position.

[0073]

Next, after the positioning is performed, as illustrated in FIG. 13, the mask 14 previously provided in the image recognition device and similarly formed as the above is superimposed on the image of the image recognition device. Here, the first electronic component 4 expands, making the dimension between the first connection terminals 1 become larger than the design value, resulting in an increase in the distance between the center positions of the left and right first alignment marking 12 groups. In FIG. 13, for example, the center of the fourth first alignment marking 12 and the axial center of the mask slit 15 coincide with each other from both right and left ends.

[0074]

In this state, the first alignment marking 12 in the mask slit 15 is recognized by the image recognition device, the center of gravity position is obtained based on area, and the center of gravity position thereof is determined as the positioning center point 16. Thereafter, the distance between the left and right alignment center points 16 is calculated to determine the center, and the X3-coordinate axis and the Y3-coordinate axis illustrated in FIG. 13 are determined and stored.

[0075]

Next, the position control is performed using the automatic position control device such that the X3-coordinate axis and the Y3-coordinate axis and the second alignment marking 13 coincide, and the stored X2-coordinate axis and the Y2-coordinate axis coincide. As illustrated in FIG. 14, the positions of the plurality of second connection terminals 5 and the plurality of first connection terminals 1 can be aligned.

[0076]

However, while the above is a description about a positioning method for use in cases where the first electronic component 4 expands and causes the dimension between the first connection terminals 1 to become larger than the design value, the same method can be used to perform the same alignment even when the first electronic component 4 contracts and causes the dimension between the first connection terminals 1 to become smaller than the design value.

[0077]

The first alignment marking 12 has been described with respect to a method of providing five left and five right (total of 10) in a round shape. However, in the case of this shape, depending on the amount of expansion or contraction of the first electronic component 4, two first alignment marks 12 may fit within the width of the mask slit 15. In this case, the alignment center point 16 is set at a position where the center of gravity is biased toward a first alignment mark 12 with a larger area. Therefore, an error occurs in alignment accuracy.

[0078]

Therefore, the shape of the first alignment marking 12 should be provided in a single long shape as illustrated in FIG. 15. Additionally, the distance between the first alignment marking 12 recognized by the image recognition device is calculated with arithmetic processing to determine the center, and as illustrated in FIG. 15, the X1-coordinate axis and the Y1-coordinate axis are calculated using arithmetic processing, and the first electronic component 4 is moved by using the automatic position control device so that the coordinate axes coincide with a preset position, where after temporary positioning is performed. In order to make reduce the impact due to shape defects in the first alignment markings 12, it is preferable to use a method to calculate the center of gravity based on area and then recognize the position of the center of gravity as the center position of the alignment markings.

[0079]

Thereafter, as illustrated in FIG. 15, the mask 14 is superimposed on the image of the image recognition device. In this state, the first alignment marking 12 in the mask slit 15 is recognized by the image recognition device, the center of gravity position is obtained based on area, and the center of gravity position thereof is determined as the alignment center point 16. Next, the distance between the right and left alignment center points 16 is calculated to determine the center, and then the X3-coordinate axis and the Y3-coordinate axis shown in FIG. 15 are determined and stored. By using a single long shape like this, since no bias will be generated in the area of the first alignment marking 12 in the mask slit, the alignment center point 16 will also be set to a position where there is no deviation.

[0080]

Therefore, by using the automatic position control device, position control is performed in such a way so that the X3-coordinate axis and the Y3-coordinate axis coincide with the second alignment marking 13, and so that the stored X2-coordinate axis and the Y2-coordinate axis coincide with each other, whereby the plurality of second connection terminals 5 and the plurality of first connection terminals 1 can be precisely aligned with each other.

[0081]

Next, a comparison with the prior art will be described. For example, when the method of Patent Document 1 illustrated in FIGS. 23 through 25 is used, although the widths of the outermost first terminal 211 and second terminal 221 are widened and consequently also widens the area, the other terminals are formed with a constant width. Therefore, this will eliminate the problem of the electrical connection resistance being too large and causing the liquid crystal display to become unstable.

[0082]

In contrast, in the present invention, when the center dimension IW1 of the first connection terminal width illustrated in FIG. 2 and the center dimension IW2 of the second connection terminal width illustrated in FIG. 3 are made to have the same width ($IW1 = IW2$), or made to have the same value as the widths of the first terminal 211 and the second terminal 221 of the prior art, the outer dimension OW1 of the first connection terminal width and the outer dimension OW2 of the second connection terminal width are formed even wider, resulting in the following relationships: $OW2 > IW2$ and $OW1 > IW1$. Therefore, when the connection terminal of the prior art and the connection terminal of the present invention are set to the same length, the areas of the first connection terminal 1 and the second connection terminal 5 of the present invention becomes wider than the area of the first terminal 211 and the second terminal 221 of the prior art, allowing for the total number of conductive particles contributing to the electrical connection to be increased and the electrical connection resistance to be reduced, whereby it is possible to eliminate problems such as liquid crystal display instability.

[0083]

However, as another example, it is also acceptable to apply plating to both the plurality of first connection terminals and the plurality of second connection terminals, and for the plating on each of these to be facing each other and brought into contact with each other in a state in which pressure is always applied to cause the first connection terminals and the second connection terminals to be overlapped and electrically connected.

[0084]

For example, as illustrated in FIG. 4, after alignment of the plurality of first connection terminals 1 and the plurality of second connection terminals 5 is performed, as illustrated in FIG. 16, an elastic member 19 is interposed between the first electronic component 4 (COF) and the pressing plate 21, and the pressing plate 21 and the second electronic component 8 are fixed in a state in which a clamping force is applied. In this way, by the repulsive force of the elastic member 19, a force to always abut against the first connection terminal 1 and the second connection terminal 5 is applied to the first connection terminal 1 and the second connection terminal 5, so that the abutted state can always be maintained, thereby making it possible to achieve an electrically-stable connection.

[0085]

Furthermore, when connected using such a method, since the first electronic component 4 (COF) and the first connection terminal 1 have flexibility, the first connection terminal 1 and the second connection terminal 5 can be electrically connected to each other at four or more points (in reality, a large number of points), and the connection resistance can be reduced. Since the area of the first connection terminal 1 and the second connection terminal 5 can be increased, the number of contact points can be further increased, whereby the connection resistance can be reduced.

[0086]

Here, since it is necessary to apply pressure uniformly to the first electronic component 4 (COF), it is preferable to use a rubber-based option that can follow the intricate shape of the elastic member 19, and it is necessary to generate a repulsive force over a long period of time (many years). Therefore, it is preferable to select a type of material that degrades slowly.

[0087]

Additionally, besides using an anisotropic conductive adhesive, for example, another example is illustrated in FIG. 17. As illustrated in FIG. 4, after aligning the plurality of first connection terminals 1 and the plurality of second connection terminals 5, as illustrated in FIG. 17, the UV-curable adhesive 17 is interposed between the first connection terminals 1 and the second connection terminals 5, and then the first electronic component 4 (COF) and the UV-curable adhesive 17 are sandwiched by a pressing jig 18 and the second electronic component 8 to which the elastic member 19 is adhered, where after ultraviolet rays 20 are irradiated in that state to cure the UV-curable adhesive 17. Thus, by always applying a force for maintaining a state of contact to the first connection terminals 1 and the second connection terminals 5 using the curing contraction phenomenon generated by the curing of the UV-curable adhesive 17, it will be possible to always maintain a state of contact, whereby establishing an electrically stable connection.

[0088]

Additionally, when the first electronic component 4 (COF) and the first connection terminals 1 overlap with each other when connected using such a method, the first connection terminals 1 and the second connection terminals 5 can be electrically connected by bringing the first connection terminals 1 and the second connection terminals 5 into contact at four or more points (in reality, a large number of points), and the connection resistance can be reduced. Since the area of the first connection terminals 1 and the second connection terminals 5 used in the electronic device can be increased, the number of

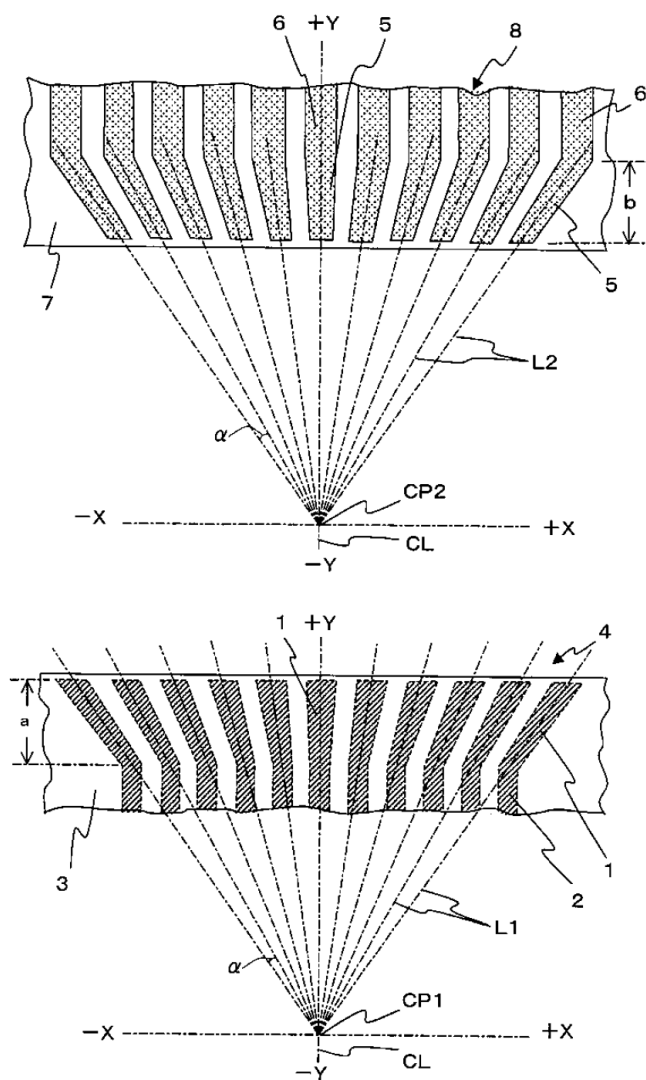
contact points can be further increased and the connection resistance can be reduced. Furthermore, the elastic member 19 is used for uniformly applying pressure, and it is preferable to use a rubber-based elastic member that does not easily erode due to ultraviolet rays 20 and has excellent ultraviolet resistance.

[Description of the Reference Numerals]

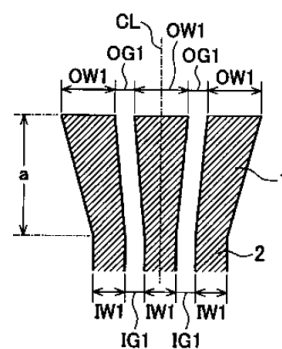
[0089]

- 1 First connection terminal
- 2 First wiring
- 3 Insulating substrate
- 4 First electronic components
- 5 Second connection terminal
- 6 Second wiring
- 7 Glass substrate
- 8 Second electronic component
- 9 Resin
- 10 Conductive particle
- 11 Anisotropic conductive adhesive
- 12 First alignment marking
- 13 Second alignment marking
- 14 Mask
- 15 Mask slit
- 16 Center point for alignment
- 17 UV-curable adhesive
- 18 Pressing jig
- 19 Elastic member
- 20 UV ray
- 21 Pressing plate
- 22 First matchmark
- 23 Second matchmark
- a Connection region of the first connection terminal
- b Connection region of the second connection terminal
- CP1 First common intersection
- CP2 Second common intersection
- L1 First straight line
- L2 Second straight line
- OW1 Outer dimension of the first connection terminal width
- IW1 Center dimension of the first connection terminal width
- OG1 Outer dimension between first connection terminals
- IG1 Center dimension between first connection terminals
- OW2 Outer dimension of the second connection terminal width
- IW2 Center dimension of the second connection terminal width
- OG2 Outer dimension between second connection terminals
- IG2 Center dimension between second connection terminals

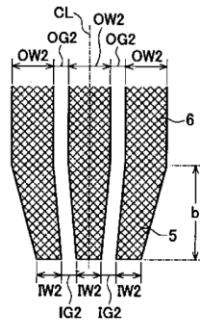
[FIG. 1]



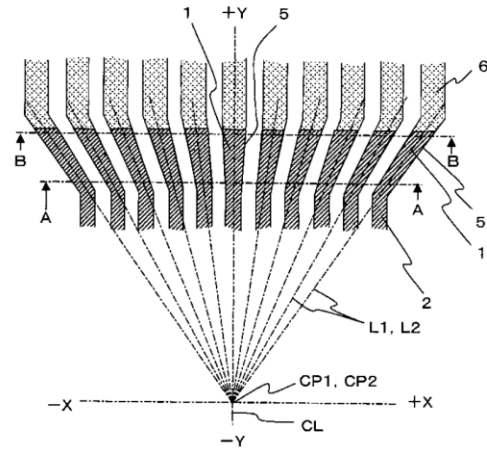
[FIG. 2]



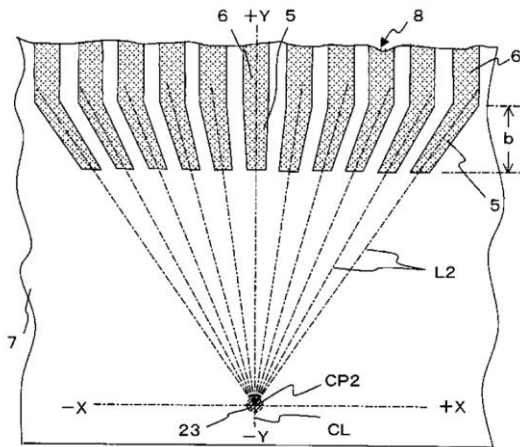
[FIG. 3]



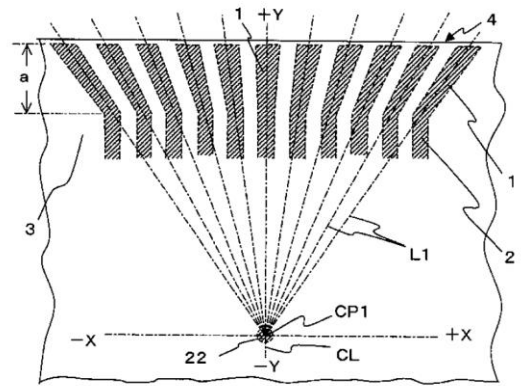
[FIG. 4]



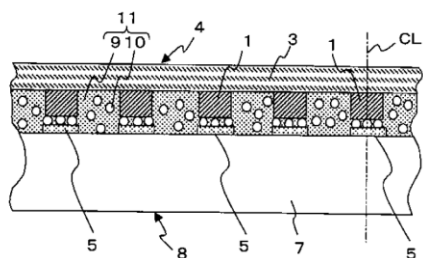
[FIG. 5]



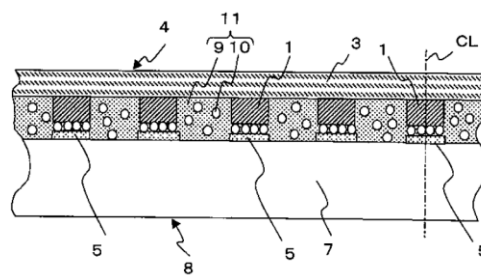
[FIG. 6]



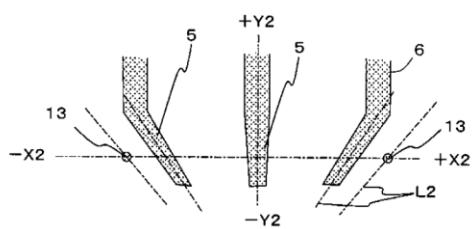
[FIG. 7]



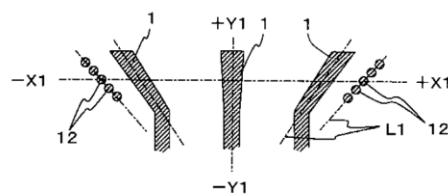
[FIG. 8]



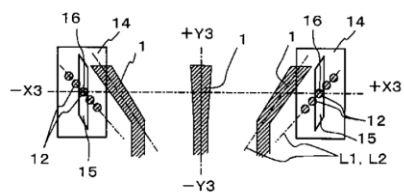
[FIG. 9]



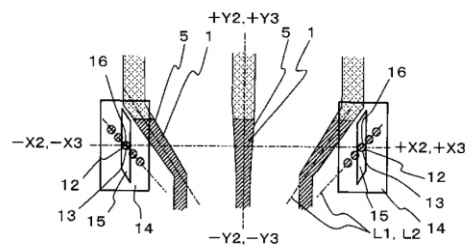
[FIG. 10]



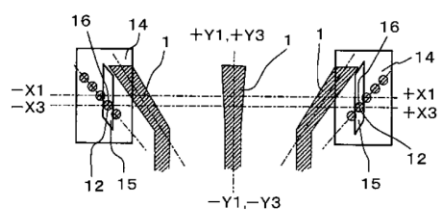
[FIG. 11]



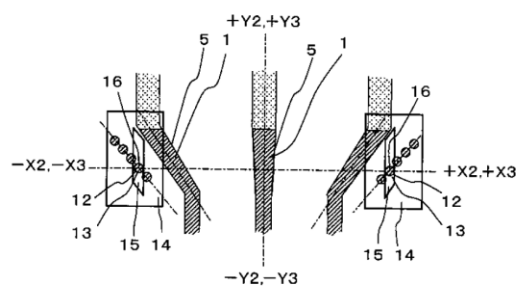
[FIG. 12]



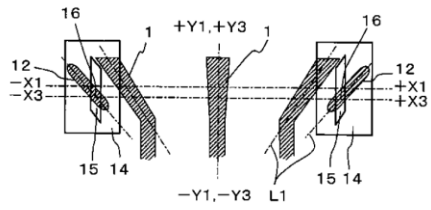
[FIG. 13]



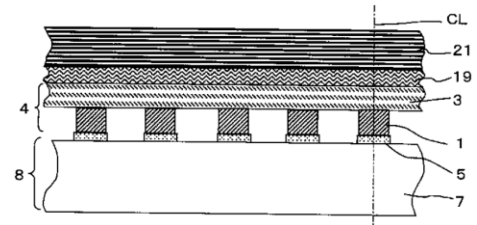
[FIG. 14]



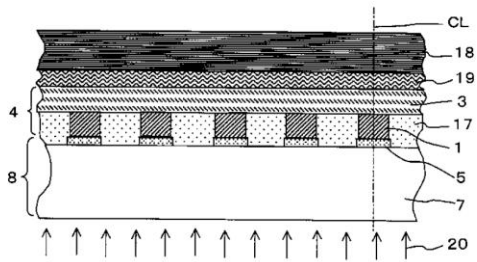
[FIG. 15]



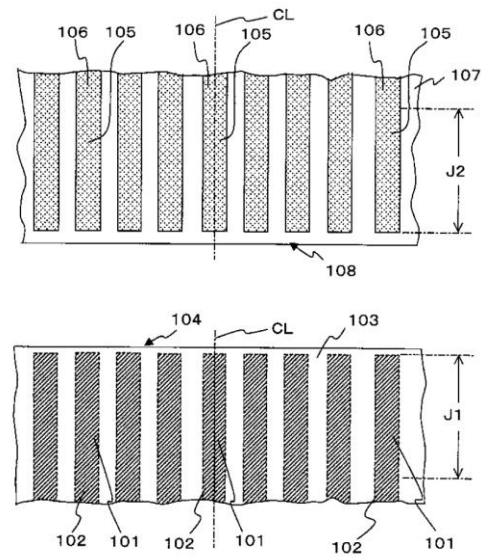
[FIG. 16]



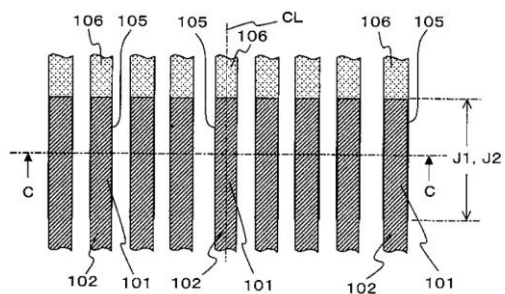
[FIG. 17]



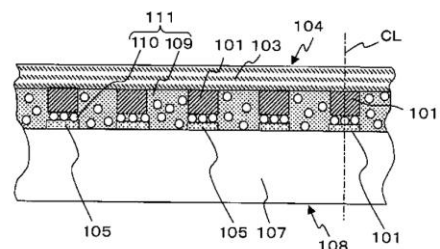
[FIG. 18]



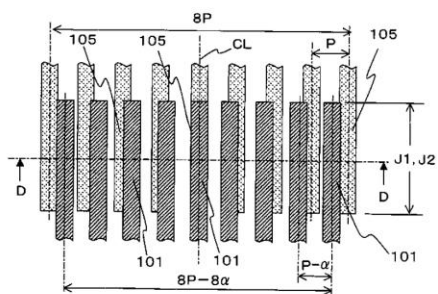
[FIG. 19]



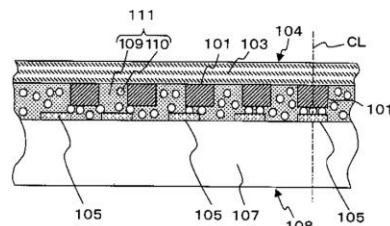
[FIG. 20]



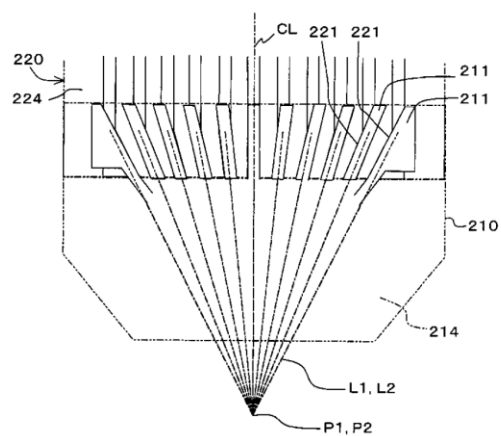
[FIG. 21]



[FIG. 22]



[FIG. 24]



[FIG. 25]

