



(11)

EP 4 826 751 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
21.10.2026 Bulletin 2026/43

(51) International Patent Classification (IPC):
H01H 13/85 (2006.01)

(21) Application number: **25760766.3**

(52) Cooperative Patent Classification (CPC):
H01H 13/14; H01H 13/26; H01H 13/85

(22) Date of filing: **12.02.2025**

(86) International application number:
PCT/CN2025/077044

(87) International publication number:
WO 2025/180223 (04.09.2025 Gazette 2025/36)

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

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(30) Priority: **29.02.2024 CN 202410236129**

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(54) **BUTTON AND ELECTRONIC DEVICE**

(57) This application relates to the field of electronic device technologies, and provides a button and an electronic device, to resolve a problem of low accuracy of the button in detecting pressing force. The button includes a button cap, an elastic beam, a haptic feedback component, sensors, and support structures. The button cap has a pressing surface for a user to press. The elastic beam is connected to the button cap. The haptic feedback component includes a first magnet and a second magnet. The first magnet and a second beam body are arranged opposite to and spaced apart from each other, and the second magnet is disposed on the elastic beam. The sensor is located on the elastic beam, and is configured to sense a deformation amount of the elastic beam. The support structure is separately fixedly connected to the elastic beam and the first magnet. A connection position of the support structure on the elastic beam is located between the sensor and the second magnet.

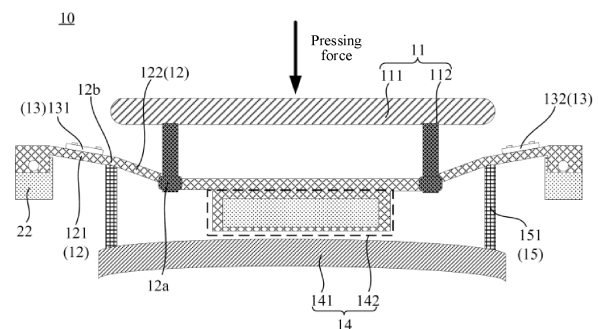


FIG. 7

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Description

[0001] This application claims priority to Chinese Patent Application No. 202410236129.6, filed with the China National Intellectual Property Administration on February 29, 2024, and entitled "BUTTON AND ELECTRONIC DEVICE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments of this application relate to the field of electronic device technologies, and in particular, to a button and an electronic device.

BACKGROUND

[0003] An electronic device usually has one or more buttons. A user may correspondingly actuate these buttons, so that the electronic device correspondingly implements corresponding functions. For example, a mobile phone has a volume-up button, a volume-down button, a lock-screen button, and the like. The user can actuate the volume-up button to increase a playback volume of the electronic device, actuate the volume-down button to decrease the playback volume of the electronic device, and actuate the lock-screen button to lock a screen of the electronic device.

[0004] With the development of button technologies, two types of button technologies have been emerged: mechanical buttons (mechanical buttons) and solid-state buttons (solid buttons). Implementation of functions of the mechanical buttons relies on mechanical movement of the buttons. When a mechanical button is pressed, metal contacts inside the mechanical button form a circuit connection, to trigger an electrical signal. Implementation of functions of the solid-state buttons relies on pressure sensors, which can detect a change in pressing force to trigger electrical signals.

[0005] The mechanical button typically has only a single function, and a user inputs a command by pressing the mechanical button. To continuously issue a command, the user needs to repeatedly press the mechanical button, resulting in low interaction efficiency. In contrast, a solid-state button based on a pressure sensor can intelligently identify a touch operation of a user, for example, identify a force magnitude, duration, and a position of a touch on the solid-state button, to distinguish touch commands such as light press, hard press, tap, and slide, so that interaction functionality of the button can be greatly expanded. Accordingly, interaction efficiency of the solid-state button is high.

SUMMARY

[0006] Embodiments of this application provide a button and an electronic device, to resolve a problem of low accuracy of the button in detecting pressing force.

[0007] To achieve the foregoing objective, the following technical solutions are used in embodiments of this application.

[0008] According to a first aspect, a button is provided. The button includes a button cap, an elastic beam, a haptic feedback component, sensors, and support structures. The button cap has a pressing surface for a user to press. The elastic beam is connected to the button cap, and the elastic beam deforms under pressing force provided by the button cap. The haptic feedback component includes a first magnet and a second magnet. The first magnet and the second magnet are arranged opposite to and spaced apart from each other, and the second magnet is disposed on the elastic beam. The second magnet and the first magnet move relative to each other and drive the elastic beam to vibrate. The sensor is located on the elastic beam, and is configured to sense a deformation amount of the elastic beam. The support structure is separately fixedly connected to the elastic beam and the first magnet. A connection position of the support structure on the elastic beam is located between the sensor and the second magnet.

[0009] The button enables a haptic feedback component and sensors to be decoupled as much as possible, so that when haptic feedback is activated and the haptic feedback component drives an elastic beam to vibrate, an impact of vibration on accuracy of the sensor in detecting the pressing force of the user is reduced or even eliminated. In this way, the button can provide enhanced haptic feedback and accurately detect the pressing force of the user when the haptic feedback is activated. In addition, the haptic feedback component is decoupled from the sensor by using the support structure. In this case, a sensor used for pressure detection and a part used as the haptic feedback component can be independently selected during button design, so that design difficulty of the button is simplified.

[0010] A connection position of the support structure on the elastic beam is referred to as a second connection position. The second connection position may divide the elastic beam into a first beam body and a second beam body. The first beam bodies are each located at an outer side of the second connection position, and the second beam body is located at an inner side of the second connection position. It may be understood that the first beam bodies are parts of the elastic beam that are connected to external structures. The second beam body is a part between the two second connection positions where two support structures are connected to the elastic beam. The second connection position belongs to neither the first beam body nor the second beam body.

[0011] The sensor and the second magnet are respectively located at two sides of the support structure. The sensor is disposed on the first beam body, and the second magnet is disposed on the second beam body. For example, the second magnet may alternatively be

disposed between two second connection positions where two support structures and the elastic beam are connected.

[0012] The first magnet, the two support structures, and the second beam body of the elastic beam are fixedly connected end to end to jointly form a stable structure. In the stable structure, electromagnetic force generated between the first magnet and the second magnet inside the haptic feedback component functions as internal force of the stable structure. In this way, the support structures implement decoupling between the haptic feedback component and the sensors. An impact of vibration of the second beam body along with the second magnet on deformation of the first beam body may be reduced or even eliminated, thereby improving accuracy of the sensor on the first beam body in detecting the pressing force.

[0013] For example, the second magnet is controlled by an alternating current signal to generate electromagnetic force with the first magnet, to drive the second beam body of the elastic beam to vibrate. The support structure fixes and supports the second connection position between the second beam body and the first beam body of the elastic beam, to reduce or even eliminate the impact of vibration of the second beam body on deformation of the first beam body, so that an impact of the haptic feedback on accuracy of the sensor on the first beam body in detecting the pressing force after the haptic feedback is activated can be reduced or even eliminated, thereby improving the accuracy of the button in detecting the pressing force of the user after the haptic feedback is activated.

[0014] When the button cap is subjected to pressing force of the user, the button cap provides a pressure to the second beam body of the elastic beam, to press the second beam body downward. In addition, when the button cap is subjected to pressing force of the user, the signal controller outputs the alternating current signal to a coil of the second magnet, so that the second magnet and the first magnet vibrate, and the vibration is transmitted back to the button cap through the second beam body, so that a finger of the user can sense the haptic feedback.

[0015] When the button cap is subjected to pressing force of the user, two second connection positions of the elastic beam are supported and fixed by the two support structures. Fixation of the second connection positions can reduce or even eliminate an impact of deformation of the second beam body on the first beam body, thereby improving the accuracy of the sensor on the first beam body in detecting the pressing force of the user.

[0016] Therefore, the button provided in embodiments of this application can ensure enhanced haptic feedback to the user and improve the accuracy of detecting the pressing force of the user.

[0017] In a possible implementation of the first aspect, the support structure includes a rigid part, a first

end of the rigid part is fixedly connected to the elastic beam, and a second end of the rigid part is fixedly connected to the first magnet.

[0018] The rigid part may be manufactured and formed of one or more rigid materials such as stainless steel and titanic alloy.

[0019] One end of the rigid part is fixedly connected to the elastic beam, and the other end of the rigid part is fixedly connected to the first magnet.

[0020] When the haptic feedback component vibrates to cause the second beam body to move toward the first magnet, the rigid part is subjected to a pressure, internal stress is generated in the rigid part, and the first magnet is pressed downward.

[0021] In this way, the rigid part and the first magnet under the pressure may generate counter-acting force to resist the pressure, and provide supporting force for the second connection position. The supporting force provided by the rigid part for the second connection position reduces or even eliminates an impact of movement of the second beam body toward the first magnet on deformation of the first beam body, so that an impact on the accuracy of a sensor on the first beam body in detecting the pressing force of the user after the haptic feedback is activated can be reduced or even eliminated, thereby improving the accuracy of the button in detecting the pressing force of the user after the haptic feedback is activated.

[0022] The vibration is bidirectional. Vibration generated by the haptic feedback component also causes the second beam body to move away from the first magnet.

[0023] When the haptic feedback component vibrates to cause the second beam body to move away from the first magnet, the rigid part is subjected to pulling force, internal tensile stress is generated in the rigid part, and the first magnet is pulled up.

[0024] In this way, the rigid part and the first magnet under the pulling force generate counter-acting force to resist the pulling force, and generate pullback force on the second connection position. The pullback force generated by the rigid part at the second connection position may reduce or even eliminate an impact of movement of the second beam body away from the first magnet on deformation of the first beam body, so that the impact on the accuracy of the sensor on the first beam body in detecting the pressing force of the user after the haptic feedback is activated can be reduced or even eliminated, thereby improving the accuracy of the button in detecting the pressing force of the user after the haptic feedback is activated.

[0025] The support structure includes the rigid part, so that when the second magnet vibrates relative to the first magnet, fixation strength of the support structure for the second connection position can be improved, to reduce as much as possible an impact of vibration of the second beam body on deformation of the first beam body, so as to reduce or even eliminate an impact on

accuracy of the sensor on the first beam body in detecting the pressing force of the user, thereby improving the accuracy of the button in detecting the pressing force of the user after the haptic feedback is activated.

[0026] In a possible implementation of the first aspect, the rigid part and the first magnet are connected to each other to form an integral structure. The rigid part and the first magnet are made of a same material, and are connected to each other to form an integrally formed structure. For example, the rigid part and the first magnet are both made of stainless steel, or titanic alloy.

[0027] The two rigid parts are respectively located at two ends of the first magnet in a length direction, and protrude toward the elastic beam. A top of the rigid part is fixedly connected to the elastic beam.

[0028] To avoid degradation of effectiveness of decoupling between the haptic feedback component and the sensor due to large electromagnetic force of the haptic feedback component that drives the second beam body to vibrate, the rigid part and the first magnet may be an integrally formed structure, to increase fixation strength between the rigid part and the first magnet and overall rigidity of the stability structure, so as to improve the effectiveness of decoupling between the haptic feedback component and the sensor, thereby ensuring the accuracy of the sensor in detecting the pressing force of the user after the haptic feedback is activated.

[0029] In a possible implementation of the first aspect, a fixation area between the rigid part and the elastic beam is smaller than a fixation area between the rigid part and the first magnet. It may be understood that the fixation area between the rigid part and the elastic beam is a contact area between the second connection position and the rigid part. For example, the rigid part and the elastic beam are welded, and the fixation area between the rigid part and the elastic beam is a welding area. For another example, the rigid part is bolted to the elastic beam, and the fixation area between the rigid part and the elastic beam is a contact area between a secure member in a bolt and the elastic beam.

[0030] Providing a relatively large fixation area between the rigid part and the first magnet can increase fixation strength between the support structure and the first magnet, to reduce a degree of deformation of the first magnet when the user presses the button. In addition, there are many parts connected to the elastic beam, but a length of the elastic beam is limited. Reducing the fixation area between the rigid part and the elastic beam can facilitate fixed connection of the support structure with the elastic beam in a limited space.

[0031] In a possible implementation of the first aspect, the fixation area between the rigid part and the elastic beam is greater than the fixation area between the rigid part and the first magnet.

[0032] Providing a relatively large fixation area be-

tween the rigid part and the elastic beam can increase fixation strength between the support structure and the elastic beam, to reduce as much as possible the impact of vibration of the second beam body on the deformation of the first beam body, so as to reduce or even eliminate the impact on accuracy of the sensor on the first beam body in detecting the pressing force of the user, thereby improving the accuracy of the button in detecting the pressing force of the user after the haptic feedback is activated.

[0033] In a possible implementation of the first aspect, the support structure includes an elastic part. The elastic part includes a first fixing portion fixed to the elastic beam, a second fixing portion fixed to the first magnet, and a connection portion connecting the first fixing portion and the second fixing portion.

[0034] It may be understood that the first fixing portion is fixedly connected to the second connection position.

[0035] The first fixing portion and the second fixing portion may be arranged at least partially in alignment with each other, or the first fixing portion and the second fixing portion may be arranged in a staggered manner. For example, the second fixing portion is located on a side of the first fixing portion close to the second magnet. For another example, the second fixing portion is located on a side of the first fixing portion away from the second magnet. The first fixing portion and the second fixing portion are arranged in a staggered manner, so that the size of the elastic part can be increased, thereby increasing a magnitude of the elastic supporting force provided by the elastic part for the second connection position.

[0036] When the user does not press the button, the elastic part may be in an unstressed state, and there is no internal stress in the elastic part. It may be understood that there is no pulling force or pressure between the first fixing portion and the connection portion, and there is no pulling force or pressure between the second fixing portion and the connection portion.

[0037] When the haptic feedback component vibrates to cause the second beam body to move toward the first magnet, the elastic part is subjected to a pressure, and internal stress is generated in the elastic part. The first fixing portion under the pressure of the elastic beam presses the connection portion downward, and the connection portion presses the second fixing portion downward.

[0038] In this way, the elastic part under the pressure generates counter-acting force to resist the pressure, and provides supporting force for the second connection position. The supporting force provided by the elastic part for the second connection position reduces or even eliminates the impact of movement of the second beam body toward the first magnet on deformation of the first beam body, so that an impact on the accuracy of a sensor on the first beam body in detecting the pressing force of the user after the haptic feedback is

activated can be reduced or even eliminated, thereby improving the accuracy of the button in detecting the pressing force of the user after the pressing-haptic feedback is activated.

[0039] The vibration is bidirectional. Vibration generated by the haptic feedback component also causes the second beam body to move away from the first magnet.

[0040] When the haptic feedback component vibrates to cause the second beam body to move away from the first magnet, the elastic part is subjected to pulling force, and internal tensile stress is generated in the elastic part. Under pulling force of the elastic beam, the first fixing portion pulls up the connection portion, and the connection portion pulls up the second fixing portion.

[0041] In this way, the elastic part under the pulling force generates counter-acting force to resist the pulling force, and generates pullback force on the second connection position. The pullback force generated by the elastic part at the second connection position may reduce or even eliminate the impact of movement of the second beam body away from the first magnet on deformation of the first beam body, so that the impact on the accuracy of the sensor on the first beam body in detecting the pressing force of the user after the haptic feedback is activated can be reduced or even eliminated, thereby improving the accuracy of the button in detecting the pressing force of the user after the haptic feedback is activated.

[0042] The elastic part may be an elastic piece, a spring, or the like.

[0043] The elastic part may implement fixation of the second connection position when the electromagnetic force between the first magnet and the second magnet is small, to reduce an impact of vibration of the second beam body on deformation of the first beam body, so as to reduce or even eliminate an impact on the accuracy of the sensor on the first beam body in detecting the pressing force of the user, thereby improving the accuracy of the button in detecting the pressing force of the user after the haptic feedback is activated. In addition, the elastic part has a characteristic of variable elasticity. Therefore, the elastic part may flexibly reduce, within a particular range of electromagnetic force, the impact of vibration of the second beam body on deformation of the first beam body, and improve adaptability of the support structure.

[0044] In a possible implementation of the first aspect, a connection position of the sensor on the elastic beam is spaced apart from a connection position of the support structure on the elastic beam.

[0045] The connection position of the sensor on the elastic beam is spaced apart from the second connection position. It may be understood that the sensor and the support structure do not positionally interfere with each other (or in other words, are arranged in a staggered manner), and a side edge of the sensor close to

the support structure is spaced apart from a side edge of the second connection position close to the sensor. In this way, effectiveness of the support structure in decoupling the haptic feedback component from the sensor after the haptic feedback is activated can be improved, to reduce an impact of vibration of the haptic feedback component on the sensor, thereby improving accuracy of the sensor in detecting the pressing force of the user after the haptic feedback is activated.

[0046] In a possible implementation of the first aspect, a connection position of the button cap on the elastic beam is spaced apart from the connection position of the support structure on the elastic beam.

[0047] A position at which the elastic beam is connected to the button cap may be referred to as a first connection position. The first connection position and the second connection position are spaced apart from each other. It may be understood that the button cap and the support structure do not positionally interfere with each other (or in other words, are arranged in a staggered manner), and a side edge of the first connection position close to the second connection position is spaced apart from a side edge of the second connection position close to the first connection position. In this way, attenuation of the haptic feedback transmitted by the button cap from the haptic feedback component due to the support structures can be avoided, thereby improving an effect of the haptic feedback provided by the button to the user.

[0048] In a possible implementation of the first aspect, the button cap includes a cap body and at least one connection body. The connection body is separately connected to the cap body and the elastic beam. The connection body is located between the support structure and the second magnet.

[0049] The connection body in the button cap may be fixedly connected to the elastic beam in a manner such as bolting or welding (laser welding or brazing). The two connection bodies are separately fixedly connected to the elastic beam.

[0050] The connection body is disposed between the support structure and the second magnet, so that the button cap can be connected to the first beam body on which the sensor is located, to improve the sensitivity of the sensor in detecting the pressing force applied by the user to the button cap, thereby improving the accuracy of the button in detecting the pressing force of the user.

[0051] In a possible implementation of the first aspect, a dimension of the first magnet in a direction perpendicular to a pressing surface is greater than or equal to 0.3 mm.

[0052] When the user presses the button cap to cause the elastic beam to deform under stress, the elastic beam may also transmit the pressing force to the first magnet through the support structure, so that the first magnet may also deform. To reduce a deformation amount of the first magnet, the first magnet may be

manufactured using a rigid material, or a thickness of the first magnet may be increased.

[0053] In this implementation, the dimension of the first magnet in the direction perpendicular to the pressing surface is greater than or equal to 0.3 mm, so that the thickness of the first magnet can be increased, and the deformation amount of the first magnet can be reduced.

[0054] In a possible implementation of the first aspect, a spacing distance between the first magnet and the second magnet, in the direction perpendicular to the pressing surface, is greater than or equal to 0.05 mm.

[0055] In this way, the first magnet and the second magnet can be prevented from colliding with each other during vibration, and a small space is reserved, to facilitate miniaturization of the button.

[0056] In a possible implementation of the first aspect, the sensor includes at least one of a microelectro mechanical systems piezoresistive sensor, a metal strain gauge pressure sensor, an optical sensor, and an ultrasonic deformation sensor.

[0057] These sensors have a characteristic of high accuracy of detecting the pressing force of the user, so that accuracy of the button in detecting the pressing force of the user can be improved.

[0058] In a possible implementation of the first aspect, the elastic beam includes a first elastic portion and two second elastic portions fixedly connected to two ends of the first elastic portion, respectively. The second magnet is disposed on the first elastic portion, the sensor is disposed on the second elastic portion, and the support structure is fixedly connected to the second elastic portion.

[0059] In this implementation, the elastic beam is formed by assembling a plurality of parts. Therefore, the plurality of parts can be simultaneously manufactured, to improve manufacturing efficiency of the elastic beam. In addition, compared with the entire structure of the elastic beam, the structure of each part is simpler, and therefore, the part is simpler to manufacture, thereby reducing difficulty in manufacturing the elastic beam.

[0060] The second magnet may be disposed on the first elastic portion. When the second magnet vibrates, the second magnet may drive the first elastic portion to vibrate.

[0061] The sensor may be disposed on the second elastic portion. The sensor may detect the pressing force applied by the user to the button by detecting a deformation amount of the second elastic portion.

[0062] In some examples, the rigidity of the first elastic portion may be the same as the rigidity of the second elastic portion. For example, the first elastic portion and the second elastic portion are manufactured using a same material. In some other examples, the rigidity of the first elastic portion may be different from the rigidity of the second elastic portion. For example, the rigidity of the first elastic portion is greater than the rigidity of

the second elastic portion.

[0063] According to a second aspect, this application provides an electronic device. The electronic device includes a housing and a button. The button is the button according to any implementation of the first aspect. A housing exposes at least a part of a button cap of the button.

[0064] In a possible implementation of the second aspect, the button is a solid-state button. The solid-state button can intelligently identify a touch operation of a user, for example, identify a force magnitude, duration, and a position of a touch on the solid-state button, to identify touch commands such as light press, hard press, tap, and slide, so that interaction functionality of the button can be greatly expanded. Accordingly, interaction efficiency of the solid-state button is high.

[0065] In a possible implementation of the second aspect, the housing further includes a rear cover and a middle frame, an elastic beam of the button is fixedly connected to the middle frame, and a first magnet and the middle frame are independent of each other. In this way, when the user presses the button, the button cap may press the elastic beam downward, so that the elastic beam drives, through the support structures, the first magnet to move downward together, to press the button downward.

[0066] The electronic device according to the second aspect has the button according to any one of the first aspect. Therefore, the electronic device according to the second aspect has beneficial effects of the button. This is not described herein again.

BRIEF DESCRIPTION OF DRAWINGS

[0067]

FIG. 1 is a schematic diagram of a structure of a solid-state button;

FIG. 2 is a schematic diagram of a structure of the solid-state button shown in FIG. 1 in a stressed state;

FIG. 3 is a schematic diagram of a structure of an electronic device;

FIG. 4 is a three-dimensional exploded view of the electronic device shown in FIG. 3;

FIG. 5 is a schematic diagram of a partial structure of a solid-state button mounted on an electronic device according to an embodiment of this application;

FIG. 6 is a schematic diagram of a structure of the solid-state button shown in FIG. 5 deforming under electromagnetic force of a haptic feedback component;

FIG. 7 is a schematic diagram of a structure of the solid-state button shown in FIG. 5 deforming under both pressing force of a user and electromagnetic force of a haptic feedback component;

FIG. 8 is a schematic diagram of a structure of a

sensor;
 FIG. 9 is a circuit diagram of a Wheatstone bridge;
 FIG. 10 is a schematic diagram of strain of a sensor when a solid-state button is subject to force other than perpendicular pressing force of a user and electromagnetic force of a haptic feedback component;
 FIG. 11 is a schematic diagram of a structure of another solid-state button according to an embodiment of this application;
 FIG. 12 is a schematic diagram of a three-dimensional structure of a rigid part and a first magnet in FIG. 11;
 FIG. 13 is a schematic diagram of a structure of still another solid-state button according to an embodiment of this application;
 FIG. 14 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application;
 FIG. 15 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application;
 FIG. 16 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application;
 FIG. 17 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application; and
 FIG. 18 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0068] The following clearly describes technical solutions in embodiments of this application with reference to accompanying drawings. Apparently, the described embodiments are some rather than all of embodiments of this application. All other embodiments obtained by a person skilled in the art based on embodiments provided in this application fall within the protection scope of this application.

[0069] Unless the context requires otherwise, throughout the specification and claims, the term "including" is interpreted as an open and inclusive meaning, that is, "including but not limited to". In the descriptions of this specification, terms "an embodiment", "some embodiments", "an exemplary embodiment", "an example", "a specific example" or "some examples" are intended to indicate that specific characteristics, structures, materials, or features described associated with the embodiment or example are included in at least one embodiment or example of this application. Exemplary descriptions of the foregoing terms do not necessarily refer to the same embodiment or example. Besides, the specific features, structures, materials or characteristics may be included in proper manners in any one or more embodiments or examples.

[0070] In the descriptions of embodiments of this application, unless otherwise specified, "a plurality of" means two or more.

[0071] Terms such as "first" and "second" mentioned below are merely intended for a purpose of description, and shall not be understood as an indication or implication of relative importance or implicit indication of a quantity of indicated technical features. Therefore, a feature defined by "first" or "second" may explicitly or implicitly include one or more features. In the description of this application, unless otherwise specified, "a plurality of" means two or more than two.

[0072] The phrase "at least one of A, B, and C" has a same meaning as the phrase "at least one of A, B, or C", and both include the following combinations of A, B, and C: only A, only B, only C, a combination of A and B, a combination of A and C, a combination of B and C, and a combination of A, B, and C.

[0073] The phrase "A and/or B" includes the following three combinations: only A, only B, and a combination of A and B.

[0074] In addition, in this application, orientation terms such as "up" and "down" are defined relative to an orientation in which a part is schematically placed in the accompanying drawings. It should be understood that these directional terms are relative concepts that are used for descriptive and clarity purposes, which may vary accordingly depending on the orientation in which the parts are placed in the accompanying drawings.

[0075] In this application, the term "arranged opposite to" refers to a situation where vertical projections (also referred to as orthographic projections) of two objects on a same plane partially overlap. It may be understood that two objects being arranged opposite to each other indicates that parts of the two objects are arranged in alignment with each other.

[0076] As used in this specification, the term "substantially" includes a stated value and an average value within an acceptable range of deviation of a particular value, and the acceptable range of deviation is determined by a person of ordinary skill in the art while considering measurement in question and errors associated with measurement of a particular quantity (that is, limitations of a measurement system).

[0077] Before embodiments of this application are described, technical terms related to embodiments of this application are first briefly described.

1. Solid-state button

[0078] The solid-state button is a hardware structure that allows a user to perform touch operations to input commands to an electronic device. The solid-state button may intelligently identify a touch operation of a user, identify a force magnitude, duration, and a position of a touch on the solid-state button, to identify touch commands such as light press, hard press, tap, and slide,

so that interaction manners between the button and the user are significantly increased, and high interaction efficiency is achieved.

[0079] FIG. 1 is a schematic diagram of a structure of a solid-state button in an unstressed state. FIG. 2 is a schematic diagram of a structure of the solid-state button shown in FIG. 1 in a stressed state.

[0080] The solid-state button is mounted on the electronic device. A solid-state button 10 may include a button cap 11 configured to be touched by a user. The user may press the button cap 11, to perform touch operations such as single-tap, double-tap or multiple taps, long press, and slide, to input different touch commands to the electronic device.

[0081] The solid-state button 10 may further include an elastic beam 12. An end of the elastic beam 12 may be connected to a middle frame 20 of the electronic device. The elastic beam 12 may be further connected to the button cap 11, and is configured to receive pressing force transmitted by the button cap 11 and deform correspondingly. Specifically, a degree of deformation of the elastic beam 12 under the pressing force is negatively correlated to a rigidity of the elastic beam 12. For example, the higher the rigidity of the elastic beam 12, the smaller the deformation caused by the pressing force; and the lower the rigidity of the elastic beam 12, the greater the deformation caused by the pressing force.

[0082] The elastic beam 12 may be manufactured using a suitable material such as silicon steel or stainless steel. This is not limited herein.

[0083] The solid-state button 10 may further include sensors (sensors) 13. Typically, the sensor 13 may include a pressure sensor printed with polymer ink. The sensor 13 may be disposed on the elastic beam 12. The sensor 13 may sense the degree of deformation of the elastic beam 12 to sense a magnitude of the pressing force of the user. For example, as shown in FIG. 2, the sensors 13 are fixed to the elastic beam 12. When the elastic beam 12 deforms due to the pressing force, the elastic beam 12 drives the sensors 13 to deform, so that the sensors 13 each output, due to deformation of the sensor itself, a sensor signal indicating information such as a pressure value, pressure duration, and a pressure position of the pressing force applied to the button cap 11. The solid-state button 10 may use the sensor signal as an output signal of the solid-state button 10.

[0084] Rigidity of the elastic beam 12 is negatively correlated to sensitivity of the sensor 13 in detecting the pressing force. It may be understood that when rigidity of the elastic beam 12 is higher, deformation of the elastic beam 12 due to the pressing force is smaller, and as a result, sensitivity of the sensor 13 in detecting the pressing force is lower.

2. Haptic feedback component

[0085] A haptic feedback component 14 may activate haptic feedback when the pressing force applied by the user to press the button cap 11 reaches a preset pressure threshold. The haptic feedback component 14 provides electromagnetic force to the button cap 11 so as to provide haptic feedback to the user, thereby improving the user's haptic experience when pressing the solid-state button 10. Therefore, to improve the user's haptic experience when pressing the solid-state button 10, as shown in FIG. 1 and FIG. 2, typically, the solid-state button 10 may further include the haptic feedback component 14.

[0086] The haptic feedback component 14 may include a first magnet 141 and a second magnet 142. The first magnet 141 and the second magnet 142 are arranged opposite to and spaced apart from each other. At least one of the first magnet 141 and the second magnet 142 may be an electrically-controlled magnet. The electrically-controlled magnet may include a magnetic conductor and a coil wrapped around the magnetic conductor. A current signal is provided to the coil by a signal controller, so that the electrically-controlled magnet generates a magnetic field.

[0087] Electromagnetic force is generated between the first magnet 141 and the second magnet 142, to generate vibration. The electromagnetic force between the first magnet 141 and the second magnet 142 is negatively correlated to a spacing distance between the first magnet 141 and the second magnet 142. The electromagnetic force between the first magnet 141 and the second magnet 142 is positively correlated to a size of the first magnet 141, a size of the second magnet 142, a quantity of turns of a coil in the electrically-controlled magnet, and the like.

[0088] For example, when a spacing distance between the first magnet 141 and the second magnet 142 is shorter, electromagnetic force between the first magnet 141 and the second magnet 142 is larger.

[0089] For another example, when a size of the first magnet 141 and/or the second magnet 142 is larger, electromagnetic force between the first magnet 141 and the second magnet 142 is larger.

[0090] For ease of description, an example in which the first magnet 141 is a permanent magnet and the second magnet 142 is an electrically-controlled magnet is used for description below. It may be understood that in a specific implementation scenario, alternatively, the first magnet 141 may be an electrically-controlled magnet and the second magnet 142 may be a permanent magnet, or both the first magnet 141 and the second magnet 142 may be electrically-controlled magnets.

[0091] When the second magnet 142 receives a forward current signal of the signal controller, the second magnet 142 generates a polarity opposite to that of the first magnet 141, so that attraction force is generated between the second magnet 142 and the first magnet

141. When the second magnet 142 receives a reverse current signal of the signal controller, repulsive force is generated between the second magnet 142 and the first magnet 141.

[0092] One of the first magnet 141 and the second magnet 142 may be disposed on the elastic beam 12, and the other of the first magnet 141 and the second magnet 142 may be disposed on the middle frame 20 of the electronic device. For example, as shown in FIG. 1 and FIG. 2, the second magnet 142 is disposed on a side surface of the elastic beam 12 away from the button cap 11, and the first magnet 141 is disposed on a side surface of the middle frame 20 close to the button cap 11. It may be understood that, the second magnet 142 and the first magnet 141 are located between the elastic beam 12 and the middle frame 20.

[0093] For ease of description, descriptions below are provided by using an example in which the second magnet 142 is disposed on the side surface of the elastic beam 12 away from the button cap 11, and the first magnet 141 is disposed on the side surface of the middle frame 20 close to the button cap 11. However, in actual implementation, the second magnet 142 may be disposed on the side surface of the middle frame 20 close to the button cap 11, and the first magnet 141 may be disposed on the side surface of the elastic beam 12 away from the button cap 11.

[0094] The middle frame 20 is a fixed structure in the electronic device, and therefore, a position of the first magnet 141 located on the middle frame 20 is fixed.

[0095] When the second magnet 142 receives the forward current signal provided by the signal controller, attraction force is generated between the second magnet 142 and the first magnet 141. Because a position of the first magnet 141 is fixed, the second magnet 142 drives the elastic beam 12 to move towards the first magnet 141. When the second magnet 142 receives the reverse current signal provided by the signal controller, repulsive force is generated between the second magnet 142 and the first magnet 141, and the second magnet 142 drives the elastic beam 12 to move away from the first magnet 141. In this way, when the user presses the solid-state button 10, the signal controller provides an alternating current signal (such as a sine wave signal) to the second magnet 142, so that the second magnet 142 and the elastic beam 12 can vibrate together.

[0096] According to the foregoing descriptions, the button cap 11 is connected to the elastic beam 12. Therefore, when the elastic beam 12 vibrates, the elastic beam 12 drives the button cap 11 to vibrate together. In this way, vibration generated by the button cap 11 provides the haptic feedback to the user, thereby improving the user's haptic experience when pressing the solid-state button 10.

[0097] However, when the solid-state button 10 includes the haptic feedback component 14, to provide haptic feedback to the user, the haptic feedback com-

ponent 14 generates vibration on the elastic beam 12, resulting in a reduction in accuracy of the sensor 13 in determining the pressing force of the user by sensing deformation of the elastic beam 12.

[0098] To resolve the foregoing problem and reduce impact of vibration generated by the haptic feedback component 14 on accuracy of the sensor 13 in detecting the pressing force, in some solutions, the elastic beam 12 is manufactured using a more rigid material, to reduce impact of vibration on the deformation of the elastic beam 12. However, according to the foregoing descriptions, the rigidity of the elastic beam 12 is negatively correlated to the sensitivity of the sensor 13 in detecting the pressing force. Therefore, in this manner, the accuracy of the sensor 13 in detecting the pressing force is improved, but the sensitivity of the sensor 13 in detecting the pressing force is reduced. In addition, because the rigidity of the elastic beam 12 increases, the intensity of vibration of the elastic beam 12 is reduced, which also cause a problem that intensity of the haptic feedback provided by the haptic feedback component 14 to the user is reduced.

[0099] Therefore, currently, there is no technical solution in the industry that can balance the effect of haptic feedback provided by the haptic feedback component 14 to the user and accuracy of the sensor 13 in determining the pressing force of the user.

[0100] An embodiment of this application provides a button and an electronic device on which the button is mounted. The button enables a haptic feedback component and sensors to be decoupled as much as possible, so that an impact of vibration of an elastic beam driven by the haptic feedback component on accuracy of the sensor in detecting the pressing force of the user is reduced or even eliminated. In this way, the button can provide enhanced haptic feedback and accurately detect the pressing force of the user. In addition, the haptic feedback component is decoupled from the sensor. In this case, a sensor used for pressure detection and a part used as the haptic feedback component can be independently selected during button design, so that design difficulty of the button is simplified.

[0101] The foregoing button may be a solid-state button, or may be a mechanical button. This is not limited in this embodiment of this application. For ease of understanding, the solid-state button is used as an example for description below.

[0102] The electronic device provided in this application is an electronic device on which a solid-state button may be mounted. The electronic device includes, but is not limited to, electronic devices such as a mobile phone, a tablet personal computer (tablet personal computer), a laptop computer (laptop computer), a personal digital assistant (personal digital assistant, PDA), a personal computer, a notebook computer, an in-vehicle device, and a wearable device. The wearable device includes, but is not limited to, a smart bracelet, a smart watch, a smart head-mounted display, smart

glasses, and the like. For ease of understanding, a scenario in which the electronic device includes the mobile phone is always used as an example below for description.

[0103] Refer to FIG. 3 and FIG. 4. FIG. 3 is a schematic diagram of a structure of an electronic device. FIG. 4 is a three-dimensional exploded view of the electronic device shown in FIG. 3. An electronic device 100 may include a solid-state button 10, a housing 30, a screen 40, and a circuit board 50. The housing 30 and the screen 40 together define an accommodating space, and the circuit board 50 may be located in the accommodating space.

[0104] It can be understood that FIG. 3 and FIG. 4 schematically show only some parts included in the electronic device 100. Actual shapes, actual sizes, actual positions, and actual structures of these parts are not limited to FIG. 3, FIG. 4, and the following accompanying drawings.

[0105] The screen 40 is configured to display an image, a video, and the like. The screen 40 includes a light-transmitting cover plate 41 and a display screen 42. The light-transmitting cover plate 41 and the display screen 42 are disposed in a stacked manner and fixedly connected. The light-transmitting cover plate 41 is provided mainly for achieving protection and dust-proofing for the display screen 42. A material of the light-transmitting cover plate 41 includes, but is not limited to, glass. The display screen 42 may be a flexible display screen, or may be a rigid display screen. For example, the display screen 42 may be an organic light-emitting diode (organic light-emitting diode, OLED) display screen, an active matrix-organic light-emitting diode (active-matrix organic light-emitting diode, AMOLED) display screen, a mini organic light-emitting diode (mini organic light-emitting diode) display screen, a micro light-emitting diode (micro organic light-emitting diode) display screen, a micro organic light-emitting diode (micro organic light-emitting diode) display screen, a quantum dot light emitting diodes (quantum dot light emitting diodes, QLED) display screen, or a liquid crystal display (liquid crystal display, LCD) screen, or the like. This is not limited herein.

[0106] The housing 30 is configured to protect internal electronic devices of the electronic device 100. The housing 30 may include a back cover 31 and a middle frame 20. The middle frame 20 includes a border frame 21 and a board body 22 located at an inner side of the border frame 21. The foregoing solid-state button may be fixedly connected to the board body 22, or may be fixedly connected to the border frame 21. This is not limited herein.

[0107] The back cover 31 is located on a side of the display screen 42 away from the light-transmitting cover plate 41, and is stacked with and spaced apart from the light-transmitting cover plate 41 and the display screen 42. The border frame 21 is located between the back cover 31 and the light-transmitting cover plate 41.

The border frame 21 may be fixed on the back cover 31. For example, the border frame 21 may be fixedly connected to the back cover 31 by using an adhesive, or the border frame 21 and the back cover 31 may be an integrally formed structure, that is, the border frame 21 and the back cover 31 are a whole structural member. The light-transmitting cover plate 41 is fixed on the border frame 21 through gluing. The light-transmitting cover plate 41, the back cover 31, and the border frame 21 enclose an accommodating space of the electronic device 100. The accommodating space houses the display screen 42, the middle frame 20, and the circuit board 50.

[0108] As shown in FIG. 4, the board body 22 is disposed in the accommodating space, and the board body 22 is located on a side that is of the display screen 42 and that is away from the light-transmitting cover plate 41. An edge of the board body 22 is fixed to the border frame 21. In some embodiments, the edge of the board body 22 may be fixed to the border frame 21 through gluing, or the board body 22 and the border frame 21 may be of an integrally formed structure, that is, the board body 22 and the border frame 21 are a whole structural member. The display screen 42 may be located on a side of the board body 22 close to the light-transmitting cover plate 41, and the circuit board 50 may be located on a side of the board body 22 close to the back cover 31.

[0109] The circuit board 50 is configured to dispose electronic components and implement electrical connection between the electronic devices. In some embodiments, the circuit board 50 may include a primary circuit board 51 and a secondary circuit board 52. The primary circuit board 51 and the secondary circuit board 52 are disposed in a partial space between the middle frame 20 and the back cover 31, and are stacked on the back cover 31. In some embodiments, the primary circuit board 51 and the secondary circuit board 52 are both fixed to the board body 22.

[0110] The primary circuit board 51 is configured to integrate a control chip. For example, the control chip may be an application processor (application processor, AP), a double data rate (double data rate, DDR) synchronous dynamic random access memory, a universal flash storage (UFS), or the like. In some embodiments, the primary circuit board 51 is electrically connected to the display screen 42, and the primary circuit board 51 is configured to control the display screen 42 to display an image or a video.

[0111] The primary circuit board 51 may be a rigid circuit board, a flexible printed circuit board, or a rigid-flex circuit board. The primary circuit board 51 may be an FR-4 substrate, a Rogers (Rogers) substrate, a hybrid FR-4-Rogers substrate, or the like. It should be noted that FR-4 is a designation for a flame-resistant material grade, and the Rogers substrate is a high-frequency board.

[0112] The secondary circuit board 52 is configured

to integrate electronic devices such as an antenna (such as a 5G antenna) radio frequency front end, a universal serial bus (universal serial bus, USB) device, a vibration motor, and the like.

[0113] The secondary circuit board 52 may also be a rigid circuit board, a flexible printed circuit board, or a rigid-flex circuit board. The secondary circuit board 52 may also be an FR-4 substrate, a Rogers substrate, or a hybrid substrate of the FR-4 and the Rogers.

[0114] The circuit board 50 may further include a connection structure 53. The connection structure 53 is electrically connected to the primary circuit board 51 and the secondary circuit board 52, to implement data and signal transmission between the secondary circuit board 52 and the primary circuit board 51. The connection structure 53 includes, but is not limited to, a flexible printed circuit board (flexible printed circuit, FPC), a wire, an enameled wire, or a structure formed by braiding a wire and a flexible material.

[0115] The solid-state button 10 may be mounted on the housing 30 (for example, on the border frame 21 or the back cover 31) of the electronic device 100. For example, the solid-state button 10 may be disposed at a central position on the border frame 21 and used as a volume control button, a lock-screen button, or the like of the electronic device 100.

[0116] FIG. 5 is a schematic diagram of a partial structure of a solid-state button mounted on an electronic device according to an embodiment of this application. A border frame 21 may be provided with a recess 23. At least a part of a button cap 11 in a solid-state button 10 is accommodated in the recess 23. For example, the button cap 11 may include a cap body 111, and a connection body 112 connecting the cap body 111 and an elastic beam 12. A side surface of the cap body 111 away from the elastic beam 12 includes a pressing surface for a user to press. The cap body 111 is accommodated in the recess 23 provided in a housing 30. The cap body 111 and the connection body 112 may be an integrally formed structure, or the cap body 111 and the connection body 112 may form an integral structure after being assembled with each other. This is not limited herein.

[0117] In some examples, an opening of the recess 23 may be approximately flush with the side surface of the cap body 111 away from the elastic beam 12. In this way, an outer surface (the surface for the user to press) of the solid-state button 10 and an outer surface of the housing 30 can form an even and smooth surface, thereby improving aesthetics of an electronic device 100.

[0118] In some other examples, the side surface of the cap body 111 away from the elastic beam 12 may protrude relative to the opening of the recess 23. For example, a distance by which the side surface of the cap body 111 away from the elastic beam 12 protrudes from the opening of the recess 23 may be greater than or equal to 0.05 mm and less than or equal to 0.15 mm.

For example, the protrusion distance may be 0.05 mm, 0.08 mm, 0.1 mm, 0.12 mm, 0.15 mm, or the like.

[0119] In this way, when the user blindly presses the solid-state button 10 with a finger, the user can distinguish the solid-state button 10 from the housing 30 from the sense of touch, enabling the user to find the solid-state button 10 quickly.

[0120] As shown in FIG. 5, a recess bottom of the recess 23 separates the cap body 111 and the elastic beam 12. Therefore, a through hole 231 that extends through the housing 30 may be formed at the recess bottom of the recess 23. The connection body 112 in the button cap 11 may pass through the through hole 231 and be connected to the elastic beam 12. It may be understood that one end of the connection body 112 is connected to the cap body 111 on one side of the recess bottom, and the other end of the connection body 112 is connected to the elastic beam 12 on the other side of the recess bottom.

[0121] The connection body 112 in the button cap 11 may be fixedly connected to the elastic beam 12 in a manner such as bolting or welding (laser welding or brazing). As shown in FIG. 5, the two connection bodies 112 are separately fixedly connected to the elastic beam 12. A position at which the elastic beam 12 is connected to the connection body 112 may be referred to as a first connection position 12a.

[0122] There may be one or more through holes 231 formed in the recess bottom of the recess 23. For example, a quantity of the through holes 231 may be equal to a quantity of the connection bodies 112 in the button cap 11, and each connection body 112 is connected to the elastic beam 12 through one through hole 231. For another example, the quantity of the through holes 231 may be greater than the quantity of the connection bodies 112 in the button cap 11. The through hole 231 that is not passed through by the connection body 112 allows airflow to easily enter or exit from the housing 30 when the haptic feedback component 14 in the solid-state button 10 vibrates, thereby balancing air pressure inside and outside the housing 30.

[0123] In addition, the recess bottom of the recess 23 can abut against the side surface of the cap body 111 close to the elastic beam 12 when the user presses the button cap 11 with large pressing force, to prevent damage to the solid-state button 10 caused by the user pressing the button cap 11 downward with excessively large pressing force.

[0124] In this embodiment of this application, the elastic beam 12 may be an integrally formed structure, or may be an integral structure formed by assembling a plurality of parts. This is not limited herein.

[0125] As shown in FIG. 5, the elastic beam 12 may be an integrally formed structure. Ends of the elastic beam 12 may be separately fixedly connected to the board body 22 of the electronic device 100. The elastic beam 12 and the board body 22 may be fixedly connected in a manner such as bolting or welding. Alterna-

tively, the elastic beam 12 and the board body 22 may be connected to each other to form an integral structure.

[0126] The elastic beam 12 may be fixedly connected to two connection bodies 112 in the button cap 11. When the button cap 11 is subjected to pressing force of the user, the button cap 11 transmits the pressing force to the elastic beam 12 through the first connection position 12a connected to the elastic beam 12. The elastic beam 12 deforms under the pressing force.

[0127] A sensor 13 is disposed on the elastic beam 12. For example, as shown in FIG. 5, the sensor 13 may be disposed on a side surface of the elastic beam 12 close to the button cap 11. For another example, the sensor 13 may be disposed on a side surface of the elastic beam 12 away from the button cap 11.

[0128] When the elastic beam 12 deforms under the pressing force, the sensor 13 can detect a degree of deformation of the elastic beam 12, to sense a magnitude of the pressing force applied by the user. How the sensor 13 specifically determines the pressing force has been described previously, and details are not described herein again.

[0129] There may be two sensors 13. The two sensors 13 may be respectively disposed close to the two first connection positions 12a. For example, as shown in FIG. 5, two first connection positions 12a are located between two sensors 13. It may be understood that the sensors 13 are each located at an outer side of the first connection position 12a.

[0130] In this embodiment of this application, the electronic device may further determine a pressing position of the user by using the two sensors 13. For example, as shown in FIG. 5, the two sensors 13 include a first sensor 131 and a second sensor 132. When pressing force detected by the first sensor 131 is roughly equal to pressing force detected by the second sensor 132, the electronic device 100 may determine that the user presses the central position on the button cap 11. When the pressing force detected by the first sensor 131 is greater than the pressing force detected by the second sensor 132, the electronic device may determine that the user presses a position on the button cap 11 close to the first sensor 131. When the pressing force detected by the first sensor 131 is smaller than the pressing force detected by the second sensor 132, the electronic device may determine that the user presses a position on the button cap 11 close to the second sensor 131.

[0131] On this basis, the electronic device 100 may determine a change of the position of pressing by the user on the button cap 11 of the solid-state button 10 by obtaining a change of the pressing force detected by the first sensor 131 and a change of the pressing force detected by the second sensor 132. For example, when the pressing force detected by the first sensor 131 gradually increases and the pressing force detected by the second sensor 132 gradually decreases, the electronic

device may determine that a position of pressing by the user on the button cap 11 moves from the second sensor 132 toward the first sensor 131. Similarly, when the pressing force detected by the first sensor 131 gradually decreases and the pressing force detected by the second sensor 132 gradually increases, the electronic device may determine that a position of pressing by the user on the button cap 11 moves from the first sensor 131 toward the second sensor 132.

[0132] In this way, the user can input an interaction command to the electronic device through interactions such as pressing different positions on the solid-state button 10 or sliding with a finger on the solid-state button 10, so that interaction functionality of the solid-state button 10 is expanded, and interaction efficiency of the solid-state button 10 is improved.

[0133] A first magnet 141 in the haptic feedback component 14 is located on a side of the elastic beam 12 away from the button cap 11, and is arranged opposite to and spaced apart from the elastic beam 12. A second magnet 142 in the haptic feedback component 14 may be disposed on the elastic beam 12. For example, the second magnet 142 is disposed on the side surface of the elastic beam 12 away from the button cap 11. Correspondingly, the first magnet 141 and the second magnet 142 are arranged opposite to and spaced apart from each other.

[0134] As shown in FIG. 5, the solid-state button 10 may further include support structures 15. The support structure 15 is separately connected to the elastic beam 12 and the first magnet 141.

[0135] A connection position of the support structure 15 on the elastic beam 12 is referred to as a second connection position 12b. The second connection position 12b may divide the elastic beam 12 into a first beam body 121 and a second beam body 122. The first beam bodies 121 are each located at an outer side of the second connection position 12b, and the second beam body 122 is located at an inner side of the second connection position 12b. It may be understood that the first beam bodies 121 are parts of the elastic beam 12 that are connected to the board body 22. The second beam body 122 is a part between the two second connection positions 12b where the two support structures 15 are connected to the elastic beam 12. The second connection position 12b belongs to neither the first beam body 121 nor the second beam body 122.

[0136] The sensor 13 and the second magnet 142 are respectively located at two sides of the support structure 15. The sensor 13 is disposed on the first beam body 121, and the second magnet 142 is disposed on the second beam body 122. For example, the second magnet 142 may alternatively be disposed between two second connection positions 12b where the elastic beam 12 and two support structures 15 are connected to each other.

[0137] In some examples, the connection position of the sensor 13 on the elastic beam 12 is spaced apart

from the second connection position 12b. It may be understood that the sensor 13 and the support structure 15 do not positionally interfere with each other (or in other words, are arranged in a staggered manner), and a side edge of the sensor 13 close to the support structure 15 is spaced apart from a side edge of the second connection position 12b close to the sensor 13. In this way, effectiveness of the support structure 15 in decoupling the haptic feedback component 14 from the sensor 13 can be improved, to reduce an impact of vibration of the haptic feedback component 14 on the sensor 13 after the haptic feedback is activated, thereby improving accuracy of the sensor 13 in detecting the pressing force of the user after the haptic feedback is activated.

[0138] Similarly, in some examples, the first connection position 12a and the second connection position 12b are spaced apart from each other. It may be understood that the connection body 112 and the support structure 15 do not positionally interfere with each other (or in other words, are arranged in a staggered manner), and a side edge of the first connection position 12a close to the second connection position 12b is spaced apart from a side edge of the second connection position 12b close to the first connection position 12a. In this way, attenuation of the haptic feedback transmitted by the connection body 112 from the haptic feedback component 14 due to the support structures 15 can be avoided, thereby improving an effect of the haptic feedback provided by the solid-state button 10 to the user.

[0139] In some examples, when the electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate is large, the effectiveness of decoupling between the haptic feedback component 14 and the sensor 13 may be degraded. In this way, vibration intensity of the second beam body 122 can be reduced by reducing the spacing distance between the support structure 15 and the second magnet 142, to ensure the effectiveness of decoupling between the haptic feedback component 14 and the sensor 13, thereby ensuring accuracy of the sensor 13 in detecting the pressing force of the user after the haptic feedback is activated.

[0140] In other words, the spacing distance between the support structure 15 and the second magnet 142 may be negatively correlated to the vibration intensity of the second beam body 122 (or the electromagnetic force between the first magnet 141 and the second magnet 142). In this way, the effectiveness of decoupling between the haptic feedback component 14 and the sensor 13 can be ensured, thereby ensuring accuracy of the sensor 13 in detecting the pressing force of the user after the haptic feedback is activated.

[0141] The support structure 15 may be fixedly connected to the first magnet 141. For example, the support structure 15 and the first magnet 141 may be fixedly connected in a manner such as bolting or welding.

Alternatively, the support structure 15 and the first magnet 141 may be connected to each other to form an integral structure.

[0142] It should be noted that, in this embodiment of this application, the first magnet 141 is not connected to the middle frame 20 (for example, the board body 22) of the electronic device 100.

[0143] In this way, the first magnet 141, the two support structures 15, and the second beam body 122 of the elastic beam 12 are fixedly connected end to end to jointly form a stable structure. In the stable structure, electromagnetic force generated between the first magnet 141 and the second magnet 142 inside the haptic feedback component 14 functions as internal force of the stable structure, so that the support structure 15 implements decoupling of the haptic feedback component 14 from the sensors 13. When the second beam body 122 vibrates along with the second magnet 142, an impact on deformation of the first beam body 121 may be reduced or even eliminated, thereby improving accuracy of the sensor on the first beam body 121 in detecting the pressing force.

[0144] For example, the second magnet 142 is controlled by an alternating current signal to generate electromagnetic force with the first magnet 141, to drive the second beam body 122 of the elastic beam 12 to vibrate. The support structure 15 fixes and supports the second connection position 12b between the second beam body 122 and the first beam body 121 of the elastic beam 12, to reduce or even eliminate the impact of vibration of the second beam body 122 on deformation of the first beam body 121, so that an impact of the haptic feedback on the accuracy of the sensor 13 on the first beam body 121 in detecting the pressing force after the haptic feedback is activated can be reduced or even eliminated, thereby improving accuracy of the solid-state button 10 in detecting the pressing force of the user after the haptic feedback is activated.

[0145] FIG. 6 is a schematic diagram of a structure of the solid-state button shown in FIG. 5 deforming under electromagnetic force of a haptic feedback component.

[0146] FIG. 6 may be a schematic diagram of a solid-state button deforming when the button cap 11 is not subjected to pressing force of the user or the pressing force is very small, and a haptic feedback component 14 is activated to cause a signal controller to output an alternating current signal to a coil of a second magnet 142, to make the second magnet 142 and the first magnet 141 vibrate.

[0147] It can be seen from FIG. 6 that the first beam body 121 undergoes substantially no deformation when the haptic feedback component 14 is activated, and the second magnet 142 and the first magnet 141 vibrate to drive the second beam body 122 to deform. Therefore, upon verification, the support structure 15 can reduce or even eliminate an impact of deformation of the second beam body 122 on deformation of the first beam body 121.

[0148] In an example, when a finger of the user slides on the button cap 11 and applies a pressing force of 0.3 N (Newton) to the button cap, and the haptic feedback component 14 is activated to cause the second magnet 142 to generate a vibration force of 2 N relative to the first magnet 141, it can be found through detection of the sensor 13 that an impact of the vibration force (2 N) provided by the haptic feedback component 14 on strain of the sensor 13 is approximately equal to one percent of an impact of the pressing force (0.3 N) of the user on the strain of the sensor 13. At this ratio, the impact of the vibration force on the accuracy of detecting the pressing force is substantially negligible.

[0149] FIG. 7 is a schematic diagram of a structure of the solid-state button shown in FIG. 5 deforming under both pressing force of a user and electromagnetic force of a haptic feedback component.

[0150] As shown in FIG. 7, when the button cap 11 is subjected to the pressing force of the user, the button cap 11 provides a pressure to the second beam body 122 of the elastic beam 12, so that the first beam body 121 and the second beam body 122 are both pressed downward. In addition, in a process in which the button cap 11 is subjected to the pressing force of the user, the signal controller outputs an alternating current signal to the coil of the second magnet 142 to cause the second magnet 142 and the first magnet 141 to vibrate. The vibration is transmitted back to the button cap 11 through the second beam body 122, so that the finger of the user can sense the haptic feedback.

[0151] When the button cap 11 is subjected to pressing force of the user, the two support structures 15 support and fix the two second connection positions 12b of the elastic beam 12. Fixation of the second connection positions 12b can reduce or even eliminate the impact of deformation of the second beam body 122 on deformation of the first beam body 121, thereby improving accuracy of the sensor 13 on the first beam body 121 in detecting the pressing force of the user.

[0152] It should be noted that the support structure 15 isolates an impact of electromagnetic force between the second magnet 142 and the first magnet 141 on the first beam body 121. Therefore, compared with the first beam body 121, the second beam body 122 is not only subjected to the pressing force of the user, but also to the electromagnetic force between the second magnet 142 and the first magnet 141. Due to the isolation action of the support structure 15, the first beam body 121 is substantially subjected only to the pressing force of the user. Therefore, in FIG. 7, a degree of deformation of the first beam body 121 is lower than a degree of deformation of the second beam body 122. For example, in FIG. 7, an inclination angle of the first beam body 121 is smaller than an inclination angle of the second beam body 122.

[0153] Therefore, the solid-state button provided in embodiments of this application can ensure enhanced

haptic feedback to the user and improve the accuracy of detecting the pressing force of the user.

[0154] It should be noted that when the user presses the button cap 11 to cause the elastic beam 12 to deform under stress, the elastic beam 12 may also transmit the pressing force to the first magnet 141 through the support structure 15, so that the first magnet 141 may also deform. To reduce a deformation amount of the first magnet 141, the first magnet 141 may be manufactured using a rigid material, or a thickness (a corresponding dimension in a direction of the pressing force in FIG. 7, or a corresponding dimension in a direction perpendicular to a plane on which the cap body 111 is located) of the first magnet 141 may be increased.

[0155] For example, the thickness of the first magnet 141 may be greater than or equal to 0.3 mm. For example, the thickness of the first magnet 141 may be 0.3 mm, 0.35 mm, 0.4 mm, 0.42 mm, 0.47 mm, 0.5 mm, or the like. This is not limited herein.

[0156] The following describes, based on a specific structure and working principle of a sensor, an impact of vibration generated by the haptic feedback component 14 on accuracy of detecting pressing force when a solid-state button 10 does not have a support structure 15, and describes how a haptic feedback component 14 reduces or even eliminates an impact on accuracy of detecting the pressing force when the solid-state button 10 has the support structure 15.

[0157] FIG. 8 is a schematic diagram of a structure of a sensor. FIG. 9 is a circuit diagram of a Wheatstone bridge.

[0158] It should be noted that the schematic diagram shown in FIG. 8 illustrates a corresponding operating status of a first sensor 131 on a left side of the solid-state button, and corresponding strain of a second sensor 132 may be symmetrical to that of the first sensor 131. To avoid repetition, the first sensor 131 is used as an example for description subsequently, and a situation of the second sensor 132 may be undoubtedly deduced based on a symmetrical relationship.

[0159] A resistive pressure sensor is used as an example for description in FIG. 8. As shown in FIG. 8, the first sensor 131 includes an organic thin film 133, and four resistors (R1, R2, R3, and R4) formed on the organic thin film 133. The organic film 133 may be a film manufactured using polyimide (PI) or another suitable material. This is not limited herein.

[0160] The four resistors (R1, R2, R3, and R4) may form a Wheatstone bridge shown in FIG. 9 with wires. One positive signal output by a positive terminal U1 of a power supply flows to a negative terminal of a battery through the resistor R1 and the resistor R2 in sequence, and another positive signal output by the positive terminal U1 of the power supply flows to the negative terminal of the battery through the resistor R4 and the resistor R3 in sequence. A first voltage output terminal Vout1 is a node where the resistor R1 and the resistor R2 are connected. A second voltage output

terminal Vout2 is a node where the resistor R4 and the resistor R3 are connected. A voltage value output by the first voltage output terminal Vout1 of the Wheatstone bridge is $R2/(R1+R2) \times U1$, and a voltage value output by the second voltage output terminal Vout2 is $R3/(R3+R4) \times U1$.

[0161] When a user does not press the solid-state button 10, resistance values of the four resistors are equal. In this case, the voltage value output by the first voltage output terminal Vout1 and the voltage output by the second voltage output terminal Vout2 of the Wheatstone bridge are equal, and a voltage difference between the first voltage output terminal Vout1 and the second voltage output terminal Vout2 is 0.

[0162] It should be noted that in addition to being subjected to the pressing force perpendicular to the pressing surface and the electromagnetic force generated by the haptic feedback component 14, an elastic beam 12 may be also under internal stress resulting from slight twisting (about an axis in a direction from the resistor 1 to the resistor 2) of the sensor. Such twisting may arise when pressing force of the user is not perpendicular to the pressing surface on the cap body 111, or due to an installation tolerance in fixing the elastic beam 12 to the board body 22. Consequently, positions at which the resistor R1 and the resistor R4 are located undergo outward bending and tensile strain, and positions at which the resistor R2 and the resistor R3 are located undergo inward bending and compressive strain. As shown in FIG. 10, such internal stress may cause the resistor R1 and the resistor R4 to generate positive strain, and the resistor R2 and the resistor R3 to generate negative strain, or cause the resistor R1 and the resistor R4 to generate negative strain, and the resistor R2 and the resistor R3 to generate positive strain. This is not limited herein.

[0163] However, whether the resistor R1 and the resistor R4 generate positive strain, and the resistor R2 and the resistor R3 generate negative strain, or the resistor R1 and the resistor R4 generate negative strain, and the resistor R2 and the resistor R3 generate positive strain, the voltage difference between the first voltage output terminal Vout1 and the second voltage output terminal Vout2 of the Wheatstone bridge is substantially not affected. Therefore, such force other than the pressing force perpendicular to the pressing surface and the electromagnetic force generated by the haptic feedback component 14 does not affect accuracy of the sensor 13 in detecting the pressing force. In this way, the voltage difference between the first voltage output terminal Vout1 and the second voltage output terminal Vout2 of the Wheatstone bridge may be considered to be caused by the user pressing the solid-state button 10. Therefore, the pressing force applied by the user to press the solid-state button 10 can be accurately determined based on the voltage difference, so that accuracy of the solid-state button 10 in detecting the pressing force can be improved.

[0164] The following describes various structures of the support structure 15 in the solid-state button 10.

[0165] As shown in FIG. 5 to FIG. 7, in some examples, the support structure 15 may include a rigid part 151. The rigid part 151 may be manufactured using and formed of one or more rigid materials such as stainless steel and titanium alloy.

[0166] One end of the rigid part 151 is fixedly connected to an elastic beam 12, and the other end of the rigid part 151 is fixedly connected to a first magnet 141.

[0167] When a haptic feedback component 14 vibrates to cause a second beam body 122 to move toward the first magnet 141, the rigid part 151 is subjected to a pressure, internal stress is generated in the rigid part 151, and the first magnet 141 is pressed downward.

[0168] In this way, the rigid part 151 and the first magnet 141 under the pressure may generate counteracting force to resist the pressure, and provide supporting force for a second connection position 12b. The supporting force provided by the rigid part 151 for the second connection position 12b reduces or even eliminates the impact of movement of the second beam body 122 toward the first magnet 141 on deformation of the first beam body 121, so that an impact on accuracy of the sensor 13 on the first beam body 121 in detecting the pressing force of the user after the haptic feedback is activated can be reduced or even eliminated, thereby improving the accuracy of the solid-state button 10 in detecting the pressing force of the user after the haptic feedback is activated.

[0169] The vibration is bidirectional. Vibration generated by the haptic feedback component 14 also causes the second beam body 122 to move away from the first magnet 141.

[0170] When vibration of the haptic feedback component 14 vibrates to cause the second beam body 122 to move away from the first magnet 141, the rigid part 151 is subjected to pulling force, internal tensile stress is generated in the rigid part 151, and the first magnet 141 is pulled up.

[0171] In this way, the rigid part 151 and the first magnet 141 under the pulling force generate counteracting force to resist the pulling force, and generate pullback force on the second connection position 12b. The pullback force generated by the rigid part 151 at the second connection position 12b reduces or even eliminates the impact of movement of the second beam body 122 away from the first magnet 141 on deformation of the first beam body 121, so that an impact on accuracy of the sensor 13 on the first beam body 121 in detecting the pressing force of the user after the haptic feedback is activated can be reduced or even eliminated, thereby improving the accuracy of the solid-state button 10 in detecting the pressing force of the user after the haptic feedback is activated.

[0172] The rigid part 151 and the elastic beam 12 may be fixedly connected in a manner such as bolting

or welding. Alternatively, the rigid part 151 and the elastic beam 12 may be connected to each other to form an integral structure. Similarly, the rigid part 151 and the first magnet 141 may be fixedly connected in a manner such as bolting or welding. Alternatively, the rigid part 151 and the first magnet 141 may be connected to each other to form an integral structure.

[0173] For example, the rigid part 151 may include a column. A cross section of the column may be a circle, a rectangle, an ellipse, a regular polygon (for example, an equilateral triangle or a regular hexagon), or an irregular figure. This is not limited in embodiments of this application.

[0174] In some examples, a cross-sectional area (a dimension in a direction parallel to an extension direction of a button cap 11) of the rigid part 151 is positively correlated to effectiveness of decoupling between the haptic feedback component 14 and a sensor 13. It may be understood that the larger the cross-sectional area of the rigid part 151, the more stable the fixation of the second connection position 12b. Accordingly, deformation of the second beam body 122 causes a lower degree of deformation of the first beam body 121, thereby reducing an impact on accuracy of the sensor 13 in detecting pressing force of the user after the haptic feedback is activated.

[0175] Therefore, when the effectiveness of decoupling between the haptic feedback component 14 and the sensor 13 may be degraded due to large electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate, the effectiveness of decoupling between the haptic feedback component 14 and the sensor 13 may be improved by increasing the cross-sectional area of the rigid part 151, thereby ensuring accuracy of the sensor 13 in detecting the pressing force of the user after the haptic feedback is activated.

[0176] In other words, the cross-sectional area of the rigid part 151 may be positively correlated to vibration intensity of the second beam body 122 (or electromagnetic force between the first magnet 141 and the second magnet 142). In this way, the effectiveness of decoupling between the haptic feedback component 14 and the sensor 13 may be improved, thereby ensuring the accuracy of the sensor 13 in detecting the pressing force of the user after the haptic feedback is activated.

[0177] There may be two rigid parts 151, and the two rigid parts 151 are respectively located at two opposite sides of the second magnet 142.

[0178] In some examples, a spacing between the two rigid parts 151 is negatively correlated to the vibration intensity of the second beam body 122 (or the electromagnetic force between the first magnet 141 and the second magnet 142). It may be understood that if a spacing distance between the two rigid parts 151 is smaller, a length of the second beam body 122 is shorter, it is more difficult for the haptic feedback component 14 to drive the second beam body 122 to vibrate.

[0179] Therefore, when the electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate is constant, the vibration intensity of the second beam body 122 can be adjusted by adjusting the spacing distance between the two rigid parts 151, so that the second beam body 122 can transmit appropriate haptic feedback to the button cap 11, thereby improving haptic experience of the user when pressing the solid-state button 10.

[0180] For example, when the electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate is constant, the spacing distance between the two rigid parts 151 may be increased, to increase intensity of vibration of the second beam body 122 along with the second magnet 142, thereby strengthening haptic feedback provided by the haptic feedback component 14 to the user. Alternatively, the spacing distance between the two rigid parts 151 may be reduced, to weaken intensity of vibration of the second beam body 122 along with the second magnet 142, so as to reduce intensity of the haptic feedback provided by the haptic feedback component 14 to the user.

[0181] In addition, because in different solid-state buttons 10, the electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate is different, the spacing distance between the two rigid parts 151 may be adjusted based on the magnitude of the electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate in a solid-state button 10, so that the solid-state button 10 can provide appropriate haptic feedback to the user, thereby improving the user's haptic experience when pressing the solid-state button 10.

[0182] For example, in one solid-state button 10, when the electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate is large, the spacing distance between the two rigid parts 151 may be reduced, to weaken the intensity of vibration of the second beam body 122 along with the second magnet 142, so as to reduce intensity of the haptic feedback provided by the haptic feedback component 14 to the user. For another example, in another solid-state button 10, when the electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate is small, the spacing distance between the two rigid parts 151 may be increased, to increase intensity of vibration of the second beam body 122 along with the second magnet 142, thereby strengthening haptic feedback provided by the haptic feedback component 14 to the user.

[0183] FIG. 11 is a schematic diagram of a structure of another solid-state button according to an embodiment of this application. FIG. 12 is a schematic diagram of a three-dimensional structure of a rigid part and a first magnet in FIG. 11.

[0184] As shown in FIG. 11, a rigid part 151 and a first magnet 141 are of a same material, and are connected to each other to form an integrally formed structure. For example, the rigid part 151 and the first magnet 141 are both stainless steel, or a titan alloy.

[0185] FIG. 12 shows an integrally formed structure formed by the rigid part 151 and the first magnet 141. The two rigid parts 151 are respectively located at two ends of the first magnet 141 in a length direction, and protrude toward the elastic beam 12. A top of the rigid part 151 is fixedly connected to an elastic beam 12.

[0186] To avoid degradation of effectiveness of decoupling between a haptic feedback component 14 and a sensor 13 due to large electromagnetic force of the haptic feedback component 14 that drives the second beam body 122 to vibrate, the rigid part 151 and the first magnet 141 may be an integrally formed structure to increase fixation strength between the rigid part 151 and the first magnet 141 and overall rigidity of the stability structure, so as to improve the effectiveness of decoupling between the haptic feedback component 14 and the sensor 13, thereby ensuring the accuracy of the sensor 13 in detecting pressing force applied by a user after the haptic feedback is activated.

[0187] FIG. 13 is a schematic diagram of a structure of still another solid-state button according to an embodiment of this application.

[0188] In some examples, a rigid part 151 may include a lateral edge. The rigid part 151 as a frustum and the rigid part 151 as a column basically have the same functions for the elastic beam 12 and the first magnet 141, and moreover, can both decouple the stable structure from the sensor 13, thereby implementing haptic feedback for the user and improving accuracy of the sensor 13 in detecting pressing force applied by a user after the haptic feedback is activated. This is not described herein again in this application.

[0189] As shown in FIG. 13, in some examples, a fixation area between the rigid part 151 and the elastic beam 12 is smaller than a fixation area between the rigid part 151 and the first magnet 141. It may be understood that the fixation area between the rigid part 151 and the elastic beam 12 is a contact area between a second connection position 12b and the rigid part 151. For example, the rigid part 151 is welded to the elastic beam 12, and the fixation area between the rigid part 151 and the elastic beam 12 is a welding area. For another example, the rigid part 151 is bolted to the elastic beam 12, and the fixation area between the rigid part 151 and the elastic beam 12 is a contact area between a secure member in a bolt and the elastic beam 12.

[0190] Providing a relatively large fixation area between the rigid part 151 and the first magnet 141 can increase fixation strength between a support structure 15 and the first magnet 141, to reduce a degree of deformation of the first magnet 141 when a user presses the button. In addition, there are many parts

connected to the elastic beam 12 but a length of the elastic beam 12 is limited. Reducing the fixation area between the rigid part 151 and the elastic beam 12 can facilitate fixed connection of the support structure 15 with the elastic beam 12 in a limited space.

[0191] In some other examples, the fixation area between the rigid part 151 and the elastic beam 12 is greater than the fixation area between the rigid part 151 and the first magnet 141. It may be understood that the fixation area between the rigid part 151 and the elastic beam 12 is an area of the second connection position 12b on a plane parallel to a pressing surface.

[0192] Providing a relatively large fixation area between the rigid part 151 and the elastic beam 12 can increase fixation strength between the support structure 15 and the elastic beam 12, to reduce as much as possible an impact of vibration of the second beam body 122 on deformation of the first beam body 121, so as to reduce or even eliminate the impact on the accuracy of a sensor on the first beam body 121 in detecting the pressing force of the user, thereby improving the accuracy of the solid-state button in detecting the pressing force of the user after the haptic feedback is activated.

[0193] FIG. 14 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application.

[0194] Electromagnetic force generated by a haptic feedback component 14 may be variable force. Therefore, for support structures 15 to decouple the haptic feedback component 14 from sensors 13, second connection positions 12b between first beam bodies 121 and a second beam body 122 need to be fixed flexibly.

[0195] Therefore, in some examples, the support structure 15 may include an elastic part 152. The elastic part 152 may be a splinter, a spring, or the like. This is not limited herein. The elastic part 152 may be used in a scenario in which the haptic feedback component 14 generates small electromagnetic force. Specifically, the elastic part 152 may be used in a scenario in which the haptic feedback component 14 generates electromagnetic force that is smaller than elastic force of the elastic part 152.

[0196] As shown in FIG. 14, the elastic part 152 includes a first fixing portion 1521, a second fixing portion 1522, and a connection portion 1523 connecting the first fixing portion 1521 and the second fixing portion 1522. The first fixing portion 1521 is fixedly connected to the elastic beam 12, and the second fixing portion 1522 is fixedly connected to a first magnet 141. It may be understood that a position at which the first fixing portion 1521 is fixedly connected to the elastic beam 12 is the second connection position 12b.

[0197] It should be noted that the first fixing portion 1521 and the second fixing portion 1522 may be arranged at least partially in alignment with each other, or as shown in FIG. 14, the first fixing portion 1521 and the second fixing portion 1522 may be arranged in a

staggered manner. For example, the second fixing portion 1522 is located on a side of the first fixing portion 1521 close to the second magnet 142. For another example, the second fixing portion 1522 is located on a side of the first fixing portion 1521 away from the second magnet 142. The first fixing portion 1521 and the second fixing portion 1522 are arranged in a staggered manner, so that a size of the elastic part 152 can be increased, thereby increase a magnitude of elastic supporting force provided by the elastic part 152 for the second connection position 12b.

[0198] When the user does not press the solid-state button 10, the elastic part 152 may be in an unstressed state, and there is no internal stress in the elastic part 152. It may be understood that there is no pulling force or pressure between the first fixing portion 1521 and the connection portion 1523, and there is no pulling force or pressure between the second fixing portion 1522 and the connection portion 1523.

[0199] When the haptic feedback component 14 vibrates to cause the second beam body 122 to move toward the first magnet 141, the elastic part 152 is subjected to a pressure, and internal stress is generated in the elastic part 152. The first fixing portion 1521 under the pressure of the elastic beam 12 presses the connection portion 1523 downward, and the connection portion 1523 presses the second fixing portion 1522 downward.

[0200] In this way, the elastic part 152 under the pressure generates counter-acting force to resist the pressure, and provides supporting force for the second connection position 12b. The supporting force provided by the elastic part 152 for the second connection position 12b reduces or even eliminates the impact of movement of the second beam body 122 toward the first magnet 141 on deformation of the first beam body 121, so as to reduce or even eliminate an impact on accuracy of the sensor 13 on the first beam body 121 in detecting the pressing force of the user, thereby improving the accuracy of the solid-state button 10 in detecting the pressing force of the user after the haptic feedback is activated.

[0201] The vibration is bidirectional. Vibration generated by the haptic feedback component 14 also causes the second beam body 122 to move away from the first magnet 141.

[0202] When the haptic feedback component 14 vibrates to cause the second beam body 122 to move away from the first magnet 141, the elastic part 152 is subjected to pulling force, and internal tensile stress is generated in the elastic part 152. Under pulling force of the elastic beam 12, the first fixing portion 1521 pulls up the connection portion 1523, and the connection portion 1523 pulls up the second fixing portion 1522.

[0203] In this way, the elastic part 152 under the pulling force generates counter-acting force to resist the pulling force, and generates pullback force on the second connection position 12b. The pullback force gener-

ated by the elastic part 152 at the second connection position 12b reduces or even eliminates the impact of movement of the second beam body 122 away from the first magnet 141 on deformation of the first beam body 121, so that an impact on accuracy of the sensor 13 on the first beam body 121 in detecting the pressing force of the user after the haptic feedback is activated can be reduced or even eliminated, thereby improving the accuracy of the solid-state button 10 in detecting the pressing force of the user after the haptic feedback is activated.

[0204] FIG. 15 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application.

[0205] In some examples, as shown in FIG. 15, a support structure 15 may include both a rigid part 151 made of a rigid material and an elastic part 152 made of an elastic material.

[0206] The elastic part 152 may be located on a side of the rigid part 151 close to a second magnet 142, or the elastic part 152 may be located on a side of the rigid part 151 away from the second magnet 142. This is not limited in embodiments of this application.

[0207] For connection relationships between the rigid part 151, an elastic beam 12, and a first magnet 141 in FIG. 15, reference may be made to connection relationships between the rigid part 151, the elastic beam 12, and the first magnet 141 in FIG. 5 to FIG. 7. Details are not described herein again. Similarly, for connection relationships between the elastic part 152, the elastic beam 12, and the first magnet 141 in FIG. 15, reference may be made to connection relationships between the elastic part 152, the elastic beam 12, and the first magnet 141 in FIG. 14. Details are not described herein again.

[0208] When electromagnetic force is large and supporting force of the rigid part 151 is insufficient, the elastic part 152 increases supporting force of the support structure 15 for the entire elastic beam 12, to increase fixation strength for the second connection position 12b. Alternatively, when electromagnetic force is large and pullback force of the rigid part 151 is insufficient, the elastic part 152 increases pullback force of the support structure 15 for the entire elastic beam 12, to increase fixation strength for the second connection position 12b.

[0209] In the solid-state button 10 shown in FIG. 15, the support structure 15 includes both the rigid part 151 and the elastic part 152. The rigid part 151 can be used to ensure basic fixation strength for the second connection position 12b on the elastic beam 12, thereby significantly eliminating an impact of vibration of the second beam body 122 on deformation of the first beam body 121. In addition, the elastic part 152 can be used to optimize a magnitude of fixation force of the rigid part 151 on the second connection position 12b, so that the support structure 15 flexibly adapts to rigidity required for decoupling the haptic feedback component 14 from

the sensor 13 under different vibration intensity.

[0210] FIG. 16 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application.

[0211] Alternatively, two support structures 15 in a solid-state button 10 may be located between two connection bodies 112. It may be understood that two second connection positions 12b on an elastic beam 12 are located between two first connection positions 12a of the elastic beam 12, and the first connection positions 12a are located on a first beam body 121.

[0212] A second magnet 142 interacts with a first magnet 141 to drive a second beam body 122 of the elastic beam 12 to vibrate. The support structure 15 fixes and supports a position between the second beam body 122 and the first beam body 121 of the elastic beam 12, to reduce or even eliminate the impact of vibration of the second beam body 122 on deformation of the first beam body 121, so that an impact of the haptic feedback on the accuracy of the sensor 13 on the first beam body 121 in detecting the pressing force after the haptic feedback is activated can be reduced or even eliminated, thereby improving accuracy of the solid-state button 10 in detecting the pressing force of the user after the haptic feedback is activated.

[0213] When the button cap 11 is subjected to pressing force of the user, the button cap 11 provides a pressure to the first beam body 121 of the elastic beam 12. Because the sensor 13 is also located on the first beam body 121, the sensor 13 can more sensitively sense deformation of the first beam body 121 caused by the pressing force of the user, thereby improving accuracy of detecting the pressing force of the user.

[0214] When the button cap 11 is subjected to the pressing force of the user, a signal controller outputs an alternating current signal to a coil of the second magnet 142 to cause the second magnet 142 and the first magnet 141 to vibrate. The vibration is transmitted back to the button cap 11 through the second beam body 122 and the first beam body 121 in sequence, so that a finger of the user can slightly sense haptic feedback.

[0215] Therefore, the solid-state button provided in embodiments of this application can ensure enhanced haptic feedback to the user and improve the accuracy of detecting the pressing force of the user.

[0216] FIG. 17 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application.

[0217] As shown in FIG. 17, the elastic beam 12 may include a plurality of parts. For example, the elastic beam 12 includes a first elastic portion 123 and two second elastic portions 124 respectively connected to two ends of the first elastic portion 123. The second elastic portions 124 are connected to both the first elastic portion 123 and the board body 22. The second elastic portion 124 may be fixedly connected to the first elastic portion 123. Similarly, the second elastic portion

124 may be fixedly connected to the board body 22.

[0218] As shown in FIG. 17, the second magnet 142 may be disposed on the first elastic portion 123. When the second magnet 142 vibrates, the second magnet 142 may drive the first elastic portion 123 to vibrate.

[0219] A sensor 13 may be disposed on the second elastic portion 124. The sensor 13 may detect pressing force applied by a user to a solid-state button 10 by detecting a deformation amount of the second elastic portion 124.

[0220] In some examples, the rigidity of the first elastic portion 123 may be the same as the rigidity of the second elastic portion 124. For example, the first elastic portion 123 and the second elastic portion 124 are manufactured using a same material. In some other examples, the rigidity of the first elastic portion 123 may be different from the rigidity of the second elastic portion 124. For example, the rigidity of the first elastic portion 123 is greater than the rigidity of the second elastic portion 124.

[0221] In some examples, the first elastic portion 123 and the second elastic portion 124 overlap with each other on a plane parallel to the cap body 111, and a part of the first elastic portion 123 and a part of the second elastic portion 124 that overlap with each other may be fixedly connected through welding. Alternatively, as shown in FIG. 17, the solid-state button 10 may further include a first connection piece 16. In addition, a part of the first elastic portion 123 and the second elastic portion 124 that overlap with each other is connected to the first connection piece 16. For example, the first connection piece 16 may be bolted to the first elastic portion 123 and the second elastic portion 124, so that the first elastic portion 123 and the second elastic portion 124 are fixedly connected to each other by using the first connection piece 16.

[0222] Further, the first connection piece 16 may be fixedly connected to the connection body 112 in the button cap 11. It may be understood that the connection body 112 in the button cap 11 and the elastic beam 12 are spaced apart from each other, and are fixedly connected by using the first connection piece 16. In this way, the first connection piece 16 is fixedly connected to the connection body 112 in the button cap 11, the first elastic portion 123, and the second elastic portion 124, so that the fixed connection between the connection body 112, the first elastic portion 123, and the second elastic portion 124 can be implemented.

[0223] As shown in FIG. 17, an electronic device 20 may include a second connection piece 17. The second connection piece 17 is fixedly connected to the board body 22, and the second connection piece 17 may further be fixedly connected to the second elastic portion 124, so that the second elastic portion 124 is indirectly fixedly connected to the board body 22 by using the second connection piece 17.

[0224] Further, the second connection piece 17 may also be fixedly connected to a housing 30. The second

connection piece 17 may support the housing 30. When the user presses the solid-state button 10, an edge of a finger may contact the housing 30, so that pressing force may be also applied to the housing 30, to cause the housing 30 surrounding the solid-state button 10 to deform downward. The second connection piece 17 is located on the periphery of the solid-state button 10. By providing supporting for the housing 30, a problem that the housing 30 on the periphery moves downward when the user presses the solid-state button 10 can be mitigated or even avoided, and structural strength of the housing 30 is improved, thereby improving reliability of the electronic device 100.

[0225] Certainly, the second elastic portion 124 may alternatively be fixedly connected to the board body 22 of the electronic device 100 in another manner such as welding or bolting. This is not limited herein. For ease of understanding, the foregoing embodiments are fixedly connected to the board body 22 in the middle frame 20 by using the elastic beam 12. However, it should be noted that, in some other examples, the elastic beam 12 may alternatively be fixedly connected to the border frame 21 in the middle frame 20, and may be specifically disposed based on a specific actual construction of the electronic device.

[0226] Essentially, the elastic beam 12 formed by a plurality of parts in FIG. 17 has a substantially identical function as the elastic beam 12, which is an integrally formed structure in FIG. 5. Therefore, when the solid-state button 10 shown in FIG. 17 includes the support structures 15, the solid-state button 10 shown in FIG. 17 can ensure enhanced haptic feedback to the user and improve the accuracy of detecting the pressing force of the user.

[0227] In addition, because the elastic beam 12 includes a plurality of parts, the plurality of parts may be simultaneously manufactured, thereby improving manufacturing efficiency of the elastic beam 12. In addition, compared with the entire structure of the elastic beam, the structure of each part is simpler, and therefore, the part is simpler to manufacture, thereby reducing difficulty in manufacturing the elastic beam 12.

[0228] FIG. 18 is a schematic diagram of a structure of yet another solid-state button according to an embodiment of this application.

[0229] The sensor 13 in the solid-state button 10 may be a pressure sensor printed with polymer ink. The pressure sensor printed with polymer ink has an advantage of low costs. However, the pressure sensor printed with polymer ink also has problems of poor accuracy of detecting the pressing force and large temperature drift (also be referred to as zero drift). The temperature drift is a change of a parameter of a semiconductor device caused by a temperature change, and may reduce detection accuracy of a sensor.

[0230] As shown in FIG. 18, the sensor 13 in the solid-state button 10 may further be at least one of microelectro mechanical systems (microelectro me-

chanical systems, MEMS) piezoresistive sensor, a metal strain gauge pressure sensor, an optical sensor, an ultrasonic deformation sensor, or a piezoelectric pressure sensor. These sensors have high detection accuracy, and can improve accuracy of the solid-state button 10 in detecting the pressing force of the user.

[0231] In conclusion, embodiments of this application provide a solid-state button and an electronic device on which the solid-state button is mounted. The use of the support structure 15 enables the haptic feedback component 14 and the sensor 13 to be decoupled as much as possible, so that an impact of vibration of the elastic beam 12 driven by the haptic feedback component 14 on accuracy of the sensor 13 in detecting the pressing force of the user after haptic feedback is activated is reduced or even eliminated. Accordingly, the solid-state button 10 can provide enhanced haptic feedback and accurately detect the pressing force of the user.

[0232] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

Claims

1. A button, comprising:

a button cap, having a pressing surface for a user to press;
 an elastic beam, connected to the button cap;
 a haptic feedback component, comprising a first magnet and a second magnet, wherein the first magnet and the second magnet are arranged opposite to and spaced apart from each other, and the second magnet is disposed on the elastic beam;
 sensors, located on the elastic beam, and configured to sense a deformation amount of the elastic beam; and
 support structures, each separately fixedly connected to the elastic beam and the first magnet, wherein a connection position of the support structure on the elastic beam is located between the sensor and the second magnet.

2. The button according to claim 1, wherein the support structure comprises a rigid part, a first end of the rigid part is fixedly connected to the elastic beam, and a second end of the rigid part is fixedly connected to the first magnet.

3. The button according to claim 2, wherein the rigid

part and the first magnet are connected to each other to form an integral structure.

4. The button according to claim 2 or 3, wherein a fixation area between the rigid part and the elastic beam is smaller than a fixation area between the rigid part and the first magnet; or the fixation area between the rigid part and the elastic beam is greater than the fixation area between the rigid part and the first magnet. 5 10
5. The button according to any one of claims 1 to 4, wherein the support structure comprises an elastic part; and the elastic part comprises a first fixing portion fixed to the elastic beam, a second fixing portion fixed to the first magnet, and a connection portion connecting the first fixing portion and the second fixing portion. 15
6. The button according to claim 5, wherein the first fixing portion and the second fixing portion are arranged in a staggered manner on a plane parallel to the pressing surface. 20
7. The button according to any one of claims 1 to 6, wherein a connection position of the sensor on the elastic beam is spaced apart from a connection position of the support structure on the elastic beam; and/or a connection position of the button cap on the elastic beam is spaced apart from the connection position of the support structure on the elastic beam. 25 30
8. The button according to any one of claims 1 to 7, wherein the button cap comprises a cap body and at least one connection body, and the connection body is separately connected to the cap body and the elastic beam; and the connection body is located between the support structure and the second magnet. 35 40
9. The button according to any one of claims 1 to 8, wherein a dimension of the first magnet in a direction perpendicular to the pressing surface is greater than or equal to 0.3 mm. 45
10. The button according to any one of claims 1 to 9, wherein a spacing distance between the first magnet and the second magnet is greater than or equal to 0.05 mm in the direction perpendicular to the pressing surface. 50
11. The button according to any one of claims 1 to 10, wherein the sensor comprises at least one of a microelectro mechanical systems piezoresistive sensor, a metal strain gauge pressure sensor, an optical sensor, and an ultrasonic deformation sensor. 55

12. The button according to any one of claims 1 to 11, wherein the elastic beam comprises a first elastic portion and two second elastic portions fixedly connected to two ends of the first elastic portion, respectively; and

the second magnet is disposed on the first elastic portion, the sensor is disposed on the second elastic portion, and the support structure is fixedly connected to the second elastic portion.

13. An electronic device, comprising:

a housing; and
the button according to any one of claims 1 to 12, wherein the housing exposes at least a part of a button cap of the button.

14. The electronic device according to claim 13, wherein the button is a solid-state button.

15. The electronic device according to claim 13 or 14, wherein the housing further comprises a back cover and a middle frame; and the elastic beam of the button is fixedly connected to the middle frame, and the first magnet and the middle frame are independent of each other.

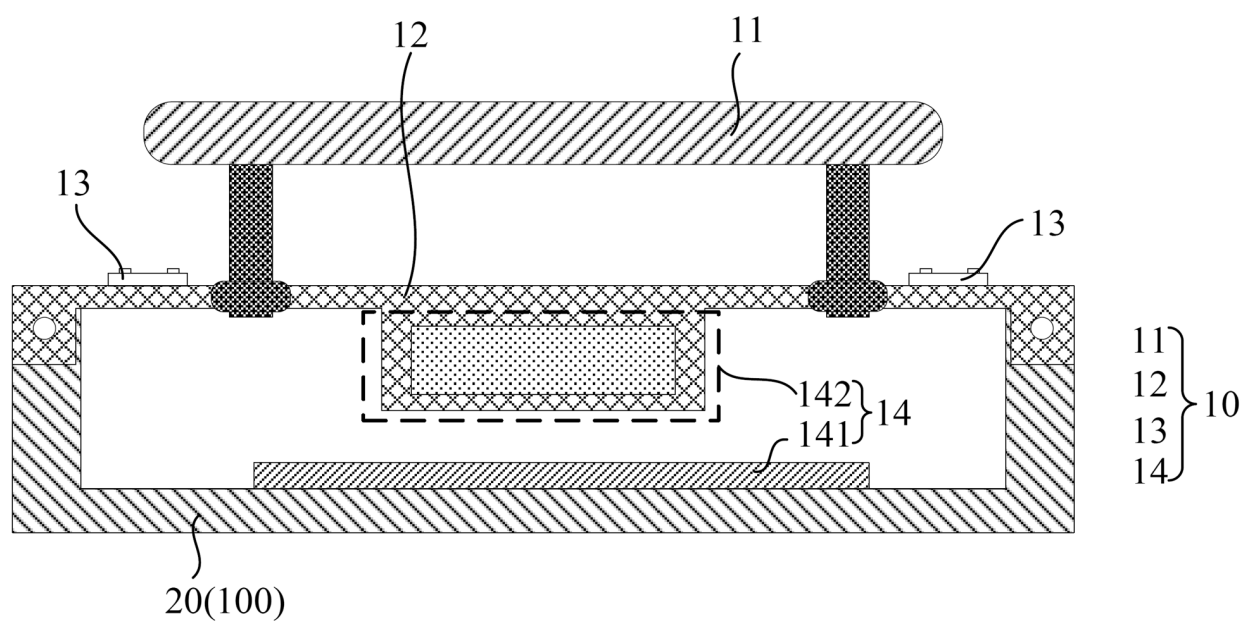


FIG. 1

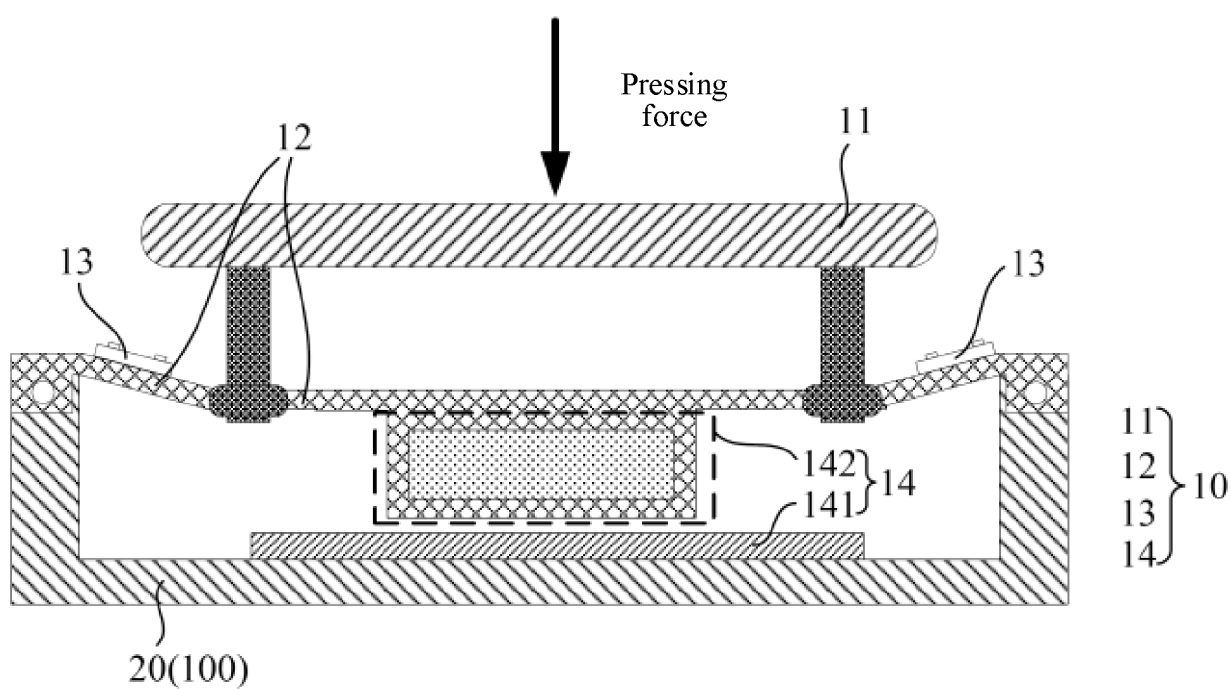


FIG. 2

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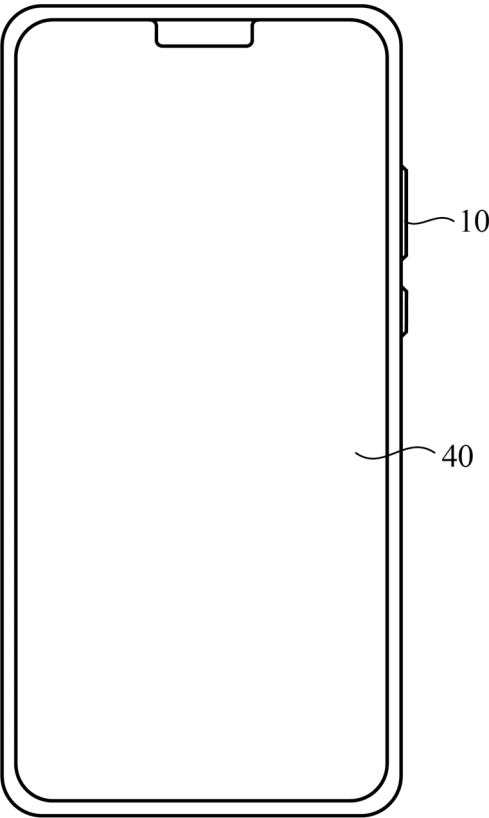


FIG. 3

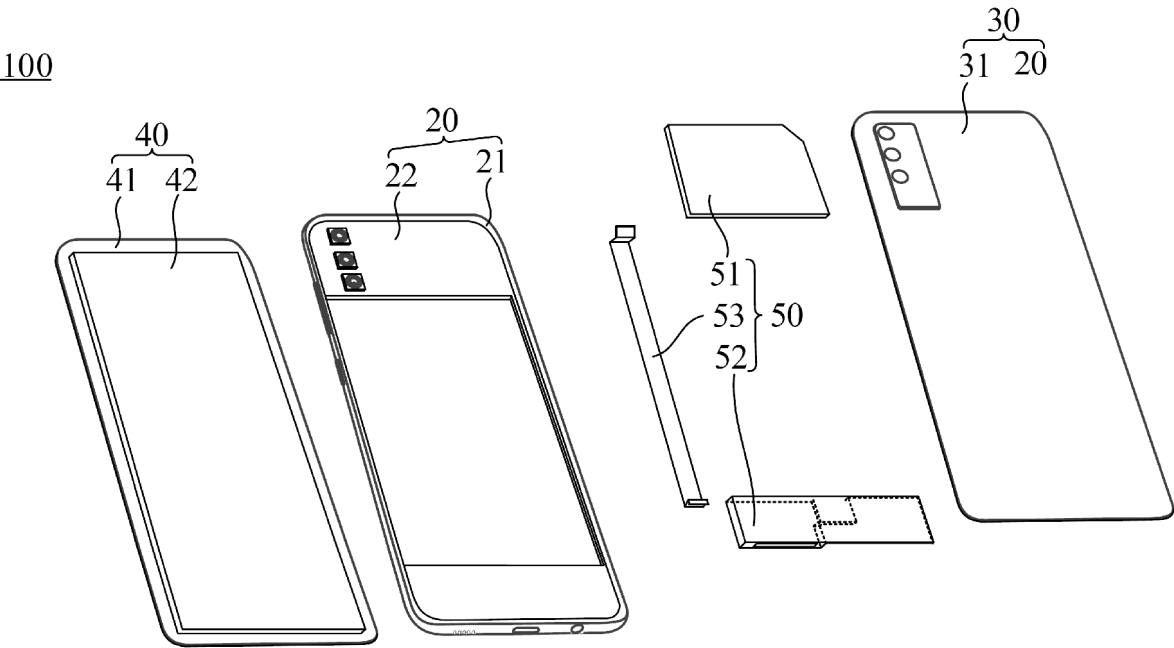


FIG. 4

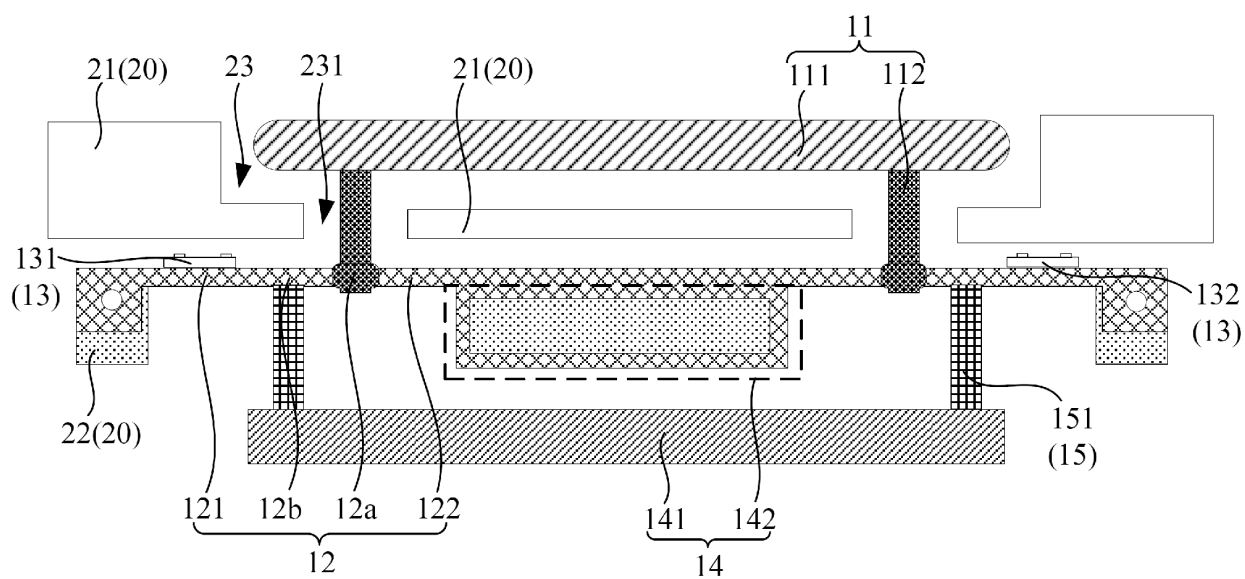


FIG. 5

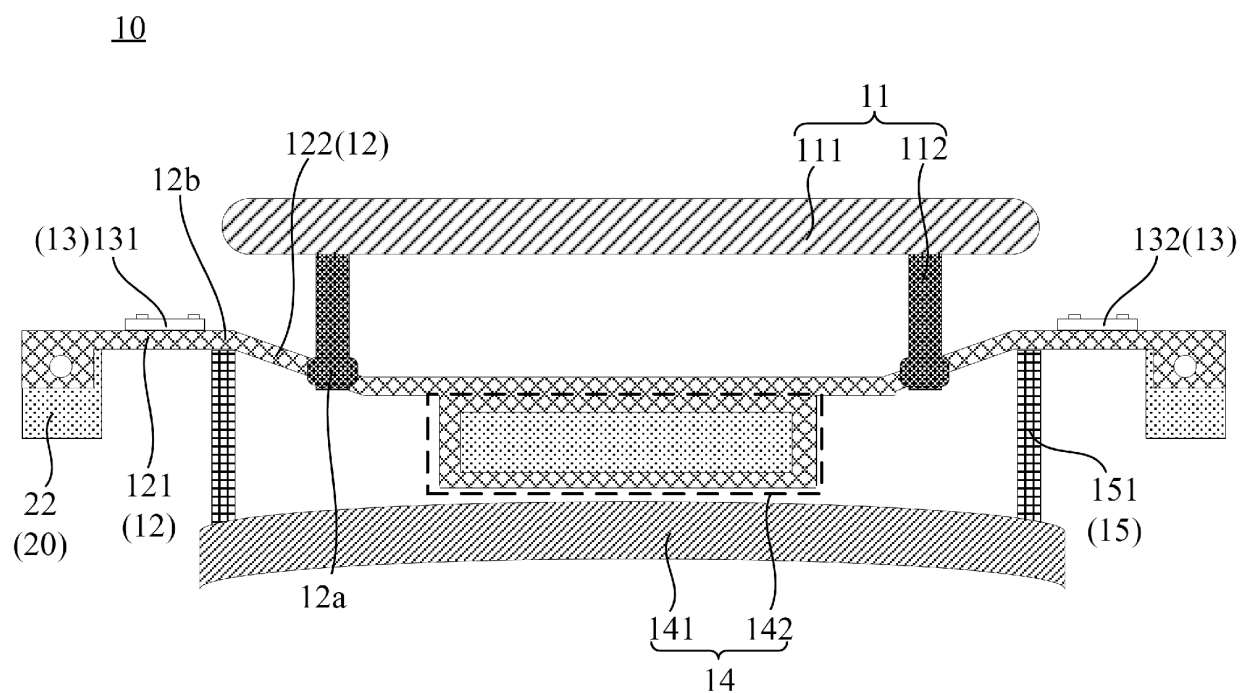


FIG. 6

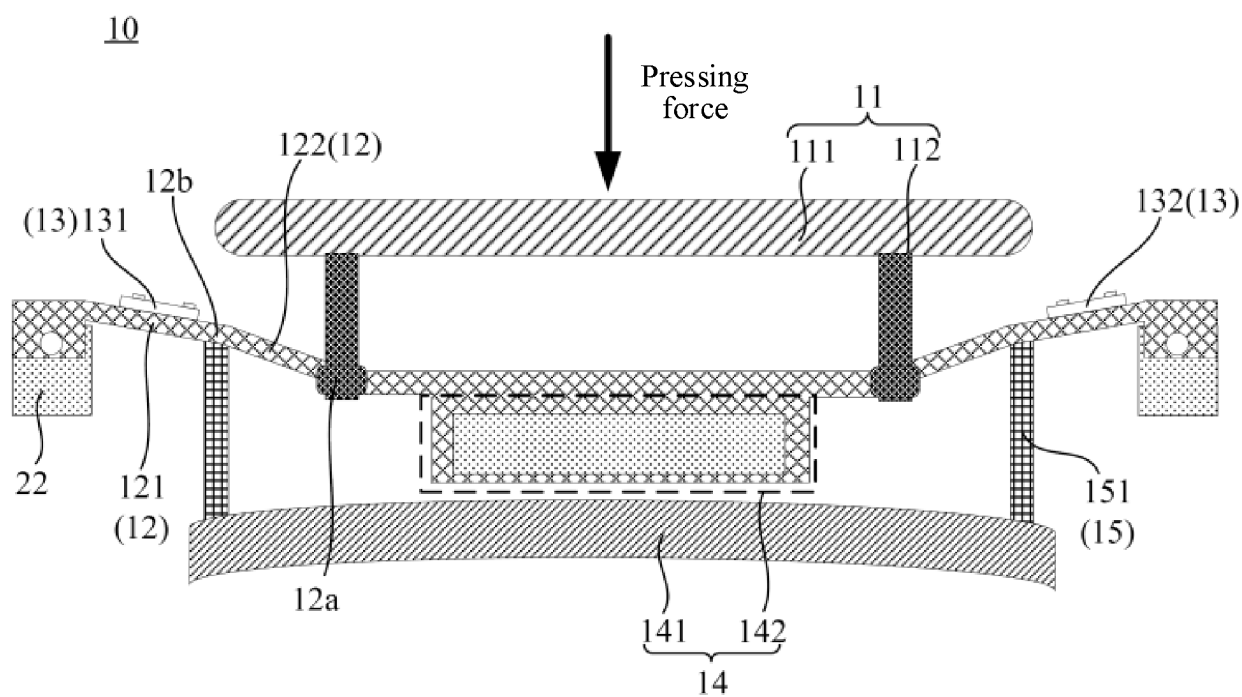


FIG. 7

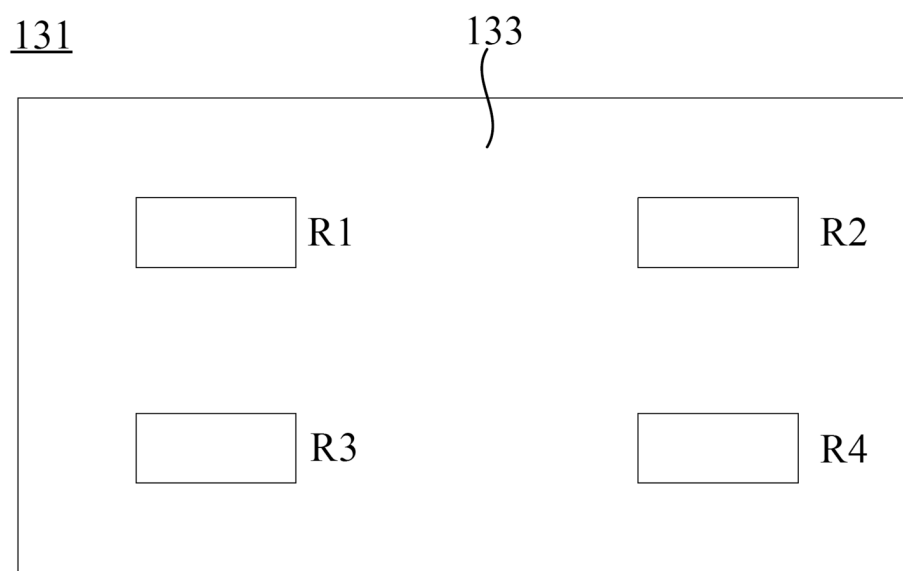


FIG. 8

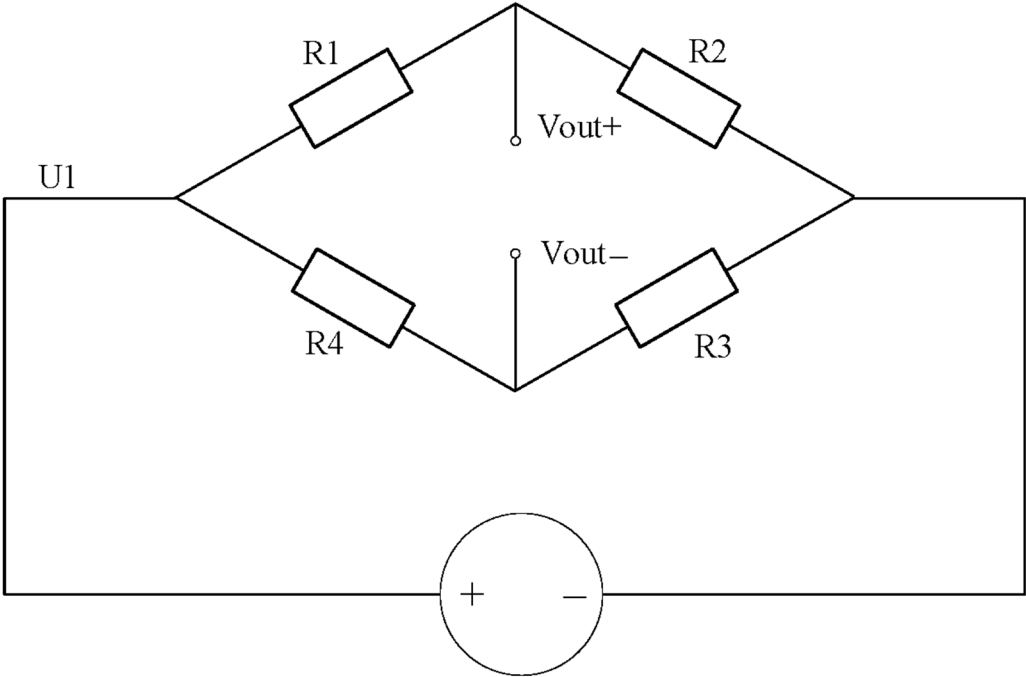


FIG. 9

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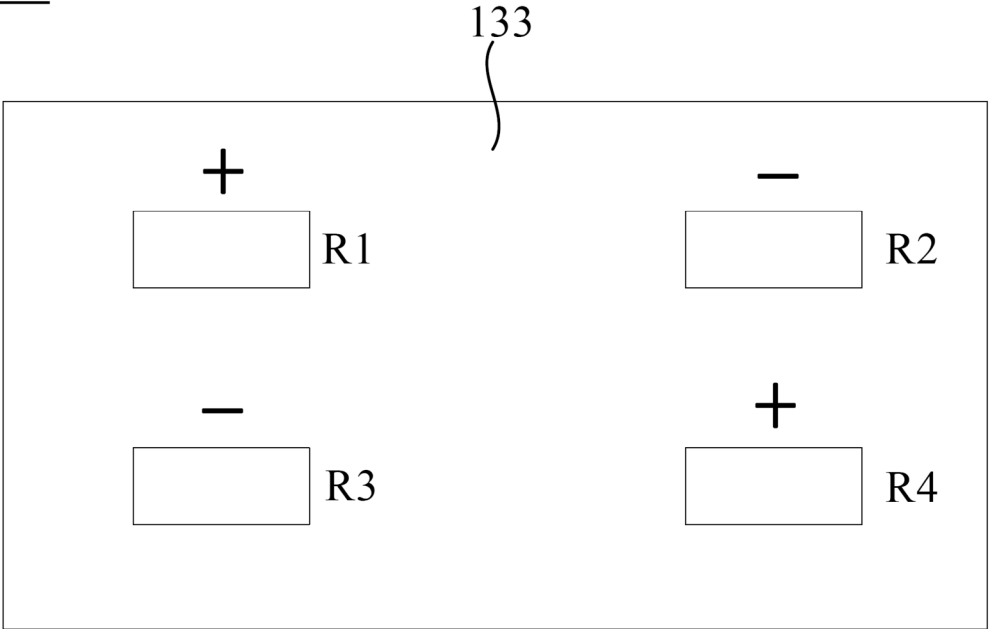


FIG. 10

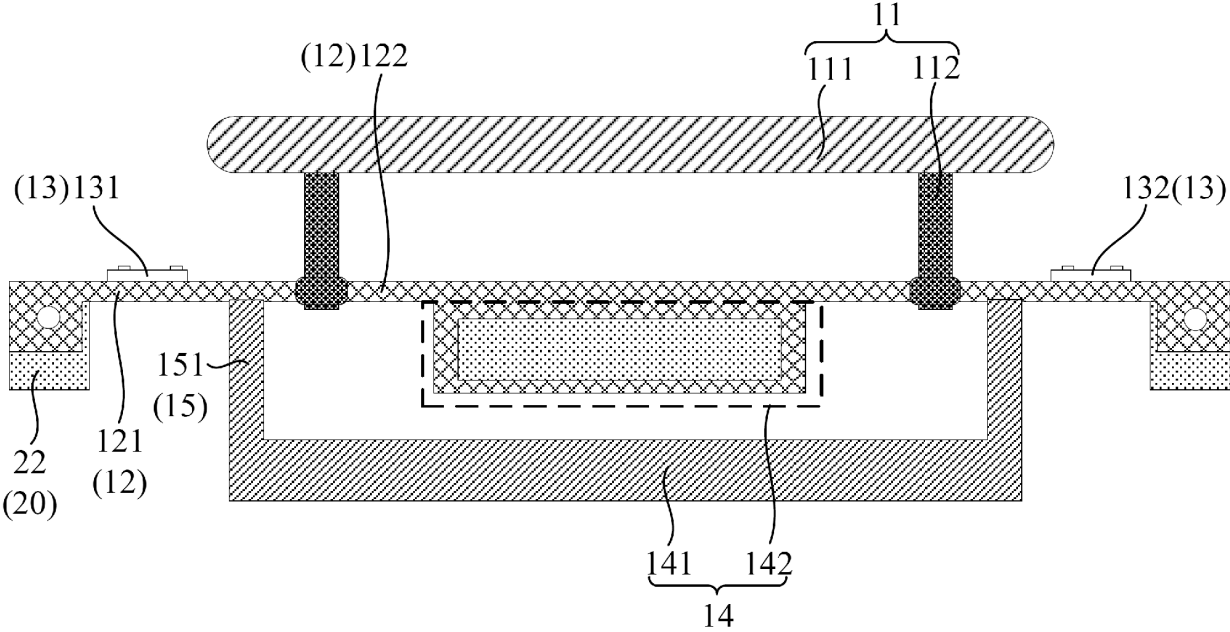


FIG. 11

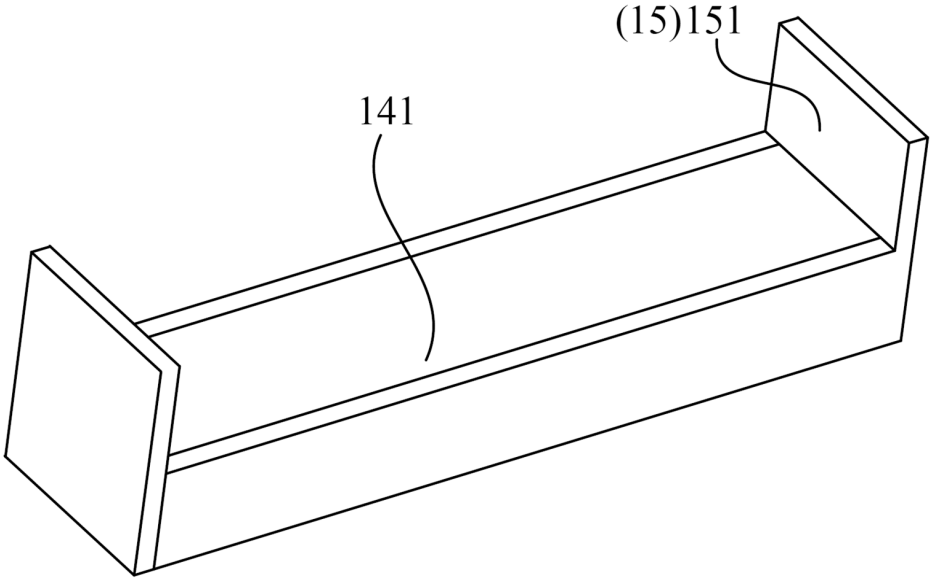


FIG. 12

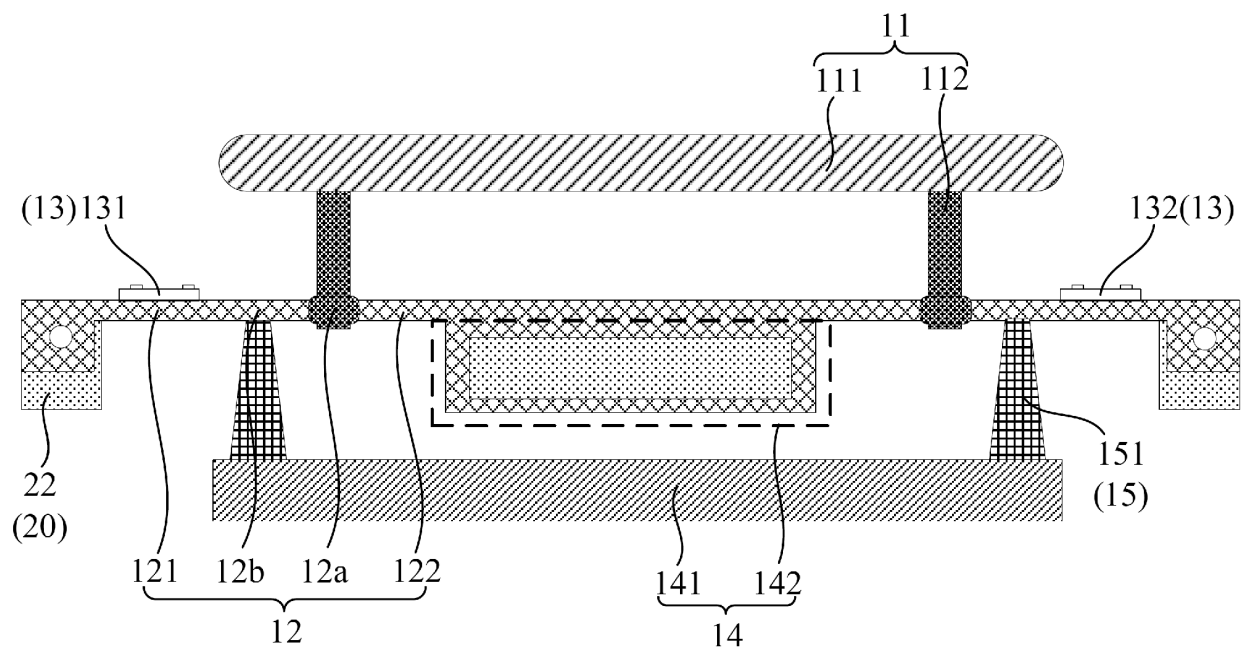


FIG. 13

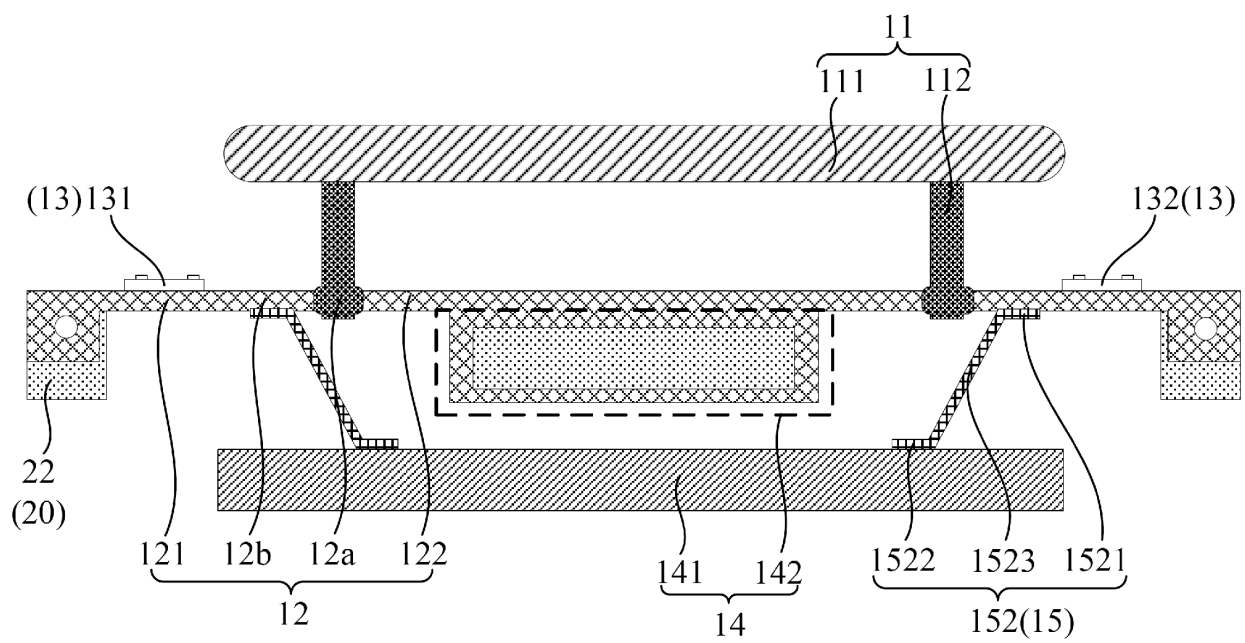


FIG. 14

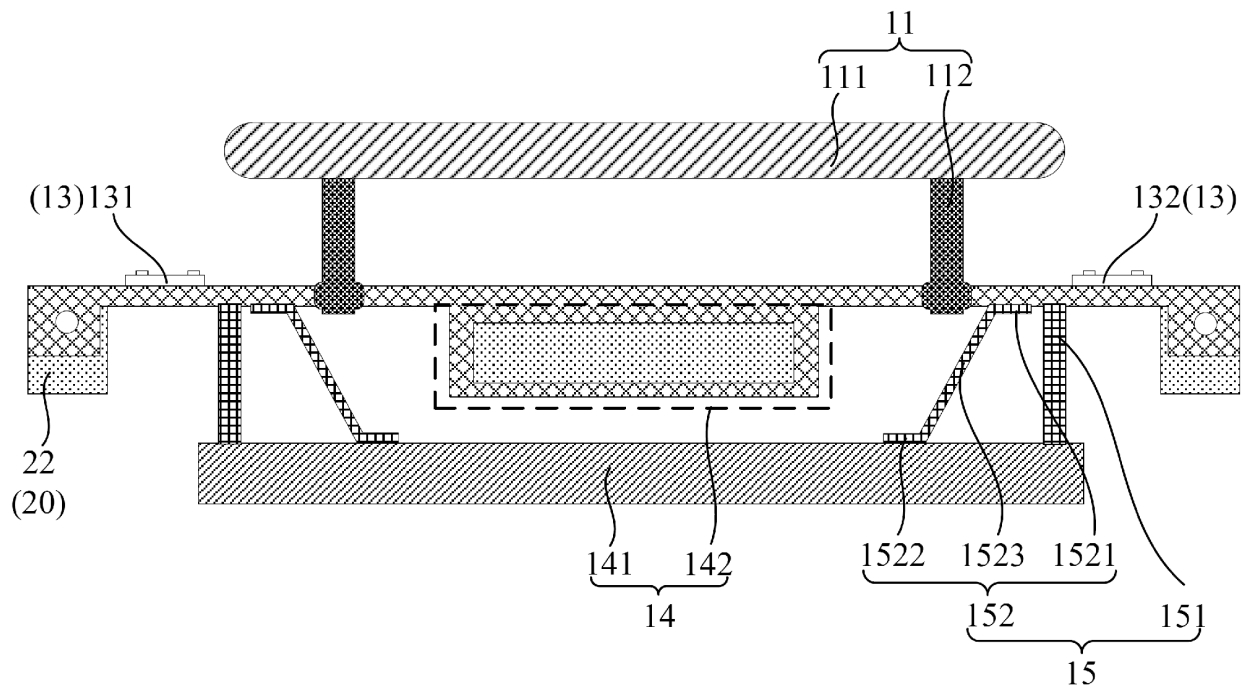


FIG. 15

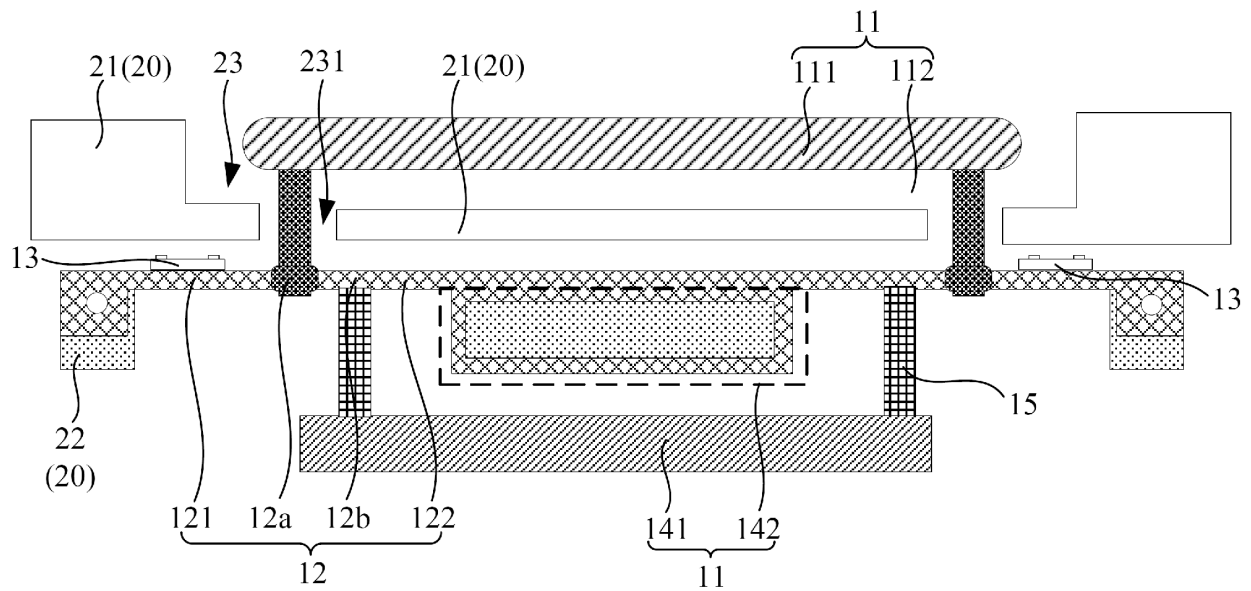


FIG. 16

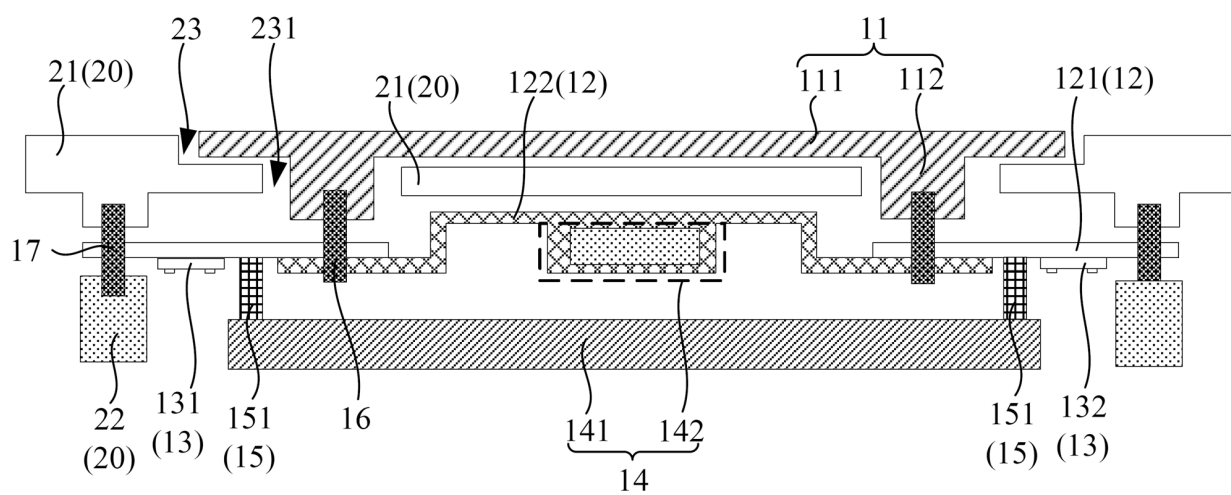


FIG. 17

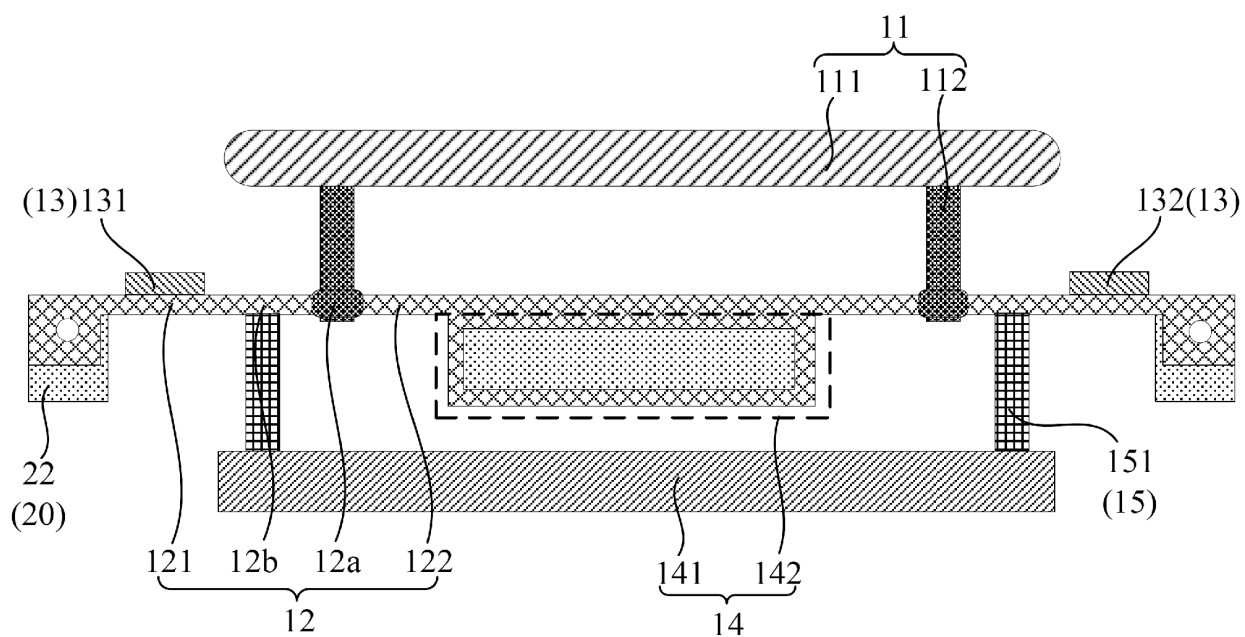


FIG. 18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/077044

A. CLASSIFICATION OF SUBJECT MATTER

H01H13/85(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

VEN, CNABS, CNTXT, WOTXT, EPTXT, USTXT, CNKI, IEEE: 按键, 按钮, 传感器, 磁, 磁体, 弹性梁, 反馈, 隔绝, 隔离, 缓冲, 减少, 键帽, 降低, 解耦, 梁, 压感, 压感反馈, 振动, 支撑, 支撑柱, beam, between, deformation, portion, pressing, sensor, spring, bent+, pressing force, support+, supporting beam, magnet+, detect+, support structure, spring beam, key module, key press

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2023094873 A1 (APPLE INC.) 30 March 2023 (2023-03-30) description, paragraphs [0073]-[0093], and figures 2A-2C	1-15
A	CN 117133567 A (VIVO MOBILE COMMUNICATION CO., LTD.) 28 November 2023 (2023-11-28) entire document	1-15
A	CN 101409164 A (TANG YIHUA) 15 April 2009 (2009-04-15) entire document	1-15
A	CN 218384924 U (BOE TECHNOLOGY GROUP CO., LTD. et al.) 24 January 2023 (2023-01-24) entire document	1-15

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"D" document cited by the applicant in the international application	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 13 May 2025	Date of mailing of the international search report 16 May 2025
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2025/077044

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)
US	2023094873	A1	30 March 2023	US	11809631 B2	07 November 2023
CN	117133567	A	28 November 2023	None		
CN	101409164	A	15 April 2009	None		
CN	218384924	U	24 January 2023	None		

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202410236129 [0001]