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(54) **Keyboard and related manufacturing process**

(57) The present invention relates to a keyboard (10), including at least an upper portion (20a), having first electrical contacts (15) corresponding to respective keys (11) of the keyboard (10), and at least a lower portion (20b), having second electrical contacts (25) that, in use, are positioned opposite said first electrical contacts (15) and at a given distance (d) therefrom. In the keyboard (10),

the distance (d) between the first and second contacts (15, 25) is obtained by means of a layer of spacers (27) having a height (h) that can be selectively determined by means of a silk-screen process. In this manner, keyboards with extremely limited overall thickness and distance between the contacts can be manufactured. The invention also relates to a process of manufacturing the keyboard (10).

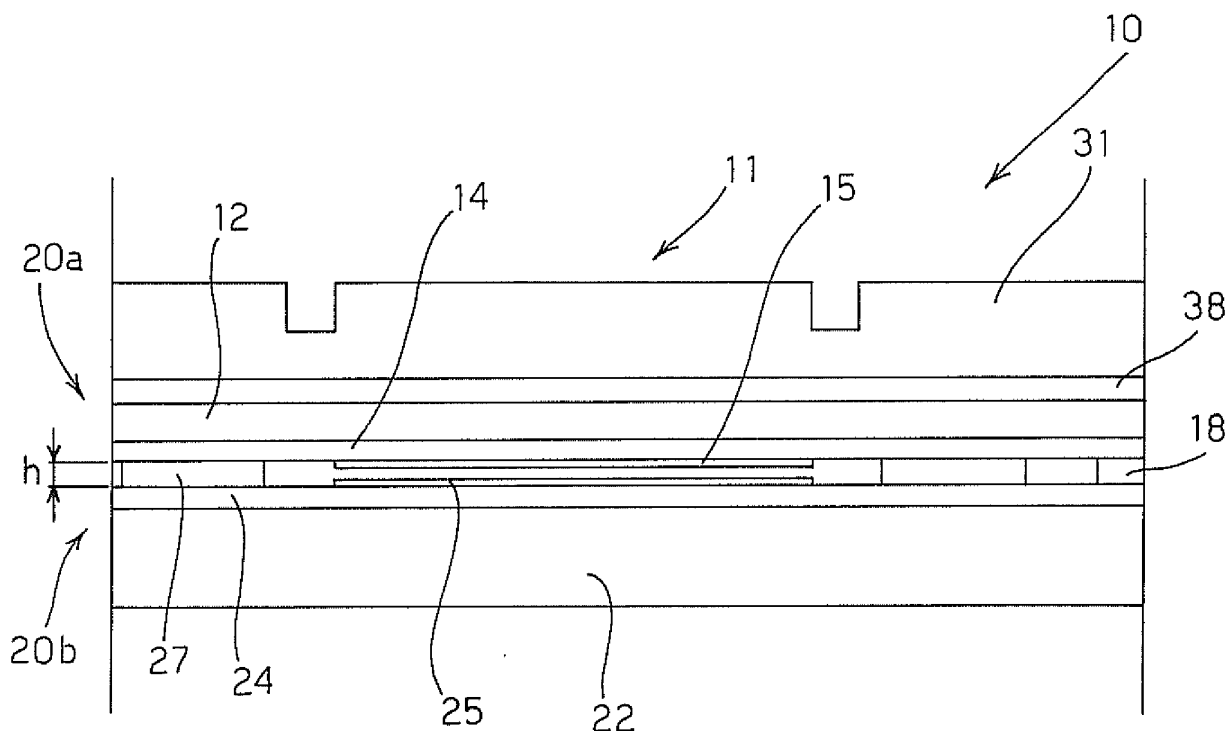


FIG. 2

Description

Technical Field

[0001] The present invention generally relates to a keyboard and to a process for manufacturing such a keyboard.

[0002] More particularly, the present invention relates to a keyboard in which the keys are formed in a single plate or sheet, and to the process for manufacturing a keyboard of that kind.

Prior art

[0003] Keyboards, especially electronic keyboards, are known which comprise a flat sheet or front sheet in which a plurality of keys are formed.

[0004] For instance, US 4,249,054 discloses an electronic keyboard in which the keys are integrated in a metal flat sheet.

[0005] The prior art keyboard is made by attaching a sheet of insulating material and a sheet of conductive material, respectively, to the metal sheet, the conductive sheet having suitable contact areas in correspondence of the keys provided on the keyboard.

[0006] A printed circuit is provided under the metal sheet and has, in correspondence of the keys, respective stationary comb-shaped contacts and, near the keys, spacer members arranged to keep the contact areas provided on the sheet of conductive material spaced apart from the stationary contacts.

[0007] Several problems are encountered with the prior art keyboard.

[0008] A first problem concerns manufacturing: actually, the manufacturing process demands use of non-homogeneous steps such as: chemical etching (metal sheet etching), moulding sheets of conductive and insulating material, gluing the latter to the metal sheet, applying a spacer member between the conductive sheet and the printed circuit.

[0009] Such a manufacturing process, including a sequence of non-homogeneous steps, demands different equipment resulting in high costs and high risk of piece rejection.

[0010] A second problem concerns the keyboard: actually, such kind of keyboard, being obtained by superimposing previously moulded sheets and a spacer member, has a high thickness as well as a predetermined and generally large distance between the contact areas provided on the sheet of conductive material and the stationary contacts.

[0011] By summarising, the Applicant has realised that several problems are encountered with the known keyboards of the kind described above, in respect of both the manufacturing process and the structure itself, so that improvements to such keyboards are possible in order to optimise both the manufacturing and the structure thereof.

Description of the invention

[0012] It is the object of the present invention to provide a keyboard which is capable of overcoming the above problems of the prior art.

[0013] The above object is achieved by the keyboard with one or more keys as claimed herein.

[0014] The present invention also relates to the process of manufacturing the keyboard according to the invention.

[0015] The claims are integral part of the technical teaching provided herein in respect of the invention.

[0016] In accordance with a preferred embodiment, the keyboard with one or more keys according to the invention comprises a lower portion and an upper portion where respective electrical contacts are formed that, in use, face each other and are spaced apart by a distance depending on a layer of spacers deposited by a silk-screen process close to the electrical contacts.

[0017] In accordance with another feature of the present invention, since the keyboard comprises a sheet of a given material and a given thickness on which the keys are formed, the layer of spacers has a height that is determined at will depending on the kind of material and the thickness of the sheet.

[0018] In accordance with yet another feature of the present invention, the layer of spacers has a height that is determined at will depending on pressure values desired for actuating the keyboard keys.

Brief description of the Figures

[0019] The above and other features of the present invention will become apparent from the following description of preferred embodiments thereof, made by way of non limiting example with reference to the accompanying drawings, in which elements denoted by a same or similar numerical reference correspond to components having the same or similar function and construction, and in which:

- Fig. 1 is a flow chart illustrating the process for manufacturing the keyboard of the invention;
- Fig. 2 is a schematic cross-sectional view of a preferred embodiment of the keyboard of the invention; and
- Fig. 3 is a schematic cross-sectional view of the keyboard of the invention in accordance with a variant of the preferred embodiment.

Description of preferred embodiments

[0020] Referring to Figs. 1 and 2, a process for manufacturing a keyboard 10 with one or more keys 11, according to the present invention, comprises for instance a first and a second set of steps 100 and 200, respectively, substantially mutually equivalent.

[0021] For instance, the first set of steps 100 is ar-

ranged to allow manufacturing an upper portion 20a of keyboard 10, corresponding to the portion to which a front sheet 31, e.g. of metal, having reproduced thereon one or more keys 11, is to be applied.

[0022] The second set of steps 200 is arranged to allow manufacturing a lower portion 20b of keyboard 10, corresponding to the portion to which a protective cover, e.g. a rigid bottom cover, is possibly to be applied.

[0023] Of course, the terms "upper portion" and "lower portion" are to be intended as conventional terms, allowing distinguishing different portions of a keyboard.

[0024] The first set of steps 100 preferably comprises:

- a first step 110 in which a layer 14 of a conductive paste (upper conductive layer), for instance silver-based, capable of forming for instance electrical connections of a keyboard circuit, is deposited on a substrate 12 of insulating material (upper substrate), for instance polyester or polyimide, for instance by means of a silk-screen process;
- a second step 120 of drying or baking in a furnace at a temperature preferably in the range 80°C to 150°C;
- a third step 130, in which a layer 15 of electric contact material (upper contact), e.g. graphite or transparent conductive material, capable of forming keyboard electric contacts, is deposited in predetermined positions corresponding to the positions of keys 11 in keyboard 10, preferably by means of a silk-screen process;
- a fourth step 140 of drying or baking in a furnace at a temperature preferably in the range 80°C to 150°C;

[0025] Once this step has been completed, lower portion 20b of keyboard 10 is manufactured in parallel or in sequence, by means of the second set of steps 200, comprising:

- a first step 210 in which a layer 24 of a conductive paste (lower conductive layer), for instance silver-based, capable for instance of forming electrical connections of a keyboard circuit, is deposited on a substrate 22 (bottom substrate) of insulating material, for instance polyester or polyimide, preferably by means of a silk-screen process;
- a second step 220 of drying or baking in a furnace at a temperature preferably in the range 80°C to 150°C;
- a third step 230, in which a layer 25 of electric contact material (lower contact), e.g. graphite or transparent conductive material, capable of forming electrical keyboard contacts, is deposited in predetermined positions corresponding to the position of keys 11 in keyboard 10;
- a fourth step 240 of drying or baking in a furnace at a temperature preferably in the range 80°C to 150°C;
- a fifth step 250 in which a dielectric layer 27, for instance solvent-based and to be dried in a furnace,

or UV-based and to be dried in a UV-ray furnace, is deposited in correspondence of peripheral areas of keys 11 by means of a silk-screen process; as it will be disclosed in detail below, the dielectric layer is arranged to form a separating insulating layer, whose thickness or height h can be determined at will, between upper and lower contacts 15 and 25;

- a sixth step 260 of drying or baking in a furnace at a temperature preferably in the range 80°C to 150°C, or drying in a UV-ray furnace.

[0026] Once the first and second sets of steps have been completed, in a first assembling step 310 upper portion 20a is coupled with lower portion 20b so as to bring upper contact 15 of each key 11 opposite lower contact 25 and to obtain a distance d between such contacts depending on height h of dielectric layer 27, since it is obtained by putting the dielectric layer deposited on upper portion 20a in contact with lower portion 20b.

[0027] During such step, upper portion 20a is sealed, by means of an adhesive 18 of known type, to lower portion 20b so as to form an integral body or sandwich structure and to prevent air from flowing into and out of the sandwich structure.

[0028] Preferably, sealing is performed by depositing adhesive 18 on either portion 20a or 20b, respectively, by means of a silk-screen process.

[0029] More preferably, the adhesive is deposited so as to leave the dielectric deposited in correspondence of peripheral areas of keys 11 uncovered.

[0030] In a second assembling step 320, sheet 31 is applied or glued, by means of an adhesive 28 of known type, to upper portion 20a of the sandwich structure, thereby forming keyboard 10.

[0031] Also in the second assembling step 320, the adhesive is deposited on upper portion 20a of the sandwich structure by means of a silk-screen process.

[0032] In the preferred embodiment, sheet 31, for instance a steel sheet 0.25 mm thick, is etched by using, for instance, a silk-screen process of known type that can comprise:

- ink deposition and baking at 360°, or silk-screen deposition of UV ink and polymerisation/baking at 180°C, so as to trace, for instance, the key contours;
- chemical etching or mechanical etching by means of a pantograph, over a given depth, of the key contours on one or both faces of sheet 31, for instance over a depth of 100 µm, so as to allow a given vertical displacement of the key;

[0033] Etching can be dispensed with in case of low thickness sheets, such as the sheet of the present example.

[0034] Neglecting the adhesive layers, keyboard 10 formed in this manner comprises in sequence:

- sheet 31 with keys 11 preferably etched along their

- contours;
- upper substrate 12;
- electrical connection layer 14;
- upper contact layer 15;
- dielectric layer (layer of spacers) 27 arranged to keep upper contact layer 15 separated from lower contact layer 25;
- electrical connection layer 24;
- lower substrate 22.

[0035] In accordance with the preferred embodiment, height *h* of spacer layer 27 is determined at will, depending for instance on the kind of material used for making sheet 31 and/or the sheet thickness.

[0036] Actually, spacer layer 27, being deposited by means of a silk-screen process, can take in precise manner different heights *h*, ranging for instance from few micrometres to some tenths of a millimetre, e.g. from 17 μm to 0.1 mm, by suitably changing the kind of fabric of the silk-screen frame.

[0037] In alternative or in addition, the calibration of the spacer layer can be performed by means of one or more silk-screen passes, thereby obtaining thicknesses *h* ranging from few micrometres to some tenths of a millimetre.

[0038] For a given kind of material and a given thickness of sheet 31, the calibration of the thickness of spacer layer 27 can also be used to determine pressure values desired for actuating the keyboard keys. For instance, the pressure values can be varied, in controlled manner, from 150 g to 300 g by suitably calibrating height *h* of spacer layer 27.

[0039] Other embodiments provide for modifying the etching depth on one or both faces of sheet 31, while keeping the height of the spacer layer and the sheet thickness unchanged.

[0040] According to a variant embodiment of the keyboard, the first set of steps comprises depositing a further dielectric layer or layer of spacers 28 (Fig. 3), by means of a silk-screen process, onto upper substrate 12, in particular on an upper face opposite to the face on which the contacts are deposited, layer 28 being deposited in barycentric position with respect to the keys and having a thickness *h'*. Such embodiment is preferred for instance in case of high-thickness steel sheets, for instance sheets 0.6 mm thick.

[0041] The considerations made above for the calibration of spacer layer 27 also apply to the calibration of thickness *h'* of spacer layer 28.

[0042] According to a further variant embodiment of the present invention, step 250 of deposition of the dielectric layer comprises:

- a first step in which a thin dielectric layer (some micrometre thick) is deposited on the electrical connections or conductive layer 14 and is baked;
- a second step in which the dielectric is deposited in correspondence of the peripheral areas of keys 11,

to a thickness determined according to the kind of keyboard to be made or the pressure to be applied to keys 11.

[0043] According to yet further embodiments, keyboard 10 comprises for instance a rigid or flexible printed circuit, in place of lower substrate 22. Of course, as the skilled in the art will readily appreciate, the provision of the printed circuit does not alter the manufacturing process.

[0044] According to another variant embodiment, keyboard 10 comprises a sheet 31 that, instead of being made of steel, is made of any rigid material, such as for instance metal or glass or plastics, and has a suitable thickness, e. g. from 0.25 to 3 mm, depending on the material.

[0045] The description suggests that the deposition of spacer layer 27 is performed within a given one of the sets of steps, but, as the skilled in the art will readily appreciate, such layer can be deposited on either upper portion 20a or lower portion 20b of the keyboard without thereby departing from what has been described and claimed.

[0046] Similarly, it is however to be pointed out that, in general terms, the silk-screen process also comprises the baking step since, as the skilled in the art will readily appreciate, the silk-screen deposition and baking steps are strictly related and therefore, hereinafter, the silk-screen process is intended as comprising both silk-screen deposition or baking, unless differently stated.

[0047] The operation of keyboard 10 described hereinbefore is as follows.

[0048] When a selected key 11 is pressed, with a force that can be determined depending on height *h* and/or *h'* of spacer layers 27 and/or 28, respectively, the upper contact is vertically bent and brought in contact with lower contact 25, thereby causing, in known manner, the actuation of the selected key.

[0049] Thanks to the provision, for instance, of one or more dielectric layers with heights *h* and/or *h'* that can be determined at will, the vertical bending can be minimised, for instance reduced to a few micrometres, or generally it can be made to correspond to the characteristics of the kind of sheet used or of the desired pressure.

[0050] In the preferred embodiment, the process of manufacturing the keyboard with a front sheet, as described and in all possible variant embodiments, only comprises silk-screen processes. This ensures an extremely simple manufacturing process, ensuring short working times and high quality.

[0051] In particular, forming spacer layer 27, and possibly further layer 28, by means of a silk-screen process allows attaining a minimum stroke between facing contacts 15 and 25, respectively, resulting in a durable and reliable keyboard.

[0052] Moreover, the possibility of calibrating heights *h* and/or *h'* of the spacer layers so as to attain a given key actuation force, allows manufacturing keyboards

suitable for various purposes and uses.

[0053] Lastly, advantageously the keyboard according to the invention, having no gaskets, junctions or mechanical moving parts, does not suffer from seepage of humidity or other polluting substance inside it.

[0054] Obvious changes or modifications to the above description, in respect of sizes, shapes, components, circuit elements, connections and contacts, as well as in respect of the details of the circuitry and of the illustrated construction and the operating manner, are possible without departing from the scope of the invention as defined by the following claims.

Claims

1. A keyboard with one or more keys, including:

- at least an upper portion (20a) having first electrical contacts (15) corresponding to respective one or more keys (11) of the keyboard (10);
- at least a lower portion (20b) having second electrical contacts (25) that, in use, are positioned opposite said first electrical contacts (15) and at a given distance (d) from said first electrical contacts (15);

characterised in that said given distance (d) is obtained by means of a layer of spacers (27) having a height (h) that can be selectively determined by means of a silk-screen deposition process of said layer of spacers (27) on either said upper portion (20a) or said lower portion (20b).

2. The keyboard as claimed in claim 1, **characterised in that** it includes a sheet (31) of predetermined material and thickness applied to said upper portion (20a), said sheet reproducing said one or more keys at predetermined locations and being configured so as to allow actuating said keys by exerting a given pressure.

3. The keyboard as claimed in claim 2, **characterised in that** said sheet (31) is made of a material selected in the group comprising:

- metal;
- glass;
- plastics.

4. The keyboard as claimed in claim 2 or 3, **characterised in that** said height (h) of said layer of spacers (27) is determined depending on the kind of material of which the sheet (31) is made and/or on the thickness of said sheet.

5. The keyboard as claimed in claim 2 or 3, **characterised in that** said height (h) of said layer of spacers

(27) is determined, for a given thickness of said sheet (31), depending on the given pressure to be exerted in order to actuate said one or more keys.

6. The keyboard as claimed in any one of claims 2 to 5, **characterised in that** said upper portion (20a) comprises a further layer of spacers (28), which is interposed between said sheet (31) and said upper portion (20a) in barycentric position with respect to said one or more keys and has a thickness (h') that can be selectively determined by means of a silk-screen deposition process of said further layer of spacers (28).

7. The keyboard as claimed in any one of claims 1 to 6, **characterised in that** said first and second electrical contacts (15, 25) are made of a material chosen in the group comprising:

- graphite-based material;
- transparent conductive material.

8. The keyboard as claimed in any one of claims 1 to 7, **characterised in that** said lower portion (20b) comprises a substrate (22) of insulating material or a flexible or rigid printed circuit in a position opposite to said second electrical contacts (25).

9. A process for manufacturing a keyboard (10) with one or more keys (11), the process comprising:

- a first set of steps (100) for manufacturing an upper portion (20a) of said keyboard (10); and
- a second set of steps (200) for manufacturing a lower portion (20b) of said keyboard (10);

said first set of steps (100) comprising at least the step of forming first electrical contacts (15) of said keyboard (10),

said second set of steps (200) comprising at least the step of forming second electrical contacts (25) of said keyboard (10),

the process being **characterised by** the step of silk-screening, on either said upper portion (20a) or said lower portion (20b), a layer of spacers (27) having a height (h) that can be selectively determined so as to obtain, in use, a predetermined spacing (d) between said first contacts (15) and said second contacts (25).

10. The process as claimed in claim 9, **characterised in that** said step of silk-screening a layer of spacers (27) comprises depositing a layer (27) of dielectric material by means of one or more silk-screen passes.

11. The process as claimed in claim 9 or 10, **characterised by** the further step of sealing said upper portion

(20a) to said lower portion (20b) by depositing an adhesive on at least one of said portions (20a, 20b).

12. The process as claimed in any of claims 9 to 11, **characterised by** the further step of securing a sheet (31) of predetermined thickness to said upper portion (20a), said sheet reproducing, at predetermined locations, said one or more keys. 5
13. The process as claimed in claim 12, **characterised by** the further step of silk-screening a further layer of spacers (28) onto said upper portion (20a), in bar-centric position with respect to said one or more keys (11) and with a thickness (h') that can be selectively determined. 10 15
14. The process as claimed in any one of claims 9 to 13, **characterised in that** said first and second sets of steps only comprise silk-screen processes. 20

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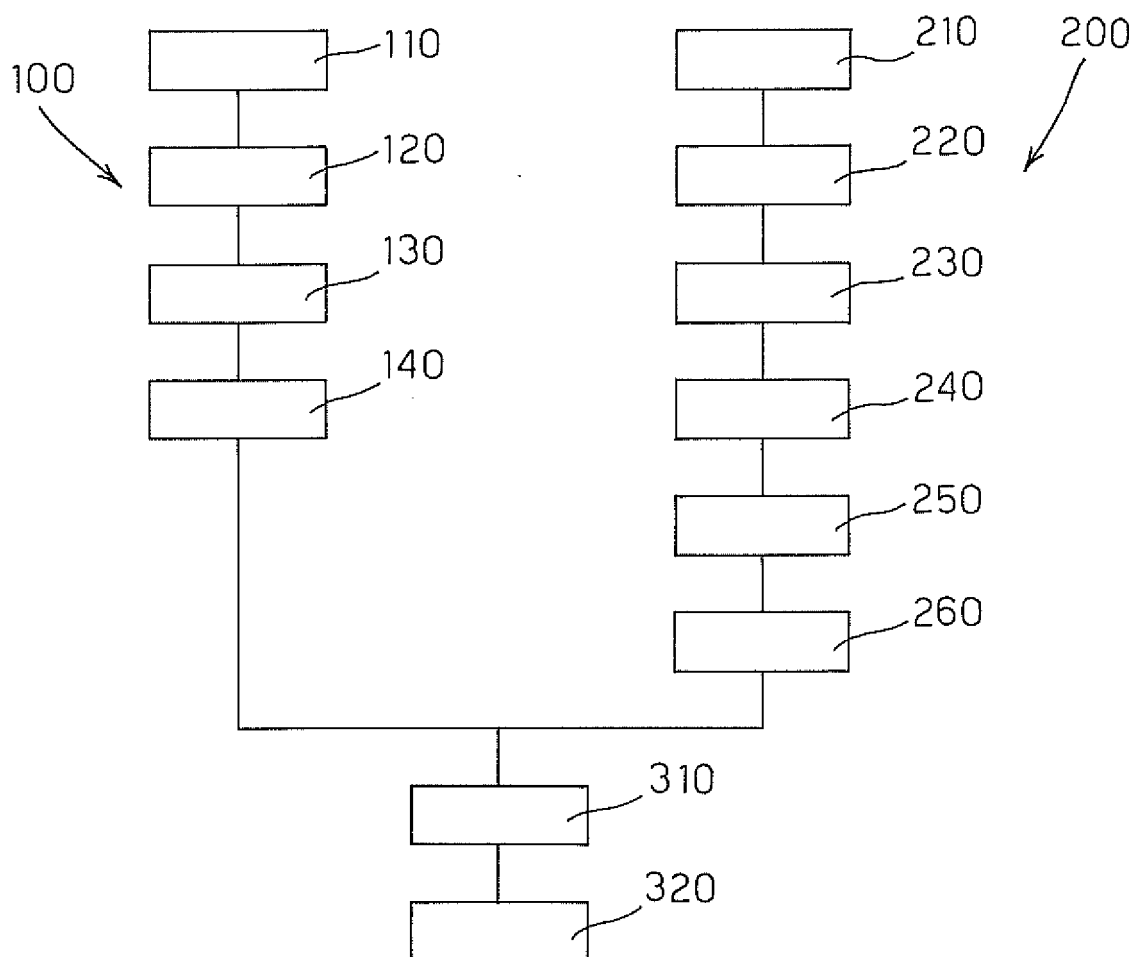


FIG. 1

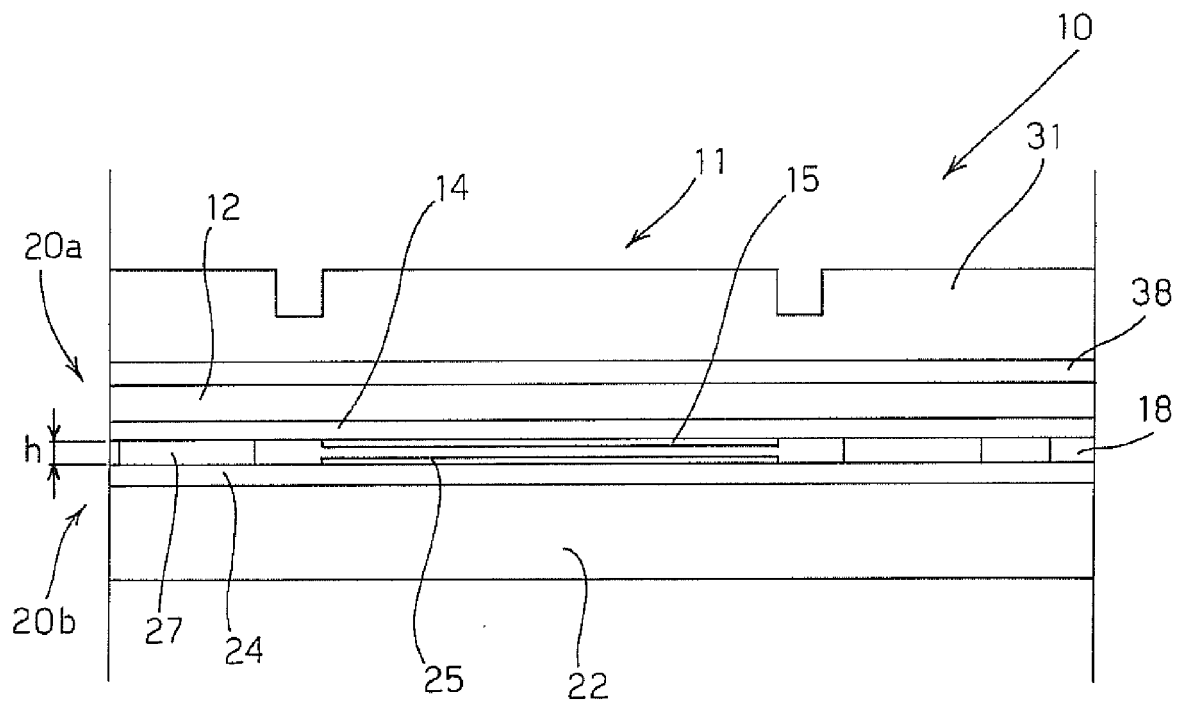


FIG. 2

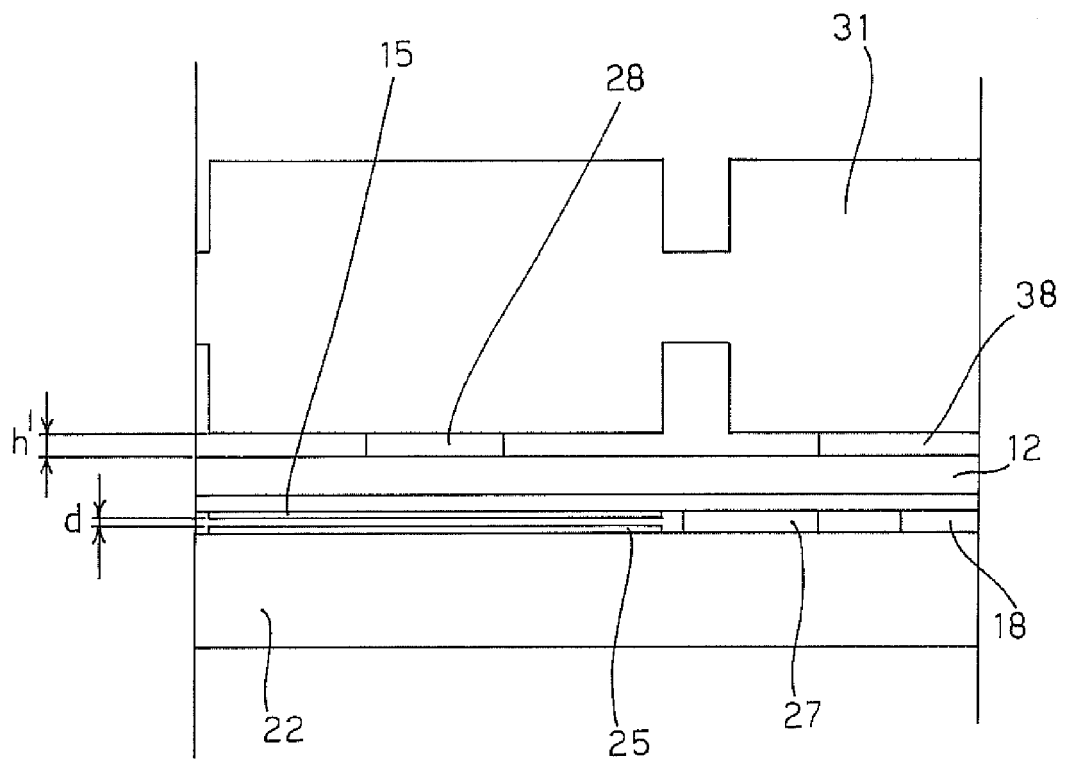


FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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