US 20250265866A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2025/0265866 A1**

HU et al. (43) **Pub. Date: Aug. 21, 2025**

(54) **FINGER FEATURE MODULE**

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(21) Appl. No.: **19/059,393**

(22) Filed: **Feb. 21, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/555,921, filed on Feb. 21, 2024, provisional application No. 63/645,229, filed on May 10, 2024, provisional application No. 63/658,535, filed on Jun. 11, 2024.

(30) **Foreign Application Priority Data**

Feb. 21, 2025 (TW) 114106399

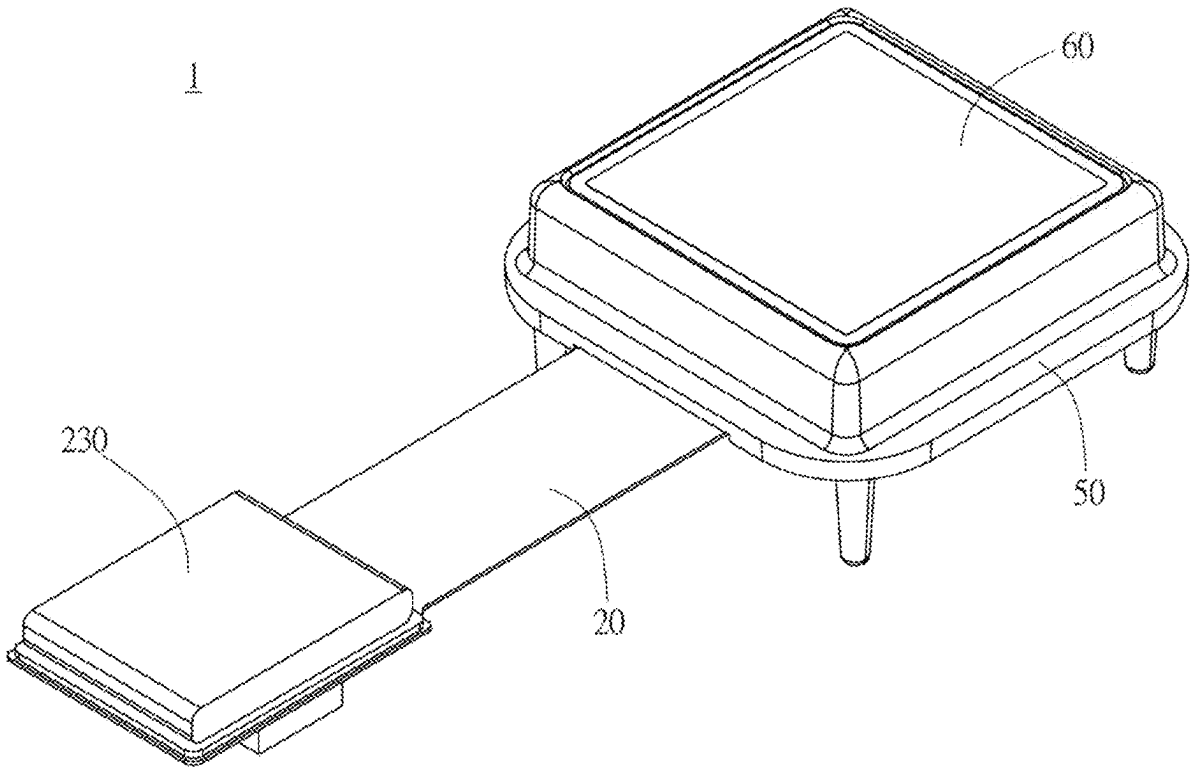
Publication Classification

(51) **Int. Cl.**
G06V 40/13 (2022.01)
H05K 1/14 (2006.01)

(52) **U.S. Cl.**
CPC ***G06V 40/1318*** (2022.01); ***H05K 1/147*** (2013.01)

(57) **ABSTRACT**

A finger feature module includes a light guide seat including a frame and a plate body disposed in the frame and having an eccentrically disposed through hole, a circuit board assembly having a first portion disposed in the frame and located above the plate body and a second portion passing through the through hole to be at least partially located below the plate body, a feature sensor on the first portion of the circuit board assembly, and a plurality of illuminants electrically connected to the circuit board assembly, wherein two of the illuminants are located at two opposite ends of the through hole, and a virtual connecting line of the two illuminants overlaps the through hole.



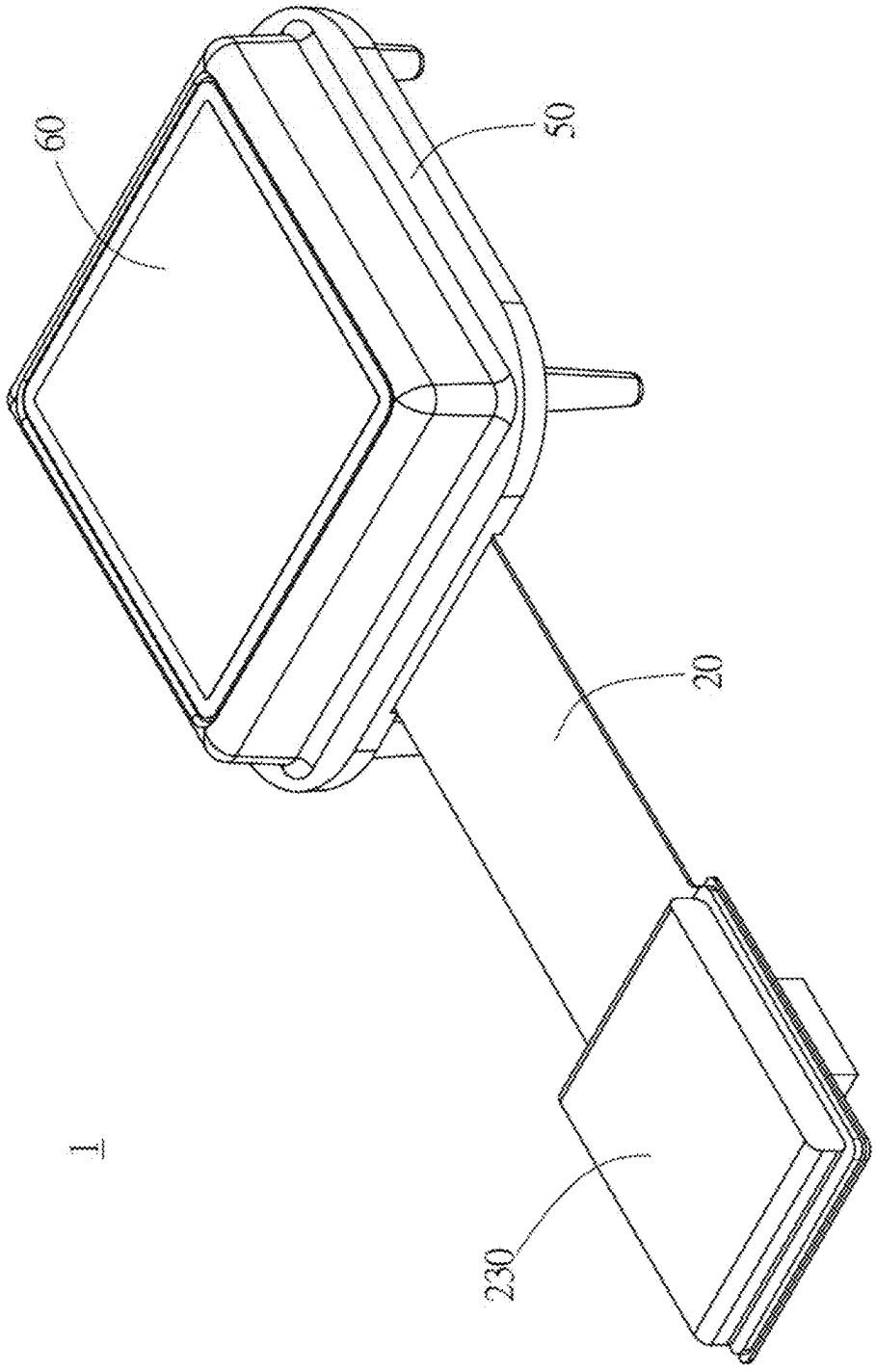


FIG. 1A

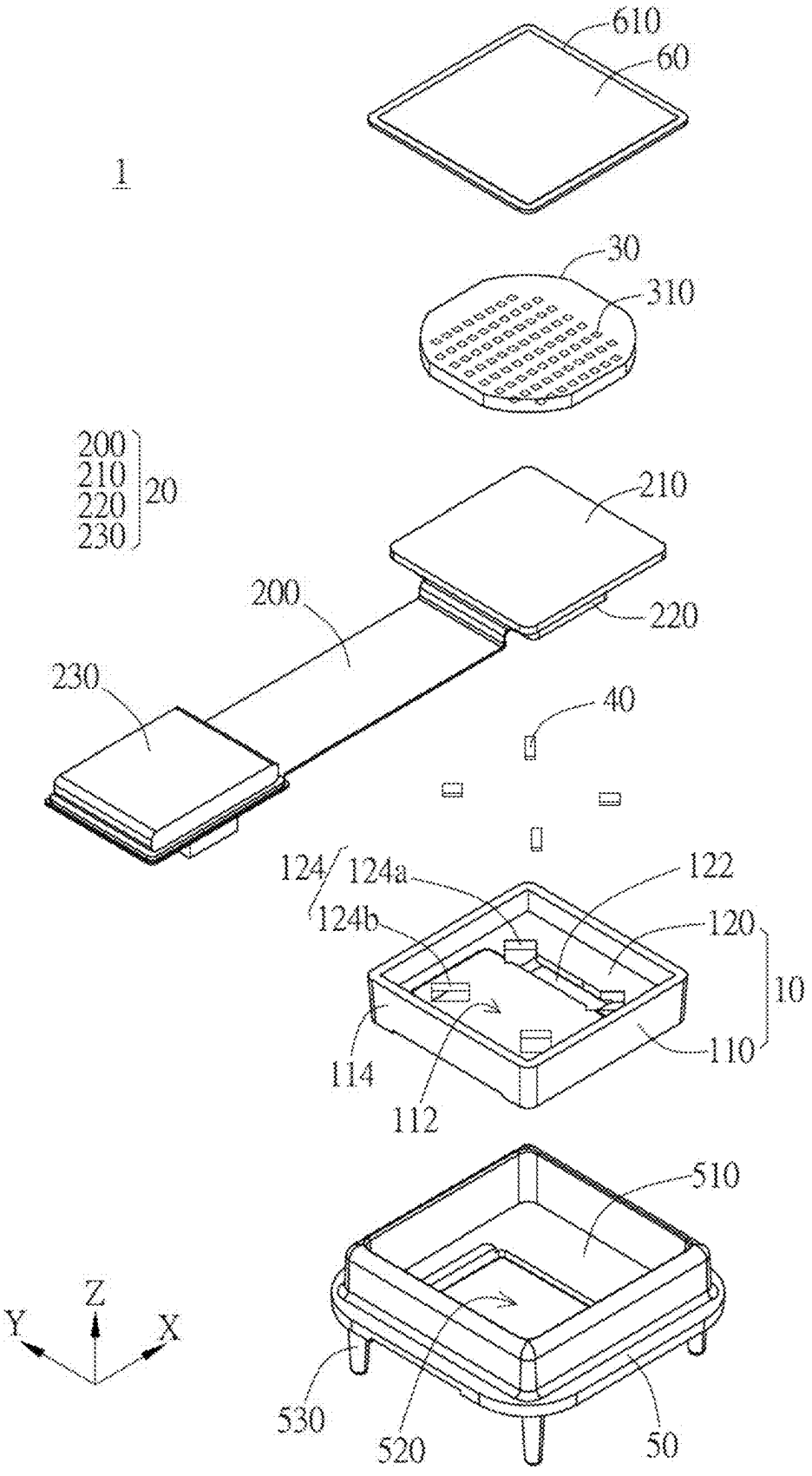

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FIG. 1B

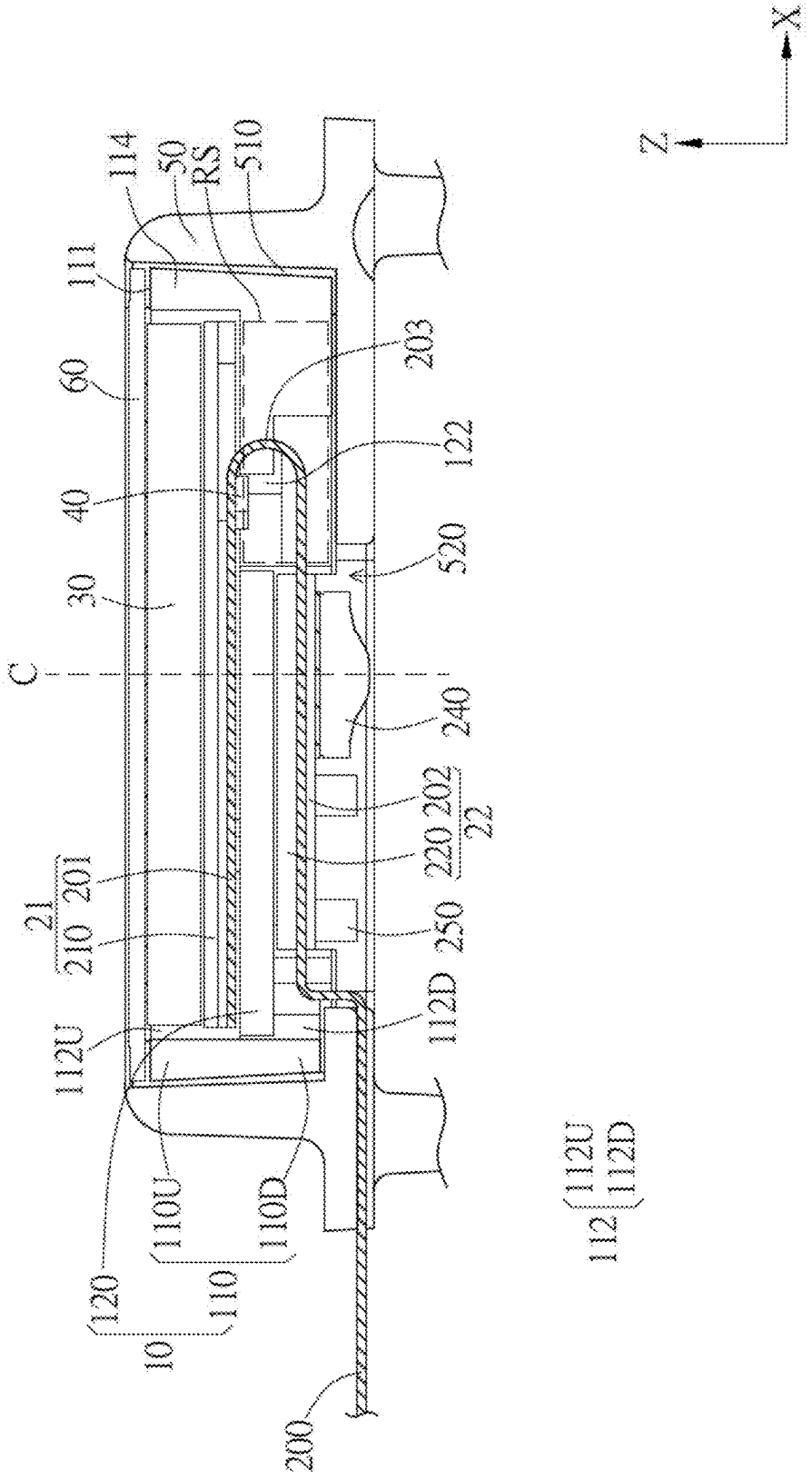
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FIG. 1C

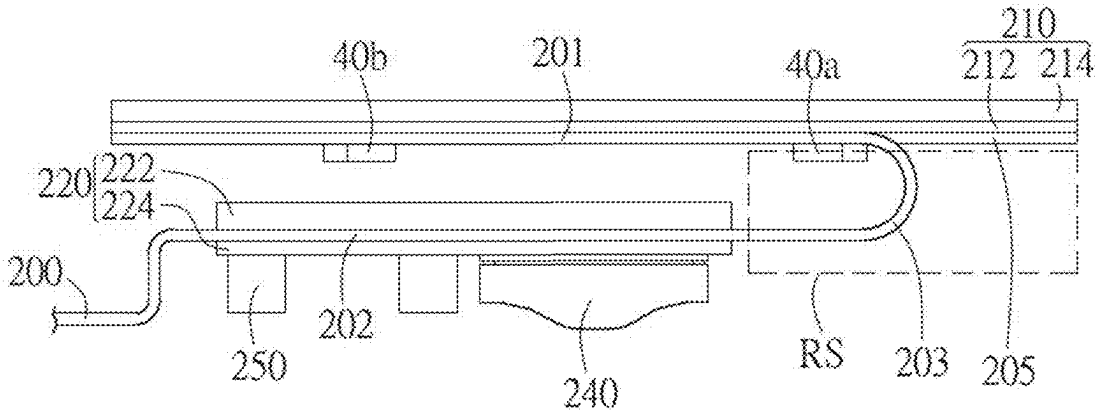
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FIG. 2A

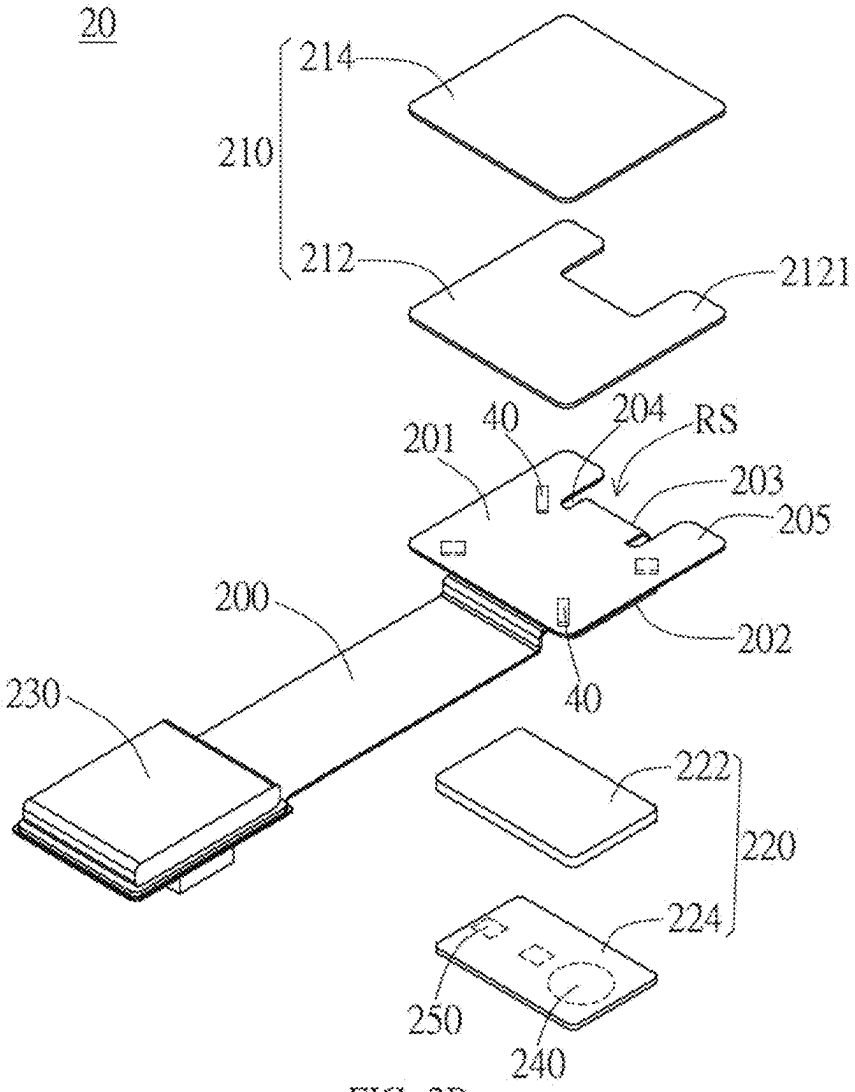
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FIG. 2B

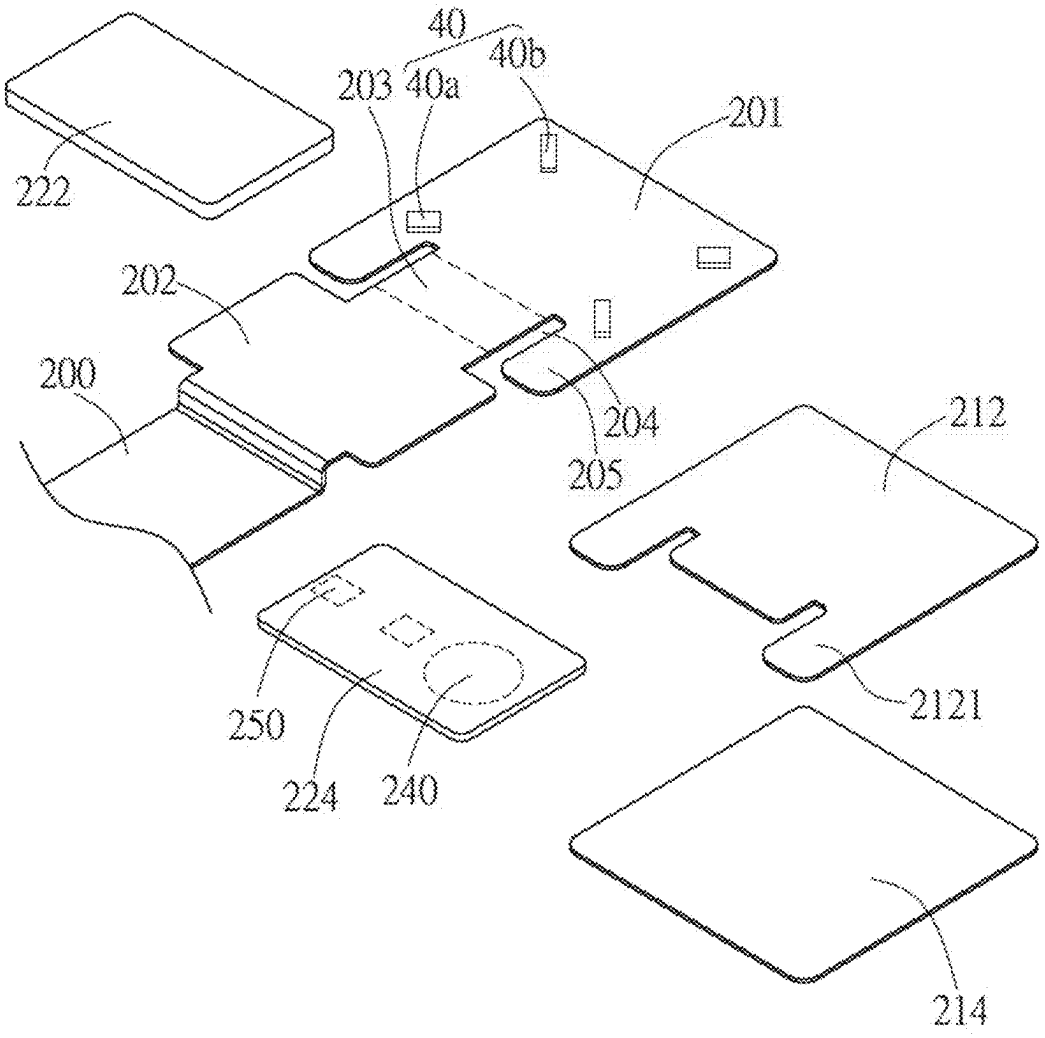

FIG. 2C

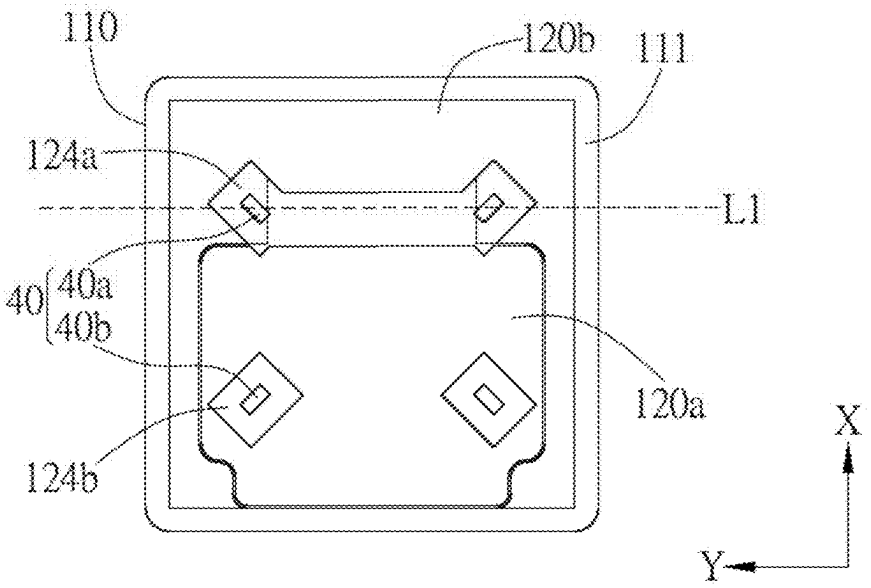
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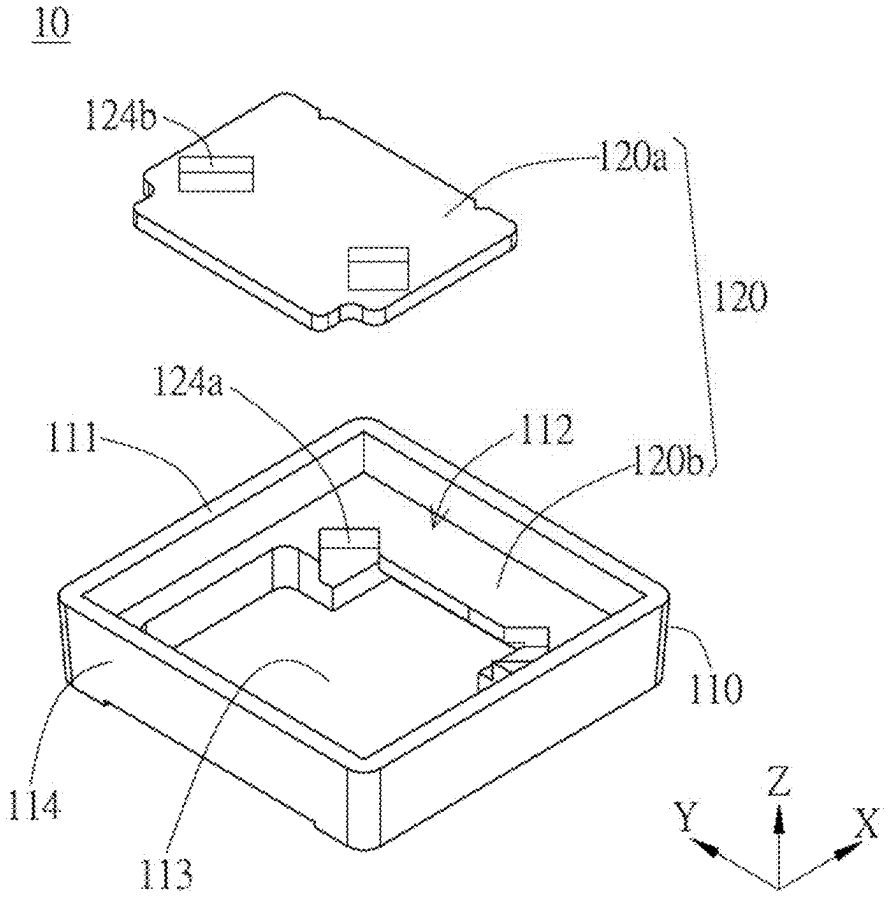
FIG. 3A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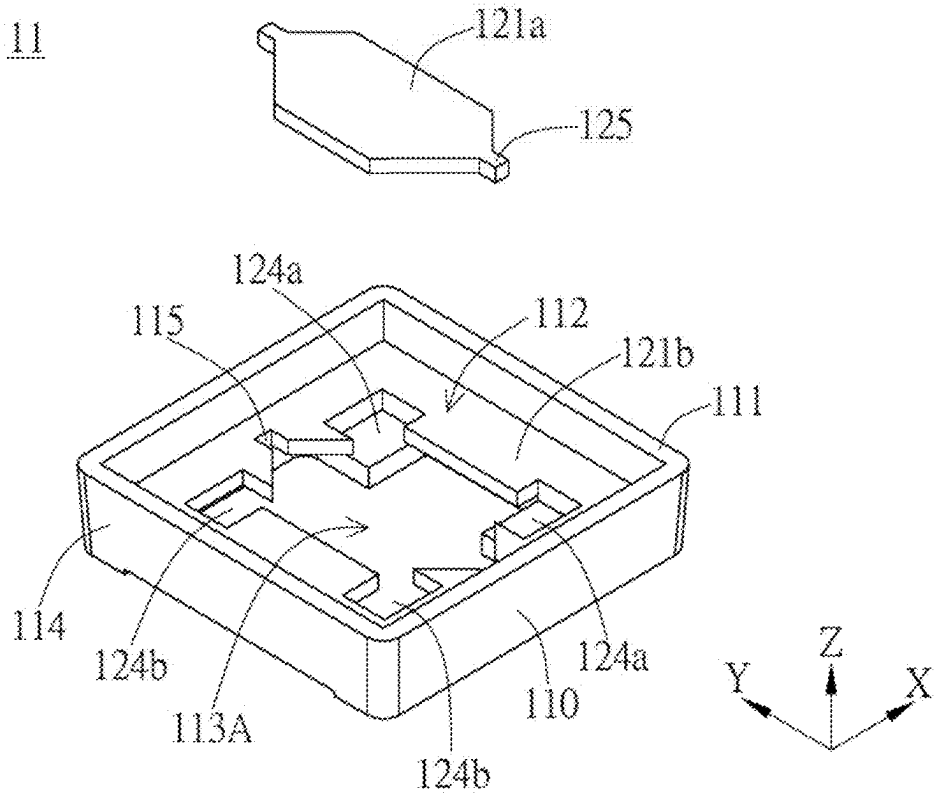
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FIG. 4A

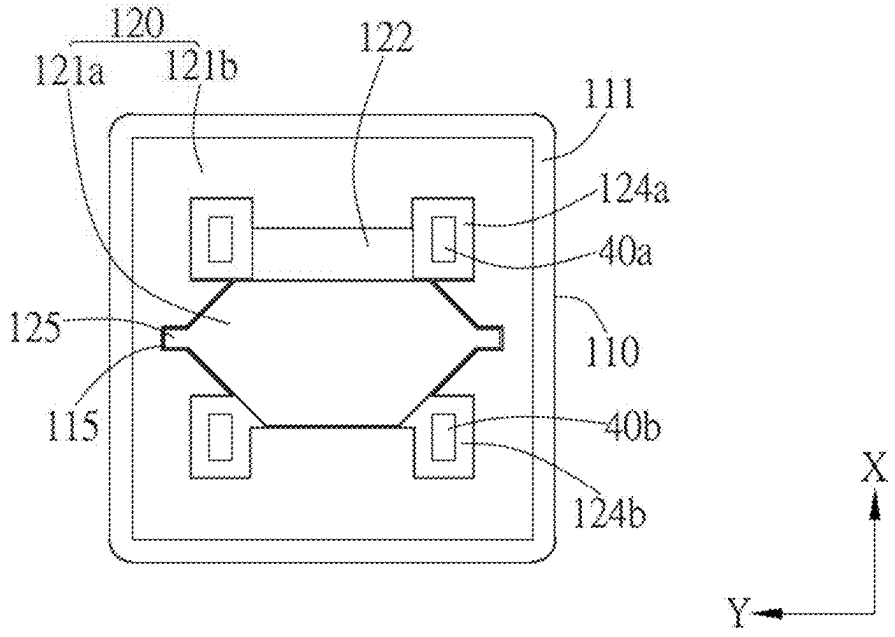
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FIG. 4B

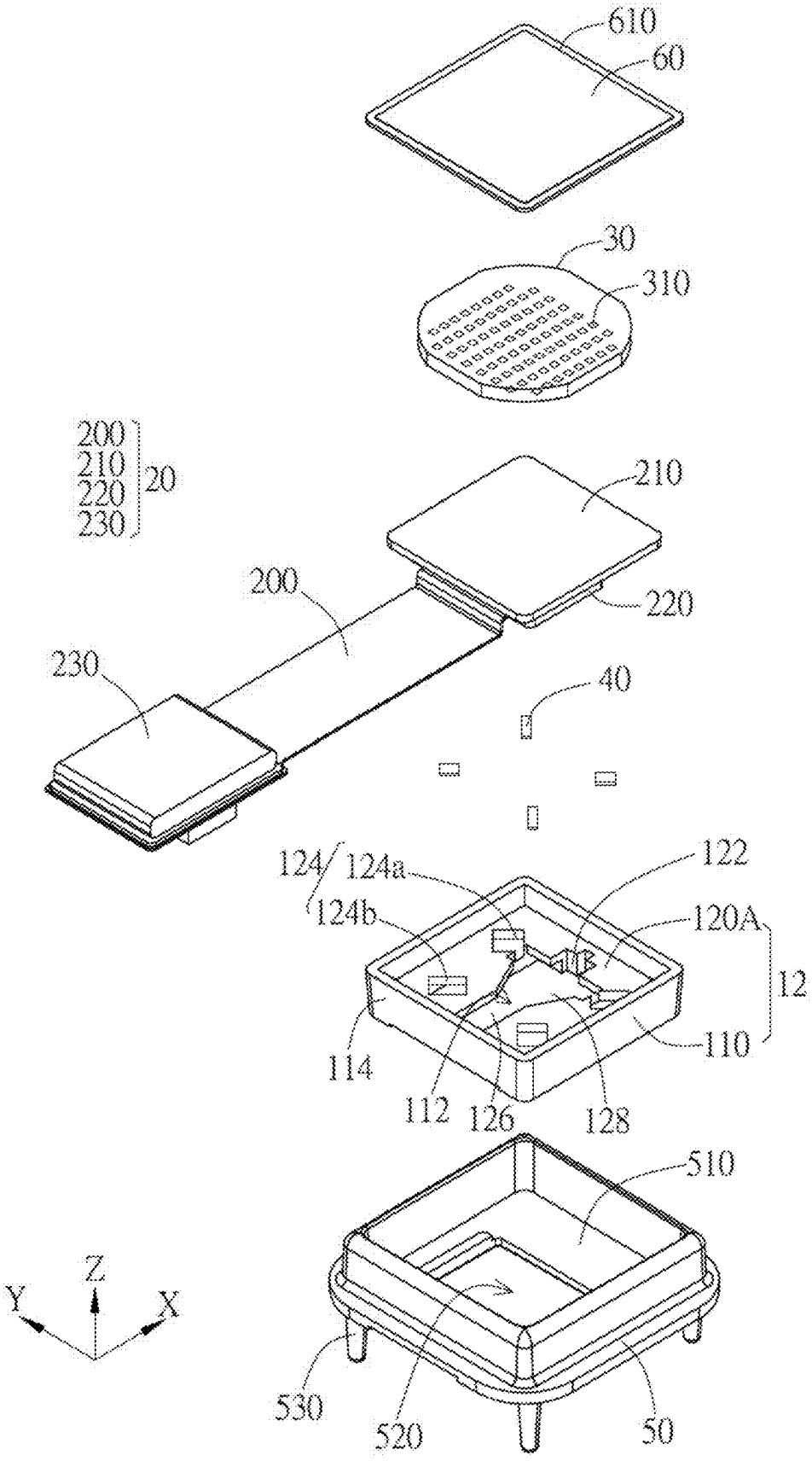
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FIG. 5A

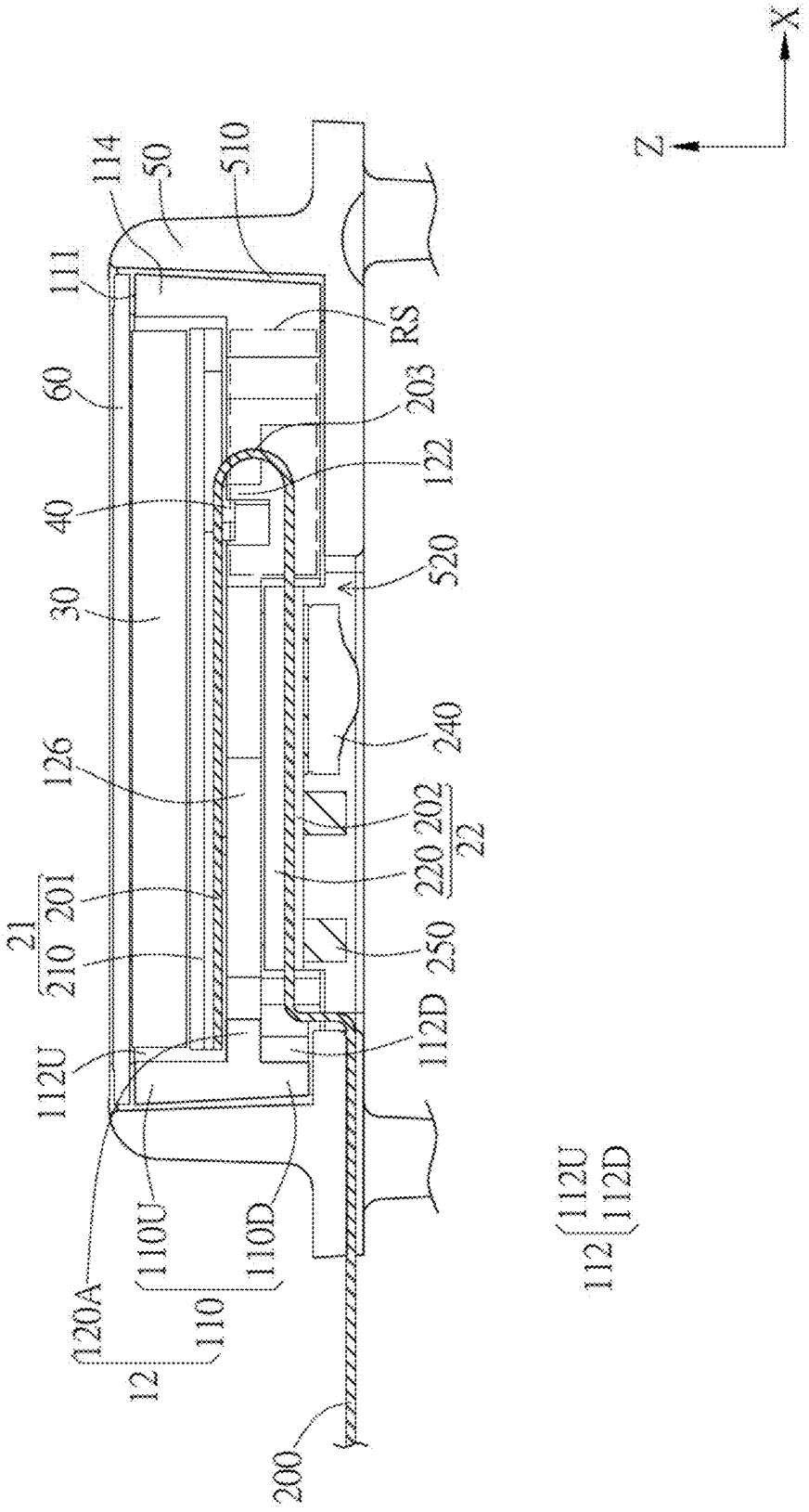
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FIG. 5B

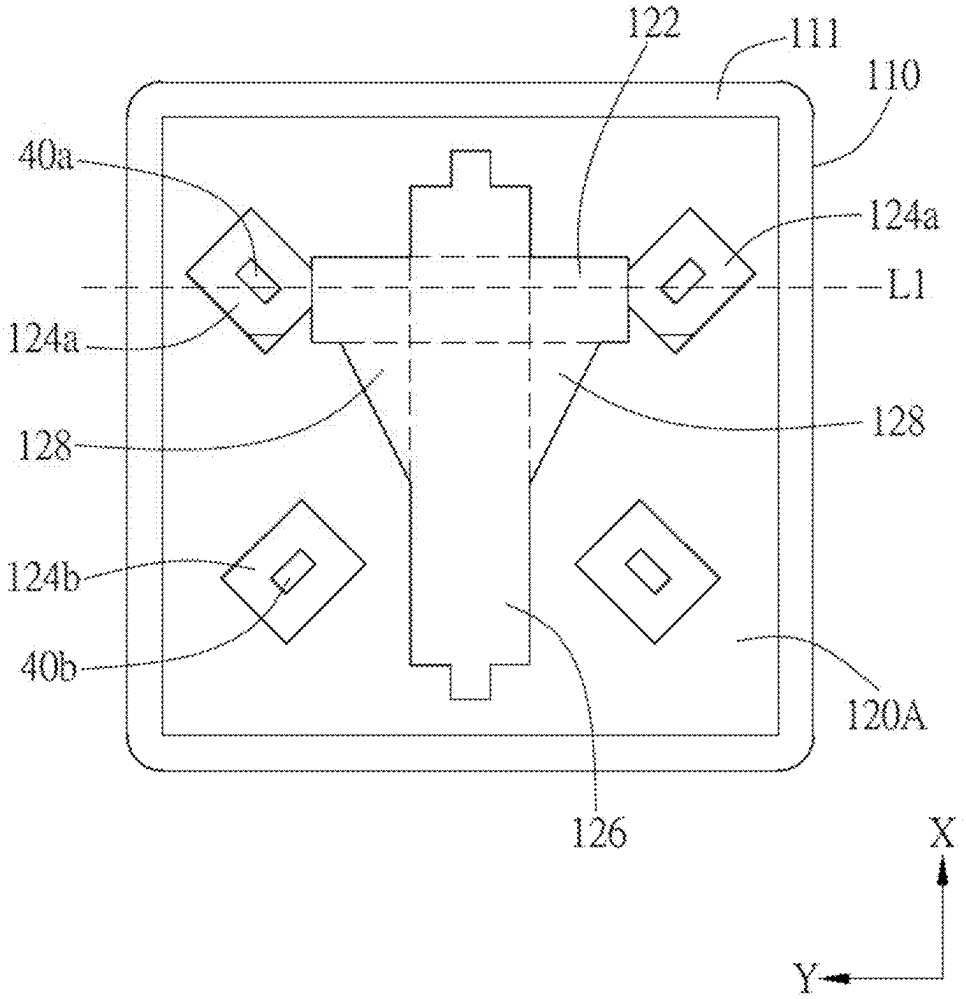

FIG. 5C

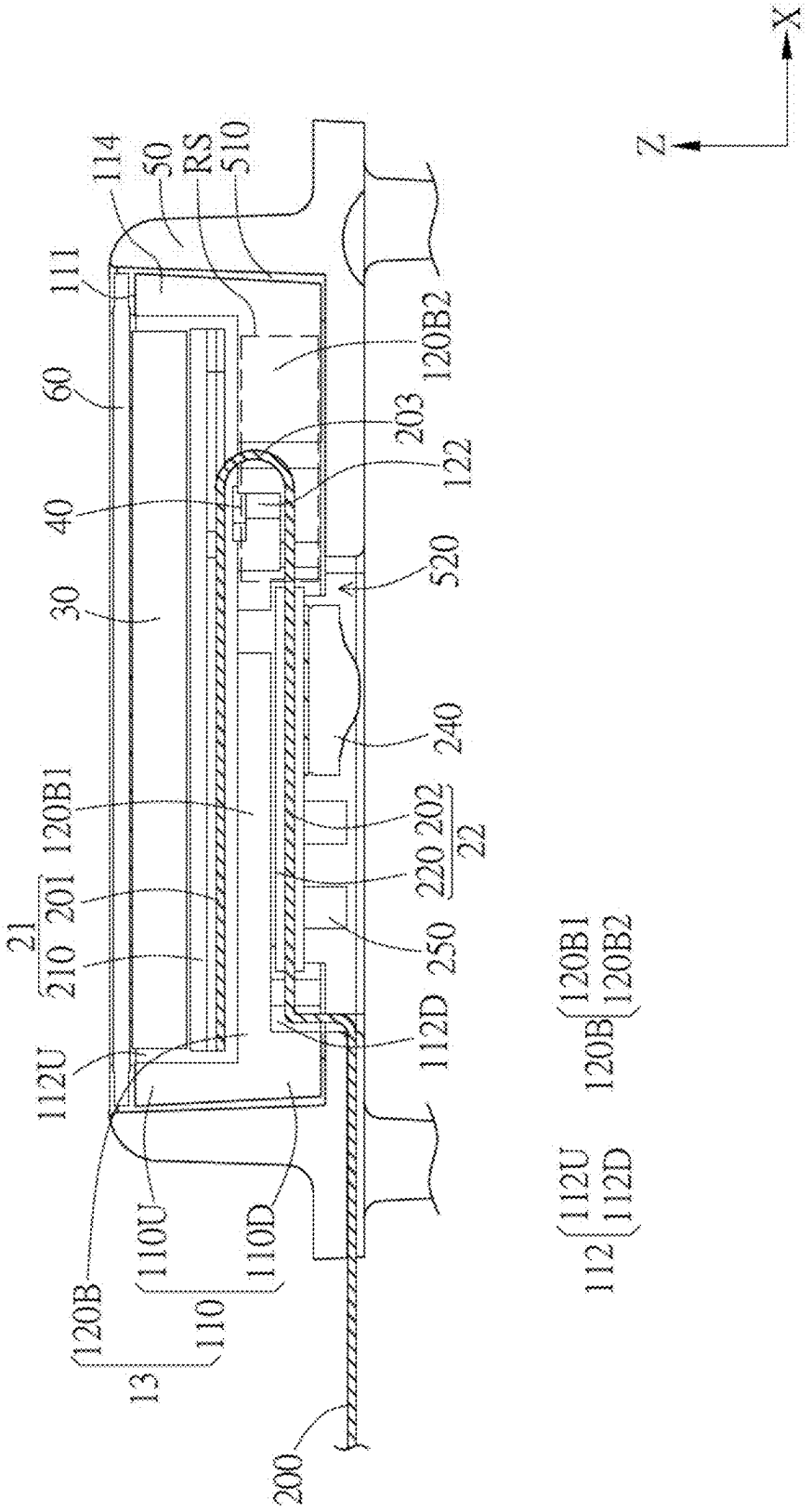
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FIG. 6A

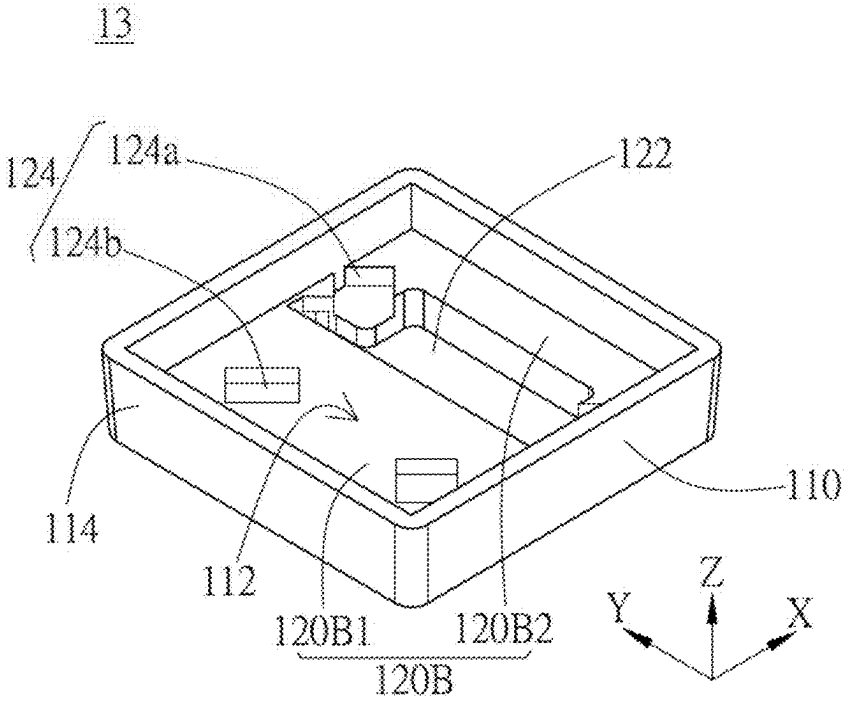
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FIG. 6B

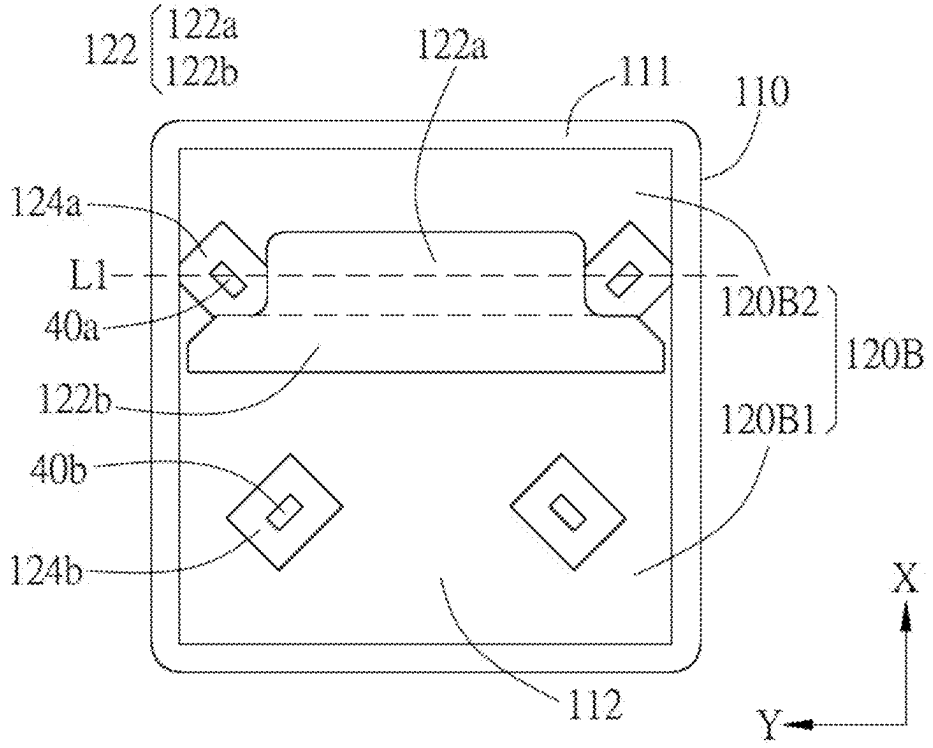
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FIG. 6C

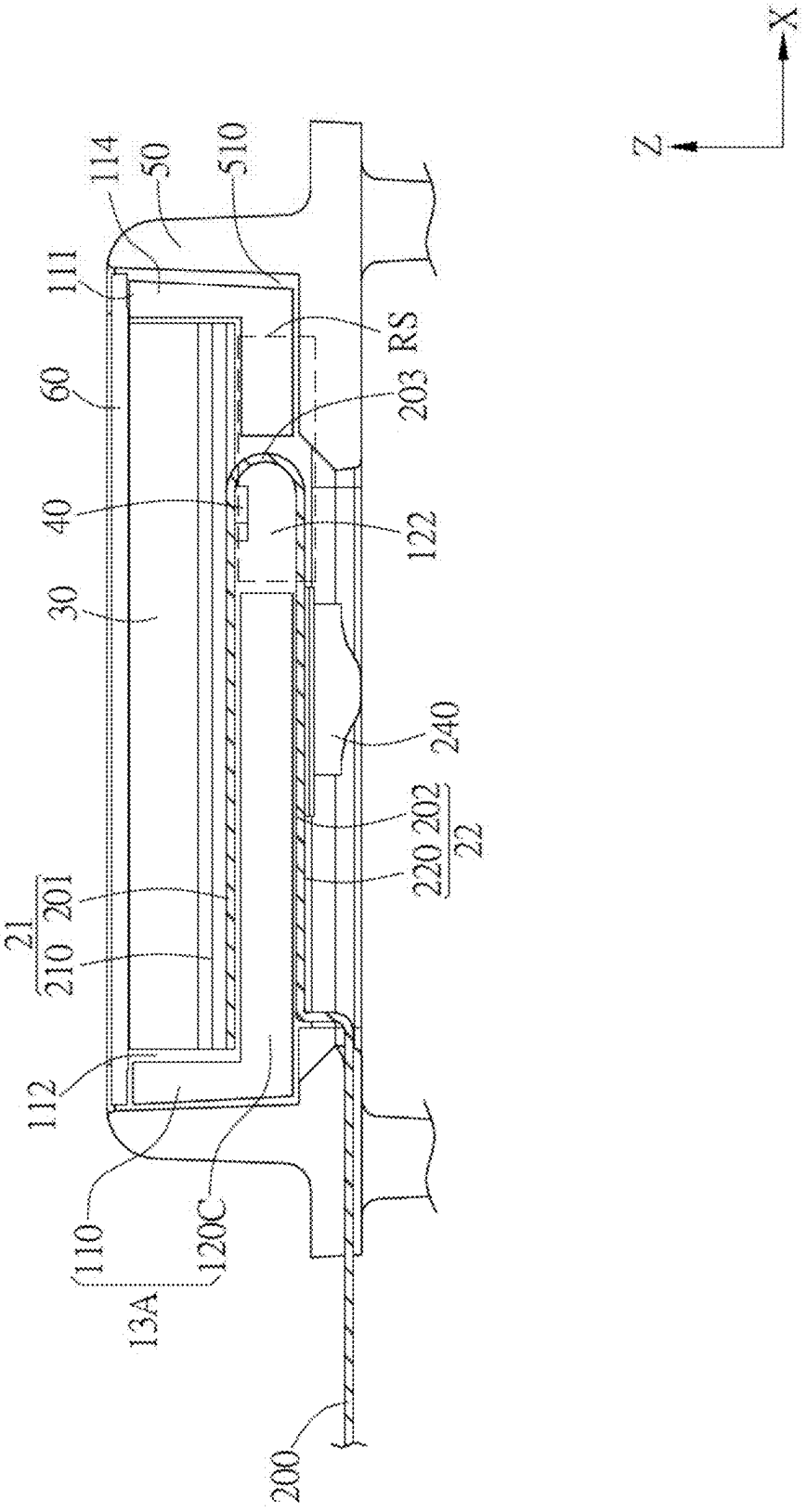
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FIG. 7A

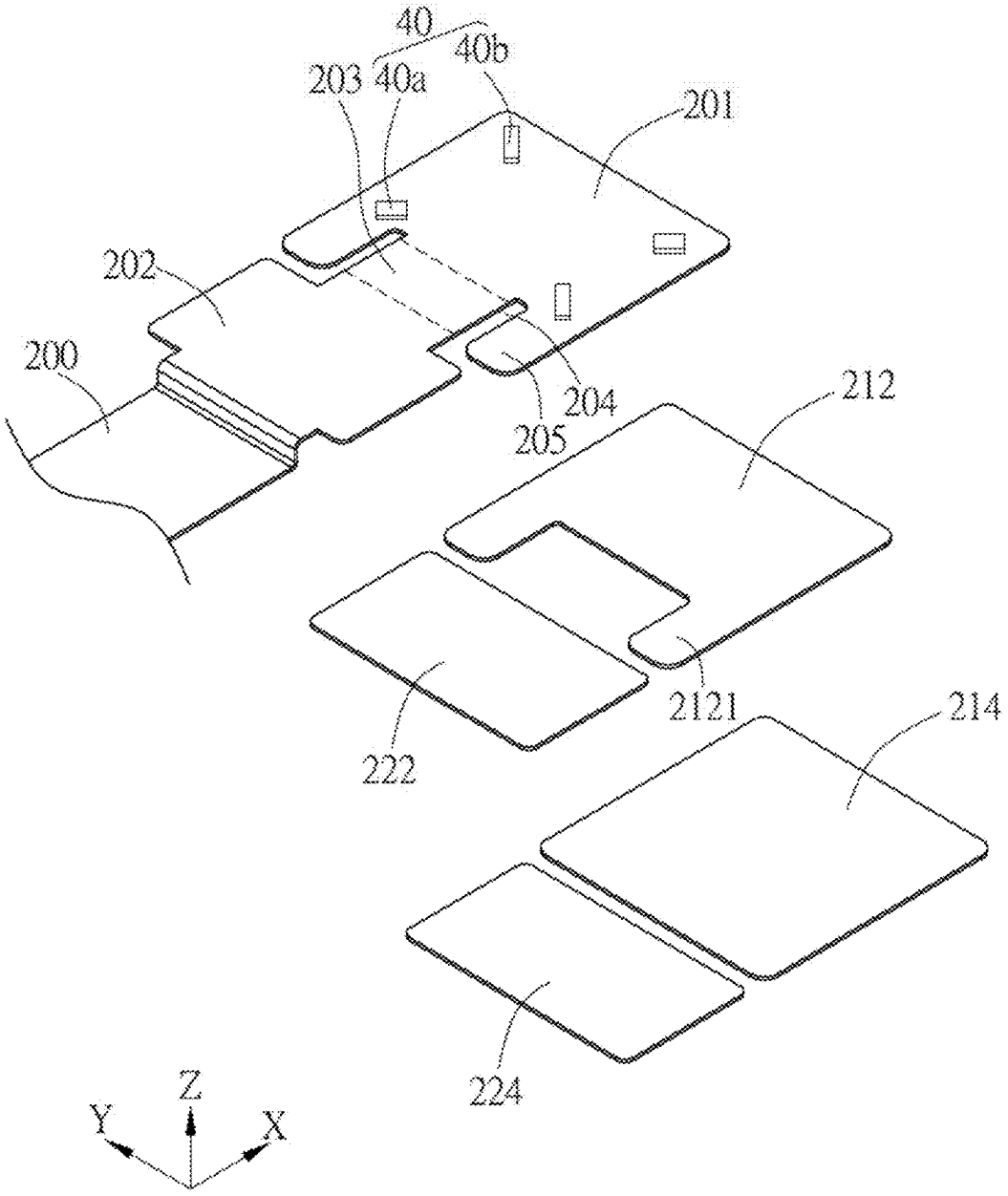

FIG. 7B

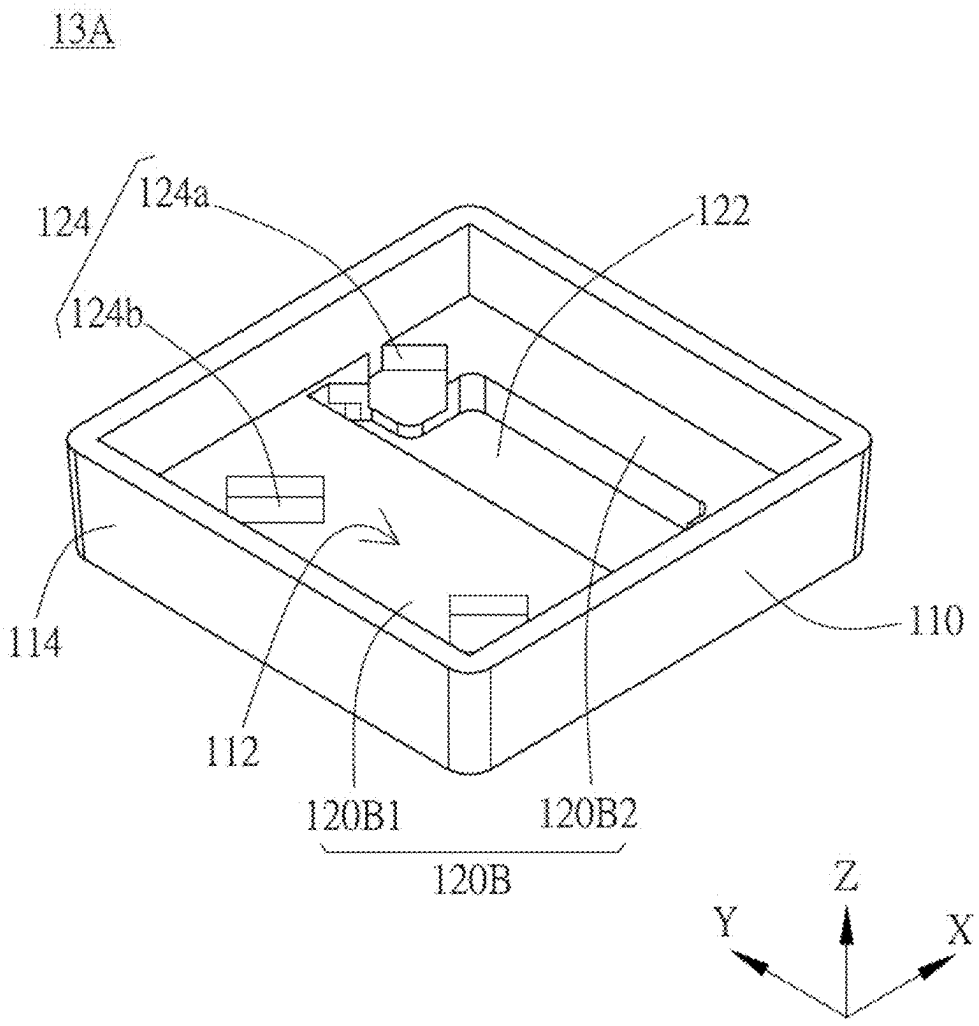

FIG. 7C

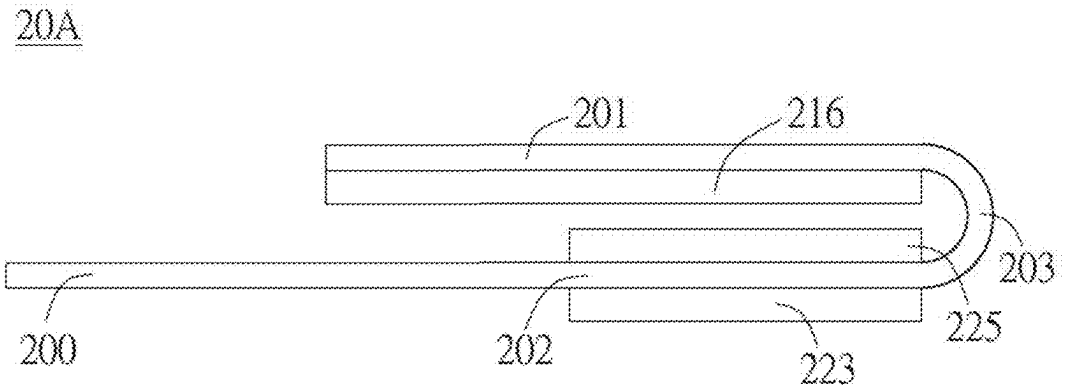

FIG. 8A

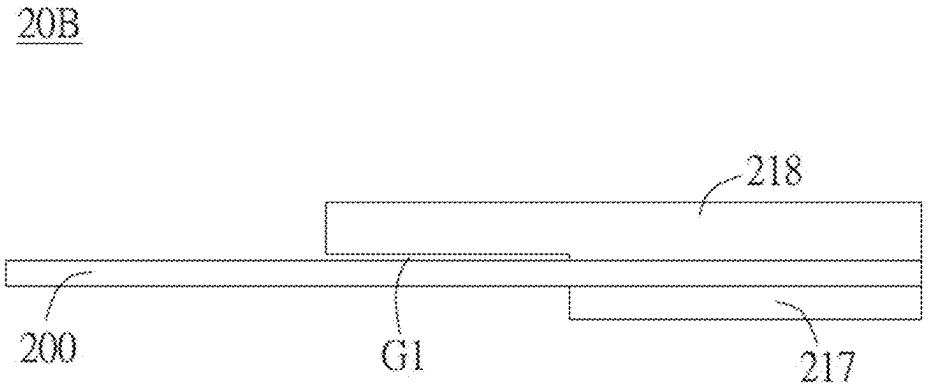

FIG. 8B

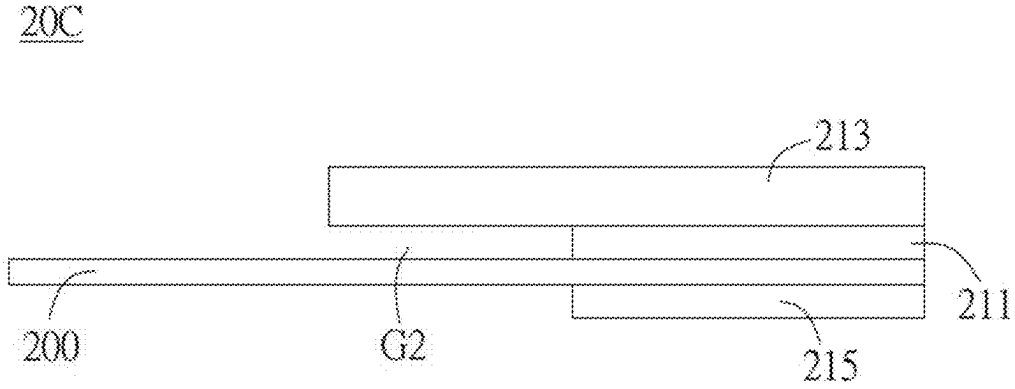

FIG. 8C

FINGER FEATURE MODULE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefits of Taiwan patent application serial No. 114106399, filed on Feb. 21, 2025, and also claims the priority benefits of U.S. provisional application Ser. No. 63/555,921, filed Feb. 21, 2024, U.S. provisional application Ser. No. 63/645,229, filed May 10, 2024, and U.S. provisional application Ser. No. 63/658,535, filed Jun. 11, 2024. The entirety of the mentioned above patent applications is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention generally relates to a finger feature module. Particularly, the invention relates to a finger feature module having a light guide seat designed with an eccentrically disposed hole.

2. Description of the Prior Art

[0003] When the finger feature module is disposed on the keyboard/housing of the electronic device, the top of the finger feature module has a key-like appearance, and the overall structural design must be highly integrated to meet the specification requirements of modern electronic devices. In order to address multiple process and functional requirements, the finger feature module design is a complex problem with no simple answers. When the finger feature module also needs to provide the keyswitch function, such as serving as a power keyswitch or a certain function key, the design difficulty is further increased.

SUMMARY OF THE INVENTION

[0004] It is an object of the invention to provide a finger feature module, wherein the light guide seat has an eccentrically disposed through hole, which facilitates the arrangement of circuit boards and reduces the possibility of components peeling off.

[0005] It is another object of the invention to provide a finger feature module, wherein the light guide seat is formed by multiple parts, facilitating the processability and manufacturability.

[0006] It is yet another object of the invention to provide a finger feature module, wherein the light guide seat has the accommodation space divided into the upper room and the lower room, enhancing the arrangement flexibility of circuit boards.

[0007] In an embodiment, the invention provides a finger feature module including a light guide seat including a frame and a plate body, the plate body disposed in the frame and having a through hole eccentrically disposed, a circuit board assembly having a first portion and a second portion, the first portion of the circuit board assembly disposed in the frame and located above the plate body, the second portion of the circuit board assembly passing through the through hole to be at least partially located below the plate body, a feature sensor disposed on the first portion of the circuit board assembly, and a plurality of illuminants electrically connected to the circuit board assembly, wherein two of the plurality of illuminants are located at two opposite ends of the through hole, and a virtual connection line of the two of the plurality of illuminants overlaps the through hole.

[0008] In an embodiment, the plate body is connected to a middle section of the frame to define an upper room and a lower room in the frame. The upper room and the lower room are respectively above and below the plate body. The through hole communicates the upper room with the lower room.

[0009] In an embodiment, the circuit board assembly includes a first circuit board located in the upper room and a second circuit board located in the lower room.

[0010] In an embodiment, the plate body is disposed with a plurality of illuminant receiving portions. The plurality of illuminants are respectively disposed in the plurality of illuminant receiving portions.

[0011] In an embodiment, the plate body includes an immovable board and a removable board. The immovable board extends from the frame toward the center of the frame to form an opening in the frame. The removable board partially covers the opening to define the through hole with the immovable board.

[0012] In an embodiment, the plate body further has a central slot. The central slot communicates with the through hole. The major axis of the central slot is perpendicular to the major axis of the through hole.

[0013] In an embodiment, the plate body further has an expanded slot. The expanded slot extends outward from where the central slot and the through hole intersect.

[0014] In another embodiment, the invention provides a finger feature module including a light guide seat including a frame and a removable board, the removable board removably disposed in the frame to define a through hole, a circuit board assembly having a first portion and a second portion, the first portion of the circuit board assembly disposed in the frame and located above the removable board, the second portion of the circuit board assembly passing through the through hole to be at least partially located below the removable board, a feature sensor disposed on the first portion of the circuit board assembly, and one or more illuminants electrically connected to the circuit board assembly to emit light toward the light guide seat.

[0015] In an embodiment, the frame has an immovable board. The immovable board extends from the frame toward a center of the frame to form an opening in the frame. The removable board partially covers the opening, so that a portion of the opening not covered by the removable board forms the through hole.

[0016] In an embodiment, the center of the frame is in the opening. The removable board partially covers the opening to cover the center of the frame, so that the through hole is eccentrically disposed with respect to the center of the frame.

[0017] In an embodiment, the portion of the opening not covered by the removable board further forms one or more illuminant receiving portions.

[0018] In an embodiment, the immovable board has two first illuminant receiving portions disposed at two ends of the through hole. Each of the two first illuminant receiving portions is configured to accommodate at least one of the illuminants.

[0019] In an embodiment, the removable board has a second illuminant receiving portion. The second illuminant receiving portion and the through hole are located at two opposite sides of the frame with respect to the center of the

frame. The second illuminant receiving portion is configured to accommodate at least one of the illuminants.

[0020] In an embodiment, the circuit board assembly includes a first circuit board and a second circuit board. The first circuit board is located on the first portion of the circuit board assembly and covers the through hole. The second circuit board is located on the second portion of the circuit board assembly and retreats with respect to the first circuit board to form a retreat space.

[0021] In an embodiment, the circuit board assembly includes a flexible printed circuit board configured to carry the first circuit board and the second circuit board. The flexible printed circuit board has a bending section passing through the through hole. The bending section is located in the retreat space.

[0022] In an embodiment, the bending section is spaced apart from a sidewall of the frame by a distance. The distance is 10% to 45% of a width of the first circuit board.

[0023] In an embodiment, the circuit board assembly includes a rigid board and a flexible printed circuit board. The rigid board is located on the first portion of the circuit board assembly. The flexible printed circuit board is configured to carry the rigid board. The feature sensor is disposed on and electrically connected to the flexible printed circuit board. The feature sensor at least partially overlaps the rigid board with the flexible printed circuit board therebetween.

[0024] In an embodiment, the circuit board assembly includes a flexible printed circuit board, a first circuit board, and a second circuit board. The first circuit board and the second circuit board are respectively disposed on the upper side and the lower side of the flexible printed circuit board. An end portion of the first circuit board has a gap with the flexible printed circuit board. The second circuit board retreats with respect to the end portion of the first circuit board.

[0025] In an embodiment, the circuit board assembly further includes an interposed circuit board. The interposed circuit board is located between the first circuit board and the flexible printed circuit board. The interposed circuit board retreats with respect to the first circuit board to form the gap.

[0026] In yet another embodiment, the invention provides a finger feature module including a light guide seat including a frame and a plate body, the frame defining an accommodation space, the plate body disposed in the frame to divide the accommodation space into an upper room and a lower room, the plate body having a through hole communicating the upper room with the lower room, a circuit board assembly including a flexible printed circuit board, a first circuit board, and a second circuit board, the first circuit board and the second circuit board disposed on the flexible printed circuit board, the flexible printed circuit board extending through the through hole from the upper room to the lower room, the first circuit board located in the upper room, the second circuit board located in the lower room, a feature sensor disposed on the first circuit board, and an illuminant electrically connected to the circuit board assembly to emit light toward the light guide seat.

[0027] In an embodiment, the first circuit board covers the through hole, and the second circuit board retreats with respect to the first circuit board.

[0028] In an embodiment, the finger feature module further includes a base holder. The base holder is configured to support the light guide seat. The base holder is provided with an opening at bottom. The circuit board assembly extends to outside of the base holder from the opening.

[0029] In an embodiment, the circuit board assembly further includes a switch. The switch is exposed from the opening, so that the finger feature module has a keyswitch function.

[0030] In an embodiment, the flexible printed circuit board has a slit to define a first flexible part, a second flexible part, and a bending section connected between the first flexible part and the second flexible part. The first circuit board and the second circuit board are respectively disposed on the first flexible part and the second flexible part. The flexible printed circuit board is bent relative to the slit to form the bending section.

[0031] In an embodiment, before the flexible printed circuit board is bent, the first flexible part has a pair of flexible wings at two opposite sides of the bending section.

[0032] In an embodiment, the illuminant is disposed on the flexible printed circuit board.

[0033] Compared with the prior art, the finger feature module of the invention has an eccentrically disposed through hole on the light guide seat, which facilitates the stack configuration of multiple circuit boards and reduces the possibility of illuminants or circuit components peeling off. Moreover, the finger feature module of the invention has the light guide seat formed by multiple parts, facilitating the manufacturability and the assembly operation. In addition, the light guide seat of the finger feature module of the invention has separated upper room and lower room to enhance the arrangement flexibility of circuit boards.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] FIGS. **1**A and **1**B are respectively a perspective view and an exploded view of the finger feature module in a first embodiment of the invention.

[0035] FIG. **1**C is a partial cross-sectional view of the finger feature module of FIG. **1**A.

[0036] FIGS. **2**A and **2**B are respectively a partial cross-sectional view and an exploded view of the circuit board assembly in the first embodiment of the invention.

[0037] FIG. **2**C is an exploded view of a part of the circuit board assembly of FIG. **2**B before the flexible printed circuit board is bent.

[0038] FIGS. **3**A and **3**B are respectively a plane view and an exploded view of the light guide seat in the first embodiment of the invention.

[0039] FIGS. **4**A and **4**B are respectively an exploded view and a plane view of the light guide seat in a second embodiment of the invention.

[0040] FIGS. **5**A and **5**B are respectively an exploded view and a cross-sectional view of the finger feature module in a third embodiment of the invention.

[0041] FIG. **5**C is a plane view of the light guide seat in the third embodiment of the invention.

[0042] FIG. **6**A is a partial cross-sectional view of the finger feature module in a fourth embodiment of the invention.

[0043] FIGS. **6**B and **6**C are respectively a perspective view and a plane view of the light guide seat in the fourth embodiment of the invention.

[0044] FIG. **7**A is a partial cross-sectional view of the finger feature module in a fifth embodiment of the invention.

[0045] FIG. **7**B is an exploded view of a part of the circuit board assembly of FIG. **7**A before the flexible printed circuit board is bent.

[0046] FIG. **7**C is a perspective view of the light guide seat in the fifth embodiment of the invention.

[0047] FIGS. **8**A to **8**C are partial cross-sectional views of the circuit board assembly in various embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0048] In the finger feature module, flexible printed circuit boards (FPCs) are often used to carry signal circuits between multiple circuit boards. However, due to the size limitation of the finger feature module itself, the flexible printed circuit boards must be bent to successfully connect multiple circuit boards which are vertically stacked. In general, if the flexible printed circuit board needs to be bent, the substrate of the light source and the light source driving circuit will encounter problems, because the stress difference near the bending section of the flexible printed circuit board is large, which can easily cause the light source or circuit components on the flexible printed circuit board to peel off. The feature sensor, the flexible printed circuit board and multiple rigid circuit boards need to be installed together in the base holder. When the bending section of the flexible printed circuit board is located at or exceeds the side edge of the finger feature unit (such as the feature sensor), the bending section is easy to be squeezed and collided during the production line or non-production line, causing damage to the circuit or components. In addition, the finger feature module further includes a light guide seat, which has an upright sidewall that can laterally surround the finger feature unit. However, if there is a defect in the entire sidewall, or the cross-sectional area, shape, or size in any direction is inconsistent, such as a flexible printed circuit board passing through a side of the sidewall, it will cause a difference in the brightness of the light emitted from the top surface of the light guide seat. The stacking design of multiple rigid circuit boards and the flexible circuit printed board in the finger feature module affects the difficulty, cost and throughput per unit time of the process.

[0049] Referring to FIGS. **1**A to **1**C, FIGS. **1**A and **1**B are respectively a perspective view and an exploded view of the finger feature module **1** in a first embodiment of the invention; FIG. **1**C is a partial cross-sectional view of the finger feature module **1** of FIG. **1**. As shown in FIGS. **1**A to **1**C, in the first embodiment, the finger feature module **1** can include a light guide seat **10**, a circuit board assembly **20**, a feature sensor **30**, and a plurality of illuminants **40**. The light guide seat **10** can include a frame **110** and a plate body **120** disposed in the frame **110**. The plate body **120** has a through hole **122**, which is eccentrically disposed. The circuit board assembly **20** has a first portion **21** and a second portion **22**. The first portion **21** of the circuit board assembly **20** is disposed in the frame **110** and located above the plate body **120**. The second portion **22** of the circuit board assembly **20** passes through the through hole **122** to be at least partially located below the plate body **120**. The feature sensor **30** is disposed on the first portion **21** of the circuit board assembly **20**. The plurality of illuminants **40** are electrically connected to the circuit board assembly **20**. Two of the plurality of illuminants **40** (e.g. illuminants **40***a*) are located at two opposite ends of the through hole **122**, and the virtual connection line L**1** of the two illuminants **40***a* overlaps the through hole **122** (as shown in FIG. **3**A).

[0050] Specifically, the light guide seat **10** can be made of any suitable optical materials and configured to guide the light emitted from the illuminants **40** along the plate body **120** toward the frame **110**, and then emit the light from the top surface (or the light-exit surface **111**) of the frame **110** to indicate the sensing area of the finger feature module **1** (i.e., the location of the feature sensor **30**). As shown in FIG. **1**B, the light guide seat **10** is preferably a three-dimensional light guide member, which extends along the X-axis, Y-axis, Z-axis directions. The light guide seat **10** has an accommodation space **112** and the through hole **122**. The accommodation space **112** is configured to accommodate at least the feature sensor **30** and the circuit board assembly **20**, and the through hole **122** is configured as a wiring slot for arranging the circuit board assembly **20**. For example, the frame **110** of the light guide seat **10** is constituted by a sidewall **114**, which laterally surrounds the plate body **120**, so that the frame **110** can define the accommodation space **112** therein. In this embodiment, the frame **110** can be a rectangular or square frame formed by four connected sidewalls **114**, but not limited thereto. In other embodiments, according to practical applications, the frame **110** can have any suitable geometric shape, such as circle, polygon, and the like. The plate body **120** of the light guide seat **10** is disposed in the frame **110** and extends in the transverse direction to connect the sidewall **114** of the frame **110** to serve as the floor plate of the frame **110**. The through hole **122** is provided in the plate body **120**, so that the circuit board assembly **20** can partially bent downward to pass through the through hole **122** from above the plate body **120** to below the plate body **120**. With such a configuration, the sidewall **114** of the frame **110** can remain intact without damage, thereby enhancing the uniformity of light output from the top surface of the sidewall **114** of the light guide seat **10** (i.e., from the light-exit surface **111**). In this embodiment, the through hole **122** is eccentrically disposed with respect to the center of the frame **110** (e.g. indicated by the central axis C). In the embodiment, "the center of the frame" can refer to the central axis C, which extends along the Z-axis direction through the center of the XY plane of the frame **110** (or the accommodation space **112**), or the geometric center of the plate body **120**. For example, as shown in FIGS. **1**B and **1**C, the through hole **122** is disposed at a position of the plate body **120** that deviates from the central axis C. As such, the through hole **122** is relatively closer to the sidewall at one side of the X-axis direction (e.g. the right sidewall) and farther away from the sidewall at the other side of the X-axis direction (e.g. the left sidewall), and the through hole **122** preferably extends along the Y-axis direction. In other words, the through hole **122** can be an elongated slot with the major axis and the minor axis respectively arranged along the Y-axis direction and the X-axis direction, and the through hole **122** does not overlap the center of the frame **110** (i.e., the central axis C) in the Z-axis direction.

[0051] In this embodiment, the sidewall **114** of the frame **110** preferably extends along the Z-axis direction and laterally surrounds the plate body **120**. The plate body **120** can be connected to the inner surface (i.e., the surface facing the central axis C) of the sidewall **114** along the XY plane, so that the light guide seat **10** can have a U-shaped or H-shaped cross section along the Z-axis direction (e.g. vertical direction/stacking direction). For example, as shown in FIG. **1**C,

in this embodiment, the plate body **120** is connected to the middle section of the frame **110** (or the sidewall **114**), so that the light guide seat **10** has the H-shaped cross section along the Z-axis direction. From another aspect, the plate body **120** divides (or partitions) the accommodation space **112** of the light guide seat **10** into an upper room **112**U and a lower room **112**D. The upper room **112**U is a space surrounded by the upper portion **110**U of the frame **110** and above the plate body **120**, and the lower room **112**D is a space surrounded by the lower portion **110**D of the frame **110** and below the plate body **120**. The through hole **122** of the plate body **120** communicates the upper room **112**U with the lower room **112**D. In another embodiment (as shown in FIG. **7**A), the plate body (e.g. **120**C) can be connected to the bottom or lower part of the frame **110** (or the sidewall **114**), so that the light guide seat (e.g. **13**A) can have the U-shaped cross section along the Z-axis direction. From another aspect, the light guide seat (e.g. **13**A) can have a single accommodation space **112** surrounded by the frame **110** and the plate body **120**, and the through hole **122** of the plate body **120** communicates the accommodation space **112** of the light guide seat (e.g. **13**A) with the outside of the light guide seat. In this embodiment, the plate body **120** is preferably connected to the sidewall surface of the frame **110** substantially orthogonally, i.e., the angle included between the plate body **120** and the sidewall **114** is preferably 90 degrees, but not limited thereto. According to practical applications, the angle between the plate body **120** and the sidewall **114** can be larger than or smaller than 90 degrees, so that the plate body **120** is disposed in the frame **110** in an inclined manner. Moreover, the plate body **120** is preferably a flat plate having a uniform thickness, but not limited thereto. According to practical applications, the plate body **120** can have different thickness at different portions.

[0052] In an embodiment, the plate body **120** can be provided with one or more illuminant receiving portions **124**, which are configured to accommodate the illuminants **40**. The number of the illuminant receiving portions **124** preferably corresponds to the number of the illuminants **40**, so that the illuminants **40** can be disposed in the illuminant receiving portions **124** in a one-to-one manner, but not limited thereto. In another embodiment, the number of the illuminant receiving portions **124** can be less than the number of the illuminants **40**, so that more than one of the illuminants **40** can be disposed in one illuminant receiving portion **124**. The illuminant receiving portion **124** can be a recessed portion (or blind hole) and/or a through hole formed in the plate body **120**. For example, in this embodiment, the finger feature module **1** has four illuminants **40**, and the plate body **120** is correspondingly provided with four illuminant receiving portions **124**. Two of the illuminant receiving portions **124** (e.g. the illuminant receiving portions **124***a*) can be the recessed portions for receiving the illuminants **40***a*, and another two of the illuminant receiving portions **124** (e.g. the illuminant receiving portions **124***b*) can be through holes for receiving the illuminants **40***b*, but not limited thereto.

[0053] In an embodiment, the circuit board assembly **20** may include a plurality of functional circuit boards, and the plurality of functional circuit boards can be connected through the flexible printed circuit board **200**. In other words, the flexible printed circuit board **200** is configured to carry and electrically connect the plurality of functional circuit boards. For example, the plurality of functional circuit boards can include a feature board and an interface board, and optionally includes a switch board. The feature board is disposed with the feature circuit, which is configured to be electrically connected to the feature sensor **30** and to output the feature signal sensed by the feature sensor **30**. The interface board can have the circuitry and the connector and is electrically connected to the feature board and the system end (e.g. connected to the connection interface of the computer mother board) to output the feature signal to the system end, thereby achieving the function of finger feature recognition. The switch board has the switch circuit, and the switch (e.g. **240**) is disposed on the switch board. The switch board is electrically connected to the switch and the interface board to output the trigger signal of the switch to the system end through the interface board, so that the finger feature module **1** can function as a keyswitch. In other words, in the case that the functional circuit boards of the circuit board assembly **20** include only the feature board and the interface board, the finger feature module **1** only has the function of finger feature recognition. In the case that the functional circuit boards of the circuit board assembly **20** include the feature board, the interface board, and the switch board, the finger feature module **1** can have both the function of finger feature recognition and the keyswitch function.

[0054] Moreover, each functional circuit board can be implemented with the rigid circuit board, the flexible printed circuit board, or the flex-rigid composite circuit board. The flex-rigid composite circuit board includes the flexible printed circuit board and one or more rigid circuit boards, which can be stacked and electrically connected to each other. In addition, each functional circuit board can be implemented with one or more circuit boards, so that the one or more circuit boards may have corresponding circuits to perform the function of the corresponding functional circuit board individually or in combination. In an embodiment, as shown in FIG. **1**C, the circuit board assembly **20** may include the flexible printed circuit board **200**, a first circuit board **210**, and a second circuit board **220**. The flexible printed circuit board **200** is configured to carry the first circuit board **210** and the second circuit board **220**. The first circuit board **210** is located on the first portion **21** of the circuit board assembly **20** and in the upper room **112**U. The second circuit board **220** is located on the second portion **22** of the circuit board assembly **20** and in the lower room **112**D. Specifically, all circuit boards of the circuit board assembly **20** can be electrically connected through a single flexible printed circuit board **200**. The first circuit board **210** is disposed on a first flexible part **201** of the flexible printed circuit board **200** to form the first portion **21** of the circuit board assembly **20**. The second circuit board **220** is disposed on a second flexible part **202** of the flexible printed circuit board **200** to form the second portion **22** of the circuit board assembly **20**. In this embodiment, the first circuit board **210** preferably extends to cover the through hole **122**, and the second circuit board **220** retreats with respect to the first circuit board **210** to form a retreat space RS. For example, the second circuit board **220** can retreat along the X-axis direction with respect to the first circuit board **210** toward the center of the frame **110** by about 15-55% of the width of the first circuit board **210** to form the retreat space RS, which is configured to accommodate the bending circuit (e.g. bending section **203** described later) of the flexible printed circuit board **200**. The flexible printed circuit board **200** has a bending section **203**, which is bent downward to pass

through the through hole **122**. The bending section **203** is connected between the first flexible part **201** and the second flexible part **202** of the flexible printed circuit board **200** and preferably located in the retreat space RS.

[0055] In this embodiment, the first circuit board **210** can serve as the feature board, and the second circuit board **220** can serve as the switch board. Correspondingly, as shown in FIG. **1**C, the circuit board assembly **20** can further include the switch **240**, and the switch **240** is disposed on and electrically connected to the second circuit board **220**. The switch **240** can provide the trigger signal in response to the pressing operation of the user, so that the finger feature module **1** can function as the keyswitch. In other words, the finger feature module **1** having the switch **240** can be a finger feature keyswitch (e.g. a power keyswitch with the finger feature recognition function). Specifically, in this embodiment, the feature board can be formed by at least the first circuit board **210**, which has the feature circuit and is electrically connected to the feature sensor **30** to output the feature signal. The switch board can be at least formed by the second circuit board **220**, which has the switch circuit and is electrically connected to the switch **240** to output the trigger signal. As shown in FIG. **1**C, in order to reserve a larger space area of the second flexible part **202** for the switch board (e.g. the second circuit board **220**), within the orthographic projection of the feature sensor **30**, the bending section **203**, the retreat space RS, the through hole **122** of the light guide seat **10** are preferably all located at the eccentric position of the orthographic projection of the feature sensor **30**. With such a configuration, the switch **240** disposed on the second circuit board **220** can be substantially located at the central region of the frame **110** to improve the triggering effect of the switch **240**. For example, in the vertical direction (i.e., the Z-axis direction), the central axis C of the frame **110** preferably extends through the switch **240**. More preferably, the center of the switch **240** substantially overlaps the central axis C of the frame **110** or is in the neighborhood of the central axis C. In other embodiments, the first circuit board **210** and the second circuit board **220** can together function as the feature board, instead of the switch board with the switch **240**, i.e., the first circuit board **210** and the second circuit board **220** only have the function of finger feature recognition.

[0056] As shown in FIG. **1**A, the circuit board assembly **20** may further include a third circuit board **230**. The third circuit board **230** can be disposed at the free end of the second portion **22** of the circuit board assembly **20** and extends to outside of the light guide seat **10** to function as the interface board, which is electrically connected to the system end. As such, the first circuit board **210** as the feature board can be electrically connected to the third circuit board **230** as the interface board through the flexible printed circuit board **200** to output the finger feature information to the system end through the interface board. Moreover, the second circuit board **220** as the switch board can be electrically connected to the feature board (e.g. the first circuit board **210**) and the interface board (e.g. the third circuit board **230**) through the flexible printed circuit board **200** to output the trigger signal to the system end. For example, the flexible printed circuit board **200** may have the outbound circuit, which is electrically connected to the switch board (e.g. the second circuit board **220**) and the interface board (e.g. the third circuit board **230**) and configured to output the trigger signal to the system end. In this embodiment, the first circuit board **210**, the second circuit board **220**, and the third circuit board **230** preferably include the rigid circuit board or the rigid board with no circuits.

[0057] Referring to FIGS. **2**A to **2**C, FIGS. **2**A and **2**B are respectively a partial cross-sectional view and an exploded view of the circuit board assembly **20** in the first embodiment of the invention; FIG. **2**C is an exploded view of a part of the circuit board assembly **20** of FIG. **2**B before the flexible printed circuit board **200** is bent. As shown in FIGS. **2**A to **20**, in this embodiment, the flexible printed circuit board **200** can be implemented as a long strip circuit board with opposite first and second ends, wherein the first end is provided for arranging the first circuit board **210** and the second circuit board **220**, and the second end is provided for arranging the third circuit board **230**. The first end of the flexible printed circuit board **200** is preferably designed with a slit **204**, so that the flexible printed circuit board **200** can be bent (or folded-back) with respect to the slit **204** to form the bending section **203**, which is connected between the first flexible part **201** and the second flexible part **202**. Specifically, as shown in FIG. **2**C, before the flexible printed circuit board **200** is bent, the slit **204** is preferably an L-shaped channel, which can be formed at two sides of the bending section **203**, so that the first flexible part **201** and the second flexible part **202** are connected only by the bending section **203**. Moreover, the first flexible part **201** has a pair of flexible wings **205**, which are adjacent to the second flexible part **202** and disposed adjacent and preferably in parallel to the bending section **203** with the slit **204** interposed therebetween. When the first flexible part **201** of the flexible printed circuit board **200** is bent (or folded-back) along the bending section **203** toward the second flexible part **202**, the first flexible part **201** and the second flexible part **202** mostly overlaps with each other in the vertical direction (e.g. the Z-axis direction), and the flexible wings **205** extend away from the second flexible part **202** with respect to the bending section **203** to form the folded flexible printed circuit board **200** of FIG. **2**B. From another aspect, in the folded flexible printed circuit board **200**, the bending section **203** is preferably completely located between the two flexible wings **205** of the first flexible part **201** and does not extend beyond the distal end (i.e., the free end that is away from the second flexible part **202**) of the flexible wings **205**, to effectively avoid the squeeze and collision between the bending section **203** and the sidewall **114** of the frame **110**, reducing the possibility of damage.

[0058] Moreover, each of the first circuit board **210** and the second circuit board **220** can be implemented with one or more circuit boards to achieve the desired electrical function. For example, as shown in FIGS. **2**A and **2**B, in an embodiment, the first circuit board **210** may include circuit boards **212** and **214**, and the second circuit board **220** may include circuit boards **222** and **224**. The circuit board **212** is disposed on and electrically connected to the first flexible part **201** and preferably has a pair of rigid wings **2121** corresponding to the flexible wings **205**. When the circuit board **212** is disposed on the first flexible part **201**, the flexible wings **205** is preferably tightly stacked on the rigid wings **2121**, and the circuit board **212** preferably covers the bending section **203** of the flexible printed circuit board **200**, so that the bending section **203** does not extend beyond the space between the rigid wings **2121**, further ensuring the bending section **203** free from damage, but not limited thereto. According to practical applications, the circuit board

212 may not have the rigid wings **2121** and may have a size substantially equal to or smaller than that of the circuit board **214** and a shape corresponding to the circuit board **214**. The circuit board **214** is stacked on and electrically connected to the circuit board **212**. The feature sensor **30** is stacked on and electrically connected to the circuit board **214**. The circuit board **214** may have a rectangular or square shape and preferably has a size corresponding to the feature sensor **30**, so that the bending section **203** is preferably located at the inner side of the outermost connection pad **310** (shown in FIG. **1**B) of the feature sensor **30**, which corresponds to the retreat space RS. From another aspect, in the stacking direction (or the Z-axis direction), the bending section **203** preferably at least partially overlaps the outermost connection pad **310** of the feature sensor **30** in the retreat space RS. In an embodiment, the bending section **203** can be completely located at the inner side of the outermost connection pad **310** of the feature sensor **30**, i.e., the bending section **203** does not extend beyond the outermost connection pad **310** in a direction toward the neighboring sidewall **114** of the light guide seat **10**. For example, the bending section **203** is spaced apart from the sidewall **114** of the frame **110** by a distance, and the distance is preferably 10% to 45% of the width of the first circuit board **210** (e.g. the circuit board **214**), but not limited thereto. In this embodiment, the distance preferably refers to the distance between the protruding point of the bending section **203** and the inner surface of the corresponding sidewall **114** that faces the protruding point in the X-axis direction. The circuit boards **222** and **224** are disposed on and electrically connected to opposite sides (e.g. upper and lower sides) of the second flexible part **202**. At least the circuit board **224** has the switch circuit, and the switch **240** is preferably disposed on and electrically connected to the lower side of the circuit board **224**. Moreover, one or more electronic devices **250** such as resistor, capacitor, electrostatic discharge (ESD) protection device (e.g. transient voltage suppressor, TSV) can be optionally disposed on the circuit board (e.g. the circuit board **224**) to provide the required electrical characteristics.

[0059] The feature sensor **30** can be a finger feature recognition chip, which is configured to extract the finger feature of the user for subsequent recognition. For example, the finger feature can be a fingerprint and/or a finger-vein. The feature sensor **30** can be a capacitive, optical, or ultrasonic fingerprint (and/or finger-vein) extraction/recognition chip. The recognition processing unit and the storage unit (not shown) can be integrated at the feature sensor **30** or the system end. In an embodiment, the recognition processing unit and the storage unit are preferably integrated at the system end, such as the central processing unit (CPU) and the memory of the computer mother board, but not limited thereto. In another embodiment, the recognition processing unit and the storage unit can be integrated to the electronic device that is equipped with the finger feature module **1**. When cutting the feature sensor **30**, it is typically cut into a smaller rectangular (or square) shaped chip. Since the user's pressing or contact usually occurs in the center of the chip, the surrounding corners become inefficient chip areas (e.g. areas of low sensing possibility) or even invalid chip areas (e.g. corners are non-sensing areas). In an embodiment, one or more corner spaces of the feature sensor **30** can be reduced through the cutting design of the feature sensor **30**. For example, the cutting design of the feature sensor **30** preferably reserves 85% to 95% of the chip area of the feature sensor **30** to form arch-chamfered or beveled corner(s), but not limited thereto. According to practical applications, the feature sensor **30** can be cut to obtain the maximum retreat space(s) without sacrificing the sensing performance and electrical connection of the feature sensor **30** (i.e., without damaging the connection pad **310**), effectively reducing the size of the finger feature module, but not limited thereto. According to practical applications, the feature sensor **30** can have any suitable shape, such as rectangular, square, polygonal geometric shape.

[0060] The illuminant **40** can be any suitable light source configured to provide light. For example, the illuminant **400** can be a single-chip or multiple-chip light emitting diode (LED), mini-LED, micro-LED, and the like. The illuminant **40** can be a side-lighting or five-face (e.g. upper/left/right/front/rear faces) lighting illuminant. As shown in FIGS. **2**A to **2**C, the illuminant **40** is preferably disposed on and electrically connected to the first flexible part **201** of the flexible printed circuit board **200**. The illuminant **40** and the first circuit board **210** are respectively located at two opposite sides of the first flexible part **201**. From another aspect, the flexible printed circuit board **200** preferably has the light source circuit, which is provided for arranging and electrically connecting the illuminant **40**. For example, before the flexible printed circuit board **200** is bent (or folded-back), the illuminant **40** and the first circuit board **210** can be respectively located at the upper side and the lower side of the first flexible part **201** (see FIG. **2**C). After the flexible printed circuit board **200** is folded-back, the illuminant **40** and the first circuit board **210** can be respectively located at the lower side and the upper side of the first flexible part **201** (see FIG. **2**B). In this embodiment, four illuminants **40** are respectively located in four illuminant receiving portions **124**, but not limited thereto. For example, two of the four illuminants **40** (e.g. illuminants **40***a*) can be disposed on the flexible wings **205** of the first flexible part **201** and extend toward the light guide seat **10** to be at least partially received in the two illuminant receiving portions **124***a*. Another two of the four illuminants **40** (e.g. illuminants **40***b*) are disposed at the side of the first flexible part **201** that is farther away from the flexible wings **205** and extend toward the light guide seat **10** to be at least partially received in the two illuminant receiving portions **124***b*, but not limited thereto. In other embodiments, the number of the illuminants **40** can be different, and two or more illuminants **40** can be disposed in the same illuminant receiving portion **124**.

[0061] FIGS. **2**A and **2**B show that the circuit boards **212** and **214** of the first circuit board **210** are sequentially stacked on the upper side of the first flexible part **201** to have the configuration that the illuminant **40** and the first circuit board **210** are respectively located at the lower side and the upper side of the first flexible part **201**, but not limited thereto. In another embodiment (not shown), at least one of the circuit boards **212** and **214** can be disposed on and electrically connected to the lower side of the first flexible part **201**, so that the illuminant **40** is not directly disposed on and electrically connected to the first flexible part **201** of the flexible printed circuit board **200**, but disposed on and electrically connected to one of the circuit boards **212** and **214** that is located at the bottommost of the first flexible part **201**. In another embodiment, the rigid wings **2121** of the circuit board **212** can be replaced by a rigid board, which has no circuit, to enhance the structural strength of the flexible

wings **205**, beneficial to the disposition and electrical connection of the illuminant **40***a* on the flexible wings **205**.

[0062] Referring to FIG. **3**A, FIG. **3**A is a plane view of the light guide seat **10** in the first embodiment of the invention to show the relative position of the illuminant **40** in the light guide seat **10**. As shown in FIG. **3**A, the two illuminant receiving portions **124***a* of the plate body **120** are disposed at two opposite ends of the through hole **122**, so that the two illuminants **40***a* received in the illuminant receiving portions **124***a* are respectively located at two opposite sides of the bending section **203** of the flexible printed circuit board **200**. The virtual connection line L**1** (e.g. along the Y-axis direction) of the illuminants **40***a* is substantially perpendicular to the bending direction of the bending section **203** (e.g. the Z-axis or X-axis direction). From another aspect, in the plane view of FIG. **3**A, the two illuminants **40***a* and the two illuminant receiving portions **124***a* are located at two sides of the through hole **122** (or the bending section **203**), so that the virtual connection line L**1** of the illuminants **40***a* and the connecting line of the two illuminant receiving portions **124***a* overlap the through hole **122** (or the bending section **203**) along the major axis of the through hole **122**. Moreover, since the through hole **122** of the light guide seat **10** is eccentrically disposed, the area neighboring the through hole **122** may not have sufficient light transmission or light output. By arranging the illuminants **40***a* in a manner that the virtual connection line L**1** of the illuminants **40***a* overlaps at least one of the bending section **203**, the retreat space RS, and the through hole **122** of the light guide seat **10** in the Z-axis direction can promote the uniformity of light output of the light guide seat **10**.

[0063] Referring to FIGS. **3**A and **3**B, FIG. **3**B is an exploded view of the light guide seat **10** in the first embodiment of the invention. In this embodiment, the plate body **120** preferably includes an immovable board **120***b* and a removable board **120***a*. The immovable board **120***b* extends from the frame **110** toward the center of the frame **110** to form an opening **113** in the frame **110**. The removable board **120***a* preferably partially covers the opening **113** to define the through hole **122** with the immovable board **120***b*. The removable board **120***a* is removably disposed in the frame **110**, and the top surface of the removable board **120***a* is preferably co-planar with the top surface of the immovable board **120***b*. The removable board **120***a* partially covers the opening **113**, so that a portion of the opening **113** that is not covered by the removable board **120***a* forms (or becomes) the through hole **122**. The opening **113** preferably extends beyond the center of the frame **110** (e.g. the central axis C), and the removable board **120***a* partially covers the opening **113** in a manner that the center of the frame **110** is covered, so that the through hole **122** is eccentrically disposed with respect to the center of the frame **110**. For example, the immovable board **120***b* and the frame **110** can be an integral structure. The immovable board **120***b* can be a U-shaped plate, which extends or protrudes from the middle section of the sidewall **114** of the frame **110** toward the center of the frame **110** to surround the opening **113**. The center of the frame **110** is in the opening **113**, i.e., the center of the frame **110** is located within the orthographic projection range of the opening **113**. Corresponding to the U-shaped immovable board **120***b*, the removable board **120***a* may have a rectangle-like shape. One end of the removable board **120***a* extends from the mouth of the U-shaped immovable board **120***b* toward the bottom of the U-shaped plate to partially cover the opening **113**. As such, the through hole **122** can be formed between the U-shaped immovable board **120***b* and the corresponding end of the removable board **120***a*. In an embodiment, the removable board **120***a* can be positioned in the frame **110** by shape-fitting in the opening **113**, but not limited thereto. In another embodiment, the immovable board **120***b* may have a support portion (e.g. **115** shown in FIG. **4**A), which is configured to support the removable board **120***a*, so that the removable board **120***a* can be positioned in the frame **110**. When the removable board **120***a* is positioned in the frame **110**, the first portion **21** of the circuit board assembly **20** is disposed in the frame **110** and located above the removable board **120***a*, and the second portion **22** of the circuit board assembly **20** passes through the through hole **122** to be at least partially located below the removable board **120***a*.

[0064] In this embodiment, the immovable board **120***b* has the two illuminant receiving portions **124***a* (or referred as the first illuminant receiving portions). The illuminant receiving portions **124***a* can be the recessed portions and arranged at two opposite ends of the through hole **122** along the major axis of the through hole **122**. Each illuminant receiving portion **124***a* is configured to receive at least one of the illuminants **40** (e.g. the illuminant **40***a*). Correspondingly, the removable board **120***a* may have the two illuminant receiving portions **124***b* (or referred as the second illuminant receiving portions). The illuminant receiving portions **124***b* can be through holes that penetrates the removable board **120***a*. The illuminant receiving portions **124***b* and the through hole **122** are disposed at two opposite sides of the frame **110** with respect to the center of the frame **110**, and the illuminant receiving portion **124***b* is configured to receive at least one of the illuminants **40** (e.g. the illuminant **40***b*). The illuminant receiving portions **124***a*, **124***b* can be an elongated groove corresponding to the side edge (preferably the long side) of the illuminants **40***a*, **40***b*, so that light emitted from the illuminants **40***a*, **40***b* can effectively enter the immovable board **120***b* and the removable board **120***a* of the plate body **120** from the adjacent sidewalls of the illuminant receiving portions **124***a*, **124***b* to improve the utilization of light.

[0065] With the removable design of the plate body **120** of the light guide seat **10**, the opening **113** in the frame **110** can be formed with a larger size to effectively facilitate the assembly operations of the circuit board assembly **20**. Moreover, by partially covering the opening **113** with the removable board **120***a* to define the eccentrically disposed through hole **122** with the immovable board **120***b* of the frame **110** can be beneficial to the circuit board arrangement of the circuit board assembly **20** to reduce the possibility of component peeling off. In other words, the light guide seat **10** formed by multiple separate parts (e.g. the frame **110** and the removable board **120***a*) can facilitate the manufacturability and the assembly convenience, but not limited thereto. In other embodiments, the removable board **120***a* can form an integral structure with the frame **110**, so that the light guide seat **10** is a single component.

[0066] As shown in FIGS. **1**A to **1**C, the finger feature module **1** can further include other components, such as a base holder **50** and a cover **60** to improve the integration application of the finger feature module **1**. The base holder **50** serves as the housing of the finger feature module **1** and is configured to support components of the finger feature module **1**. The cover **60** is correspondingly disposed on the

base holder **50** and configured to provide a plane for the user's finger to place or press. The base holder **50** is configured to support the light guide seat **10** and provided with an opening **520** at bottom, so that the circuit board assembly **20** can further extend to outside of the base holder **50** from the opening **520**. Specifically, the base holder **50** has an accommodating portion **510** and the opening **520**. The accommodating portion **510** is configured to accommodate the light guide seat **10** as well as the feature sensor **30**, the circuit board assembly **20**, and the illuminants **40** disposed in the light guide seat **10**. For example, the base holder **50** can be a housing with a hollow portion. The hollow portion can be the accommodating portion **510**, and the sidewall of the housing around the accommodating portion **510** is configured to surround the sidewall **114** of the frame **110** of the light guide seat **10**. The opening **520** is opened at the bottom of the base holder **50** and communicates with the accommodating portion **510** to allow the circuit board assembly **20** to extend from the opening **520** to outside of the base holder **50**. In the case that the finger feature module **1** has the switch **240** to implement the keyswitch function, the opening **520** preferably corresponds to the switch **240**, so that the switch **240** can be exposed from the opening **520** to correspond to the trigger member of the electronic device (e.g. keyboard). When the user presses the cover **60**, the switch **240** can be pressed against the trigger member of the electronic device to generate the trigger signal. The end of the circuit board assembly **20** that includes the third circuit board **230** (i.e., the interface board) can extend downward through the opening **520** to outside of the base holder **50**, and then is connected to the system end. In this embodiment, the base holder **50** preferably has a shape corresponding to the shape of the light guide seat **10**, such as rectangle or square shape, but not limited thereto. According to practical applications, the base holder **50** can have any suitable shape, such as circular, polygonal, and other geometric shapes. The base holder **50** can further include a positioning portion **530**, which is configured to be combined with the electronic device. For example, the positioning portion **530** can be implemented as a rod, which extends outward from the bottom of the housing and is inserted into the hole of the electronic device to achieve the positioning effect, but not limited thereto. The base holder **50** can be positioned on the electronic device by any means as appropriate.

[0067] The cover **60** is disposed on the base holder **50** to cover the accommodating portion **510**. The cover **60** preferably has a light-permeable portion **610**. In the vertical direction (or the light-output direction/Z-axis direction), the top surface (i.e., the light-exit surface **111**) of the sidewall **114** of the light guide seat **10** at least partially overlaps the light-permeable portion **610**. From another aspect, the orthographic projection of the light-exit surface **111** of the light guide seat **10** on the cover **60** preferably at least partially overlaps the light-permeable portion **610**. Specifically, the cover **60** can be a plate made of glass, polymers, for example. The cover **60** is preferably connected to the feature sensor **30** through an adhesive material, so that the cover **60** and the base holder **50** have an integral outer appearance, but not limited thereto. In an embodiment, the entire cover **60** can be the light-permeable portion **610**, but not limited thereto. In this embodiment, the light-permeable portion **610** is preferably a ring-shaped band (e.g. square ring) formed on the periphery of the cover **60**. When the light guide seat **10** guides the light of the illuminant **40** upward through the plate body **120** and the sidewall **114** of the frame **110** to emit from the top surface (i.e., the light-exit surface **111**) of the sidewall **114**, light can be substantially emitted from the light-permeable portion **610** to form a ring-shaped light pattern around the feature sensor **30**, which not only indicates the location of the sensing areas to the user, but also enhances the optical effect of the appearance.

[0068] Referring to FIGS. **4**A and **4**B, FIGS. **4**A and **4**B are respectively an exploded view and a plane view of the light guide seat **11** in a second embodiment of the invention. Hereinafter, the differences between this embodiment and the previous embodiment are described. For the same or similar details, please refer to the relevant description of the previous embodiment. As shown in FIGS. **4**A and **4**B, the light guide seat **11** of this embodiment can be used to replace the light guide seat **10** of FIG. **1**B, and the difference is the design of the removable board **121***a* and the immovable board **121***b*. Similar to the previous embodiment, when the removable board **121***a* is disposed in the frame **110**, the top surface of the removable board **121***a* is preferably co-planar with the top surface of the immovable board **121***b*, but not limited thereto. Specifically, the removable board **121***a* of the light guide seat **11** has an elongated hexagon shape, wherein the minor axis of the removable board **121***a* is arranged along the X-axis direction, and the major axis of the removable board **121***a* is arranged along the Y-axis direction. For example, two parallel sides of the hexagon are preferably parallel to the extending direction (or the major axis) of the through hole **122** (e.g. the Y-axis direction), and a pair of sides between each end of the two parallel sides extend outward and are inclinedly connected to each other. According to practical applications, the two inclinedly connected sides may have the same or different angles or lengths. A pair of tabs **125** are preferably disposed at two sides of the removable board **121***a* where the two inclined sides are connected, and the tabs **125** preferably extend outward along the Y-axis direction from two sides of the removable board **121***a*. In an embodiment, the connecting line of the tabs **125** is preferably parallel to the extending direction (or the major axis) of the through hole **122** (e.g. the Y-axis direction), but not limited thereto.

[0069] Corresponding to the shape design of the removable board **121***a*, the immovable board **121***b* preferably extends or protrudes from the surrounding sidewall **114** of the frame **110** toward the center of the frame **110** to form a corresponding opening **113**A. The immovable board **121***b* is disposed with a support portion **115**, which is configured to support the tab **125** of the removable board **121***a*. For example, the support portion **115** can be a recessed portion that recesses from the board surface of the immovable board **121***b*. Two support portions **115** are preferably disposed along the Y-axis direction at two opposite sides of the frame **110** and adjacent to the opening **113**A. Moreover, the support portions **115** are preferably disposed close to the central region of the frame **110**, so that the connecting line of the support portions **115** is proximate to or even overlaps the center of the frame **110**. When the removable board **121***a* is disposed in the frame **110**, the tabs **125** are disposed on the support portions **115**, and the removable board **121***a* partially covers the opening **113**A to define the through hole **122** with the immovable board **121***b*. Specifically, the removable board **121***a* partially covers the opening **113**A to cover the center of the frame **110**, so that the through hole **122** is eccentrically disposed with respect to the center of the frame

110. Similar to the embodiment of FIGS. **3**A and **3**B, the immovable board **121***b* has two illuminant receiving portions **124***a*, which can be the recessed portions and disposed at two opposite ends of the through hole **122** along the major axis thereof. In this embodiment, the portion of the opening **113**A that is not covered by the removable board **121***a* can further form one or more illuminant receiving portions **124***b*. Specifically, the opening **113**A can include a hexagonal region for arranging the removable board **121***a*, a region for forming the through hole **122**, and a region for forming the illuminant receiving portion **124***b*, which communicate with one another. The hexagonal region for arranging the removable board **121***a* is preferably located between the region for forming the through hole **122** and the region for forming the illuminant receiving portion **124***b*. When the removable board **121***a* is disposed in the frame **110**, the portion of the opening **113**A that is not covered by the removable board **121***a* can become the illuminant receiving portion(s) **124***b* and the through hole **122**. The illuminant receiving portions **124***b* and the through hole **122** are located at two opposite sides of the frame **110** with respect to the center of the frame **110**. The illuminant receiving portions **124***a*, **124***b* can be an elongated groove corresponding to the side edge (preferably the long side) of the illuminants **40***a*, **40***b*. The major axis and the minor axis of the illuminant receiving portions **124***a*, **124***b* are preferably respectively arranged along the X-axis direction and the Y-axis direction. In this embodiment, the illuminant receiving portions **124***a*, **124***b* are preferably disposed adjacent to four corners of the removable board **121***a*. For example, the illuminant receiving portions **124***a* and **124***b* are respectively disposed at two opposite sides of the tab **125**, so that the light emitted from the illuminants **40***a*, **40***b* can avoid the connection interface between the removable board **121***a* and the frame **110** (and the immovable board **121***b*) as much as possible to reduce the transmission loss of light.

[0070] Referring to FIGS. **5**A to **5**C, FIGS. **5**A and **5**B are respectively an exploded view and a cross-sectional view of the finger feature module in a third embodiment of the invention; FIG. **5**C is a plane view of the light guide seat **12** in the third embodiment of the invention. Hereinafter, the differences between this embodiment and the previous embodiments are described. For the same or similar details (e.g. the circuit board assembly **20**, the feature sensor **30**, the illuminant **40**, the base holder **50**, and the cover **60**), please refer to the relevant description of the previous embodiments. As shown in FIGS. **5**A to **5**C, the plate body **120**A of the light guide seat **12** is preferably connected to the middle section of the frame **110** (or the sidewall **114**) to divide the accommodation space **112** of the light guide seat **12** into the upper room **112**U and the lower room **112**D, as described in the previous embodiments. In this embodiment, the plate body **120**A can include the through hole **122** and a central slot **126**. The central slot **126** communicates with the through hole **122**. The major axis of the central slot **126** is preferably perpendicular to the major axis of the through hole **122**. Specifically, corresponding to the arrangement of the major axis of the through hole **122** along the Y-axis direction, the major axis of the central slot **126** is preferably arranged along the X-axis direction and extends across the through hole **122**, so that the central slot **126** and the through hole **122** communicate with each other to form a cross-shaped opening. The central slot **126** is provided for the third circuit board **230** (e.g. the interface board) of the circuit board assembly **20** to pass therethrough, and the through hole **122** is provided for the second circuit board **220** (e.g. the switch board) to pass therethrough. In an embodiment, the plate body **120**A can further include an expanded slot **128**. The expanded slot **128** preferably extends outward from where the central slot **126** and the through hole **122** intersect, so that the cross-shaped opening becomes a funnel-shaped opening, which allows the second circuit board **220** and the flexible printed circuit board **200** to rotate and pass therethrough, further facilitating the assembly operations. The light guide seat **12** can have an integral structure to avoid the transmission loss of light of the plate body **120**A caused by the connection interface between multiple parts, and the circuit board assembly **20** can be assembled smoothly without the need for a removable board.

[0071] Similar to the previous embodiments, the plate body **120**A is disposed with a plurality of illuminant receiving portions **124***a*, **124***b*, and the illuminants **40***a*, **40***b* are respectively received in the illuminant receiving portions **124***a*, **124***b*. As shown in the figures, two illuminant receiving portions **124***a* are respectively disposed at two ends of the major axis of the through hole **122**. The connecting line of the illuminant receiving portions **124***a* or the virtual connection line L**1** of the illuminants **40***a* preferably overlaps the through hole **122** (or the bending section **203**). The illuminant receiving portions **124***a* and **124***b* are disposed along the major axis of the central slot **126** at two ends of the central slot **126**, and the two illuminant receiving portions **124***b* are located at two opposite sides of the central slot **126** with respect to the major axis of the central slot **126**. In this embodiment, the illuminant receiving portions **124***a*, **124***b* can be an elongated groove corresponding to the side edge (preferably the long side) of the illuminants **40***a*, **40***b*, and the major axes of the illuminant receiving portions **124***a*, **124***b* are preferably directed toward the center of the frame **110** to form a radiation configuration, but not limited thereto.

[0072] Referring to FIGS. **6**A to **6**C, FIG. **6**A is a partial cross-sectional view of the finger feature module in a fourth embodiment of the invention; FIGS. **6**B and **6**C are respectively a perspective view and a plane view of the light guide seat **13** in the fourth embodiment of the invention. Hereinafter, the differences between this embodiment and the previous embodiment are described. For the same or similar details, please refer to the relevant description of the previous embodiment. As shown in FIGS. **6**A to **6**C, the light guide seat **13** of this embodiment can be used to replace the light guide seat of the previous embodiments, such as the light guide seat **12** of FIG. **5**A. In this embodiment, the plate body **120**B includes a first plate part **120**B**1** and a second plate part **120**B**2**. The first plate part **120**B**1** and the second plate part **120**B**2** may have different thicknesses. For example, the thickness of the first plate part **120**B**1** can be smaller than that of the second plate part **120**B**2**. The first plate part **120**B**1** preferably extends from the middle section of the sidewall **114** of the frame **110** toward the center of the frame **110** to divide the accommodation space **112** of the light guide seat **13** into the upper room **112**U and the lower room **112**D as described in the previous embodiments. The second plate part **120**B**2** preferably extends from the sidewall **114** of the frame **110**, which is opposite to the first plate part **120**B**1**, toward the first plate part **120**B**1**, so that the through hole **122** is formed between the first plate part **120**B**1** and the second plate part **120**B**2**. In this embodiment, the first plate part **120**B**1** preferably extends to at least the

center of the frame **110** or beyond the center of the frame **110**, so that the through hole **122** is eccentrically disposed. In other words, the extending length of the first plate part **120**B**1** (e.g. the length in the X-axis direction) is preferably larger than or equal to ½ or more of the width of the accommodation space **112** of the frame **110** in the same direction. The thickness of the second plate part **120**B**2** is preferably less than or equal to the height (i.e., the distance from the bottom to the top of the sidewall **114**) of the sidewall **114** of the frame **110**. In this embodiment, the maximum thickness of the second plate part **120**B**2** is preferably designed to be equal to or less than the height of the first plate part **120**B**1** on the sidewall **114** (i.e., the distance from the bottom of the sidewall **114** to where the first plate part **120**B**1** is disposed), so that the top surface of the second plate part **120**B**2** and the top surface of the first plate part **120**B**1** can be co-planar, but not limited thereto. According to practical applications, the design of the thickness and location of the second plate part **120**B**2** is not limited to be co-planar with the first plate part **120**B**1**. As shown in FIG. **6**A, in this embodiment, the thickness of the second plate part **120**B**2** is substantially equal to the sum of the height of the lower room **112**D in the Z-axis direction and the thickness of the first plate part **120**B**1**, so that the upper room **112**U has a wider width than the lower room **112**D in the X-direction. From another aspect, the second plate part **120**B**2** can be considered as the bottom plate of the frame **110**, so that "the plate body having an eccentrically disposed through hole (or the plate body having a through hole which is eccentrically disposed)" can refer to that the plate body itself has the through hole at the eccentric position, or the plate body and the sidewall (or bottom plate) of the frame together define an opening as the through hole between the plate body and the sidewall (or bottom plate) of the frame at the eccentric position.

[0073] Mover, in this embodiment, the through hole **122** preferably has a hat-like shape and includes a crown region **122***a* and a brim region **122***b*. For example, in the Y-axis direction, the width of the crown region **122***a* is smaller than that of the brim region **122***b*. Two illuminant receiving portions **124***a* are disposed on the second plate part **120**B**2** and preferably located at two opposite sides of the crown region **122***a*, so that the virtual connection line L**1** of the illuminants **40***a* can overlap the crown region **122***a* of the through hole **122** (or the bending section **203**). The brim region **122***b* extends from the crown region **122***a* toward the center of the frame **110** and is located between the crown region **122***a* and the first plate part **120**B**1** to facilitate the assembly operation of the circuit board assembly **20**. Similar to the previous embodiments, two illuminant receiving portions **124***b* are provided on the first plate part **120**B**1** for arranging the illuminants **40***b*. The plate body **120**B and the frame **110** of the light guide seat **13** are an integral structure to avoid the transmission loss of light of the plate body **120**B caused by the connection interface between multiple parts, and to provide sufficient space for the assembly operation and/or for the switch **240**.

[0074] Referring to FIGS. **7**A to **7**C, FIG. **7**A is a partial cross-sectional view of the finger feature module in a fifth embodiment of the invention; FIG. **7**B is an exploded view of a part of the circuit board assembly of FIG. **7**A before the flexible printed circuit board **200** is bent; FIG. **7**C is a perspective view of the light guide seat **13**A in the fifth embodiment of the invention. Hereinafter, the differences between this embodiment and the previous embodiment are described. For the same or similar details, please refer to the relevant description of the previous embodiments. As shown in FIGS. **7**A to **7**C, in this embodiment, the light guide seat **13**A has a structure similar to the light guide seat **13** of FIG. **6**. The difference is that the plate body **120**B is disposed at the bottom of the frame **110**, so that the light guide seat **13**A has a single accommodation space **112**. Specifically, the first plate part **120**B**1** and the second plate part **120**B**2** of the plate body **120**B preferably have the same thickness and are respectively connected to the bottoms of opposite sidewalls **114** of the frame **110**. The first plate part **120**B**1** and the second plate part **120**B**2** extend toward each other to form the through hole **122** as described above. Moreover, as shown in FIG. **7**B, in this embodiment, the circuit board assembly may have a different circuit board arrangement. The configuration of the flexible printed circuit board **200** of the circuit board assembly is similar to the previous embodiments. The difference is the arrangement of the circuit boards **212**, **214**, **222**, **224**. For example, the circuit board **212** and the circuit board **222** can be implemented as two pieces of circuit boards, which are cut from the same circuit board. The circuit board **214** and the circuit board **224** can also be implemented as two pieces of circuit boards, which are cut from the same circuit board. The circuit board **212** and the circuit board **222** are respectively disposed on and electrically connected to the same side (e.g. the lower side before bending) of the first flexible part **201** and the second flexible part **202** of the flexible printed circuit board **200**. The circuit board **214** and the circuit board **224** are respectively stacked on and electrically connected to the circuit board **212** and the circuit board **222**. Before the flexible printed circuit board **200** is bent or after the folded flexible printed circuit board **200** of FIG. **7**A is pulled straight, the circuit board **212** and the circuit board **222** are located at the same layer or the same height position, and the circuit board **214** and the circuit board **224** are also located at the same layer or the same height position. Moreover, since the plate body **120**B is disposed on the bottom of the frame **110**, the second circuit board **220** which is disposed on the second portion **22** of the circuit board assembly is located under the bottom of the light guide seat **13**A, and the switch **240** is located below the light guide seat **13**A and at least partially in the opening **520** of the base holder **50** to be exposed from the opening **520**.

[0075] Referring to FIGS. **8**A to **8**C, FIGS. **8**A to **8**C are partial cross-sectional views of the circuit board assembly in various embodiments of the invention, wherein any of the circuit board assemblies of FIGS. **8**A to **8**C (e.g. **20**A, **20**B, or **20**C) can be used to replace the circuit board assembly (e.g. **20**) of the previous embodiments and applied to the finger feature module of any of the previous embodiments. As shown in FIG. **8**A, in this embodiment, the circuit board assembly **20**A includes a rigid board **216** and the flexible printed circuit board **200**. The rigid board **216** is located on the first portion (e.g. the first portion **21** in the previous embodiment) of the circuit board assembly **20**A. The flexible printed circuit board **200** is configured to carry the rigid board **216**. The feature sensor **30** can be disposed on and electrically connected to the flexible printed circuit board **200** and at least partially overlaps the rigid board **216** with the flexible printed circuit board **200** therebetween. Specifically, the first portion of the circuit board assembly **20**A is the portion disposed above the plate body, and the rigid

board **216** can be used to replace the first circuit board **210** of the previous embodiments. The rigid board **216** has no circuitry and is configured to function as a reinforcement board for supporting the feature sensor **30**. For example, the rigid board **216** is preferably disposed on the lower surface of the first flexible part **201** of the flexible printed circuit board **200**. Corresponding to the rigid board **216**, the feature sensor **30** can be directly disposed on and electrically connected to the upper surface of the first flexible part **201** of the flexible printed circuit board **200**, so that the feature sensor **30** can be supported by the underlying rigid board **216**. Moreover, the circuit board assembly **20**A may further include circuit boards **223** and **225**. The circuit boards **223** and **225** are respectively disposed on the lower surface and the upper surface of the second flexible part **202** of the flexible printed circuit board **200** and retreat with respect to the rigid board **216**. The flexible printed circuit board **200** has the bending section **203** connecting the first flexible part **201** and the second flexible part **202**. The feature circuit can be at least disposed on the flexible printed circuit board **200**, or the flexible printed circuit board **200** and at least one of the circuit boards **223** and **225**.

[0076] As shown in FIG. **8**B, the circuit board assembly **20**B includes the flexible printed circuit board **200**, a first circuit board **218**, and a second circuit board **217**. The first circuit board **218** and the second circuit board **217** are respectively disposed on the upper side and the lower side of the flexible printed circuit board **200**. One end portion of the first circuit board **218** has a gap G**1** with the flexible printed circuit board **200**, and the second circuit board **217** retreats with respect to the end portion of the first circuit board **218**. Specifically, the end portion of the first circuit board **218** may not be adhered to the flexible printed circuit board **200**, so that the end portion of the first circuit board **218** becomes a free end. The second circuit board **217** retreats with respect to the free end of the first circuit board **218** (or the gap G**1**), so that the second circuit board **217** and the gap G**1** at least partially do not overlap with each other, thereby allowing the flexible printed circuit board **200** to be bent relative to the first circuit board **218**. As such, the flexible printed circuit board **200** can easily pass through the through hole **122** of the previous embodiments.

[0077] As shown in FIG. **8**C, the circuit board assembly **20**C includes the flexible printed circuit board **200**, a first circuit board **213**, and a second circuit board **215**. The first circuit board **213** and the second circuit board **215** are respectively disposed on the upper side and the lower side of the flexible printed circuit board **200**. One end portion of the first circuit board **213** has a gap G**2** with the flexible printed circuit board **200**, and the second circuit board **215** retreats with respect to the first circuit board **213**. In this embodiment, the circuit board assembly **20**C further includes an interposed circuit board **211**. The interposed circuit board **211** is located between the first circuit board **213** and the flexible printed circuit board **200**, and the interposed circuit board **211** retreats with respect to the end portion of the first circuit board **213** to form the gap G**2**. Specifically, in the extending direction (or the major axis direction) of the flexible printed circuit board **200**, the length of the first circuit board **218** is larger than that of the interposed circuit board **211**, so that when the first circuit board **218** is stacked on the interposed circuit board **211**, the first circuit board **218** has a non-overlapping portion, which forms the gap G**2** with the flexible printed circuit board **200** due to the thickness of the circuit board **211**. The second circuit board **215** retreats with respect to the non-overlapping portion of the first circuit board **218** (or the gap G**2**), so that the second circuit board **215** and the gap G**2** at least partially do not overlap with each other, thereby allowing the flexible printed circuit board **200** to be bent relative to the first circuit board **213**. As such, the flexible printed circuit board **200** can easily pass through the through hole **122** described in the previous embodiments.

[0078] It is noted that the switch **240** is not shown in FIGS. **8**A to **8**C, but according to practical applications, the circuit board assembly **20**A, **20**B, or **20**C may or may not include the switch **240** to function or not function as the keyswitch.

[0079] Although the preferred embodiments of the invention have been described herein, the above description is merely illustrative. The preferred embodiments disclosed will not limit the scope of the invention. Further modification of the invention herein disclosed will occur to those skilled in the respective arts and all such modifications are deemed to be within the scope of the invention as defined by the appended claims.

What is claimed is:

1. A finger feature module, comprising:

a light guide seat comprising a frame and a plate body, the plate body disposed in the frame and having a through hole eccentrically disposed;

a circuit board assembly having a first portion and a second portion, the first portion of the circuit board assembly disposed in the frame and located above the plate body, the second portion of the circuit board assembly passing through the through hole to be at least partially located below the plate body;

a feature sensor disposed on the first portion of the circuit board assembly; and

a plurality of illuminants electrically connected to the circuit board assembly, wherein two of the plurality of illuminants are located at two opposite ends of the through hole, and a virtual connection line of the two of the plurality of illuminants overlaps the through hole.

2. The finger feature module of claim **1**, wherein the plate body is connected to a middle section of the frame to define an upper room and a lower room in the frame; the upper room and the lower room are respectively above and below the plate body; the through hole communicates the upper room with the lower room.

3. The finger feature module of claim **2**, wherein the circuit board assembly comprises a first circuit board located in the upper room and a second circuit board located in the lower room.

4. The finger feature module of claim **1**, wherein the plate body is disposed with a plurality of illuminant receiving portions; the plurality of illuminants are respectively received in the plurality of illuminant receiving portions.

5. The finger feature module of claim **1**, wherein the plate body comprises an immovable board and a removable board; the immovable board extends from the frame toward a center of the frame to form an opening in the frame; the removable board partially covers the opening to define the through hole with the immovable board.

6. The finger feature module of claim **1**, wherein the plate body further has a central slot; the central slot communicates with the through hole; a major axis of the central slot is perpendicular to a major axis of the through hole.

7. The finger feature module of claim **6**, wherein the plate body further has an expanded slot; the expanded slot extends outward from where the central slot and the through hole intersect.

8. A finger feature module, comprising:

a light guide seat comprising a frame and a removable board, the removable board removably disposed in the frame to define a through hole;

a circuit board assembly having a first portion and a second portion, the first portion of the circuit board assembly disposed in the frame and located above the removable board, the second portion of the circuit board assembly passing through the through hole to be at least partially located below the removable board;

a feature sensor disposed on the first portion of the circuit board assembly; and

one or more illuminants electrically connected to the circuit board assembly to emit light toward the light guide seat.

9. The finger feature module of claim **8**, wherein the frame has an immovable board; the immovable board extends from the frame toward a center of the frame to form an opening in the frame; the removable board partially covers the opening, so that a portion of the opening not covered by the removable board forms the through hole.

10. The finger feature module of claim **9**, wherein the center of the frame is in the opening; the removable board partially covers the opening to cover the center of the frame, so that the through hole is eccentrically disposed with respect to the center of the frame.

11. The finger feature module of claim **9**, wherein the portion of the opening not covered by the removable board further forms one or more illuminant receiving portions.

12. The finger feature module of claim **1**, wherein the circuit board assembly comprises a first circuit board and a second circuit board; the first circuit board is located on the first portion of the circuit board assembly and covers the through hole; the second circuit board is located on the second portion of the circuit board assembly and retreats with respect to the first circuit board to form a retreat space.

13. The finger feature module of claim **12**, wherein the circuit board assembly comprises a flexible printed circuit board configured to carry the first circuit board and the second circuit board; the flexible printed circuit board has a bending section passing through the through hole; the bending section is located in the retreat space.

14. The finger feature module of claim **13**, wherein the bending section is spaced apart from a sidewall of the frame by a distance; the distance is 10% to 45% of a width of the first circuit board.

15. A finger feature module, comprising:

a light guide seat comprising a frame and a plate body, the frame defining an accommodation space, the plate body disposed in the frame to divide the accommodation space into an upper room and a lower room, the plate body having a through hole communicating the upper room with the lower room;

a circuit board assembly comprising a flexible printed circuit board, a first circuit board, and a second circuit board, the first circuit board and the second circuit board disposed on the flexible printed circuit board, the flexible printed circuit board extending through the through hole from the upper room to the lower room, the first circuit board located in the upper room, the second circuit board located in the lower room;

a feature sensor disposed on the first circuit board; and

an illuminant electrically connected to the circuit board assembly to emit light toward the light guide seat.

16. The finger feature module of claim **1**, further comprising a base holder, wherein the base holder is configured to support the light guide seat; the base holder is provided with an opening at bottom; the circuit board assembly extends to outside of the base holder from the opening.

17. The finger feature module of claim **16**, wherein the circuit board assembly further comprises a switch; the switch is exposed from the opening, so that the finger feature module has a keyswitch function.

18. The finger feature module of claim **15**, wherein the flexible printed circuit board has a slit to define a first flexible part, a second flexible part, and a bending section connected between the first flexible part and the second flexible part; the first circuit board and the second circuit board are respectively disposed on the first flexible part and the second flexible part; the flexible printed circuit board is bent relative to the slit to form the bending section.

19. The finger feature module of claim **18**, wherein before the flexible printed circuit board is bent, the first flexible part has a pair of flexible wings at two opposite sides of the bending section.

20. The finger feature module of claim **15**, wherein the illuminant is disposed on the flexible printed circuit board.

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