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(54) **SCREEN SOUND-GENERATING DEVICE**

(57) This application provides a screen sounding device. A vibrator and a hard substance that has a specific Young's modulus and area size are disposed under a screen. The vibrator drives, by using the hard substance, the screen to vibrate in a direction perpendicular to a surface of the screen. Therefore, in a process in which

the vibrator vibrates the screen by using the hard substance, a vibration area of the screen can be increased by using the hard substance, to enable, as much as possible, most regions of the screen to be vibrated, thereby generating a better vibration effect.

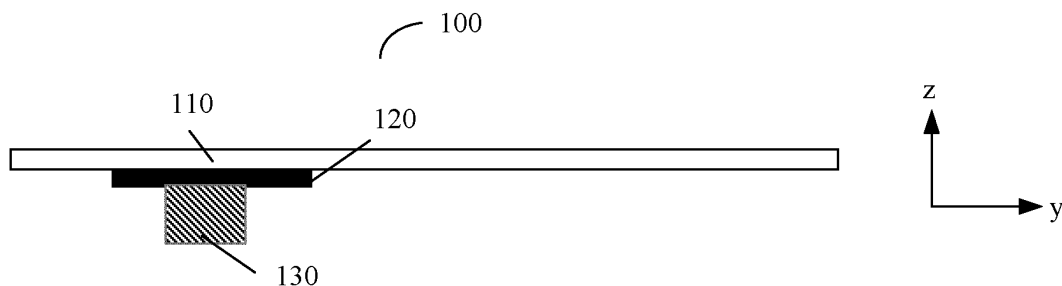


FIG. 1

Description

[0001] This application claims priority to Chinese Patent Application No. 201910229225.7, filed with the China National Intellectual Property Administration on March 25, 2019 and entitled "SCREEN SOUNDING DEVICE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the field of electronic devices, and more specifically, to a screen sounding device.

BACKGROUND

[0003] Based on design requirements of a full-screen mobile phone and a non-perforated appearance, a conventional technology provides a screen sounding technology of generating a sound through screen vibration, to replace a conventional technology of starting a receiver in a mobile phone to generate a sound. In the screen sounding technology, the screen is driven, through vibration of a vibrator disposed inside a mobile phone, to vibrate to generate a sound wave, to be transmitted to human ears.

[0004] In a current screen sounding technology, a vibrator is adhered to a middle frame of a mobile phone, and the vibrator drives the middle frame to drive a screen to vibrate, causing a poor vibration effect.

[0005] Therefore, there is an urgent need to provide a device that is based on a screen sounding technology, to improve a vibration effect.

SUMMARY

[0006] This application provides a screen sounding device, and a hard substance is disposed between a screen and a vibrator, to effectively improve a vibration effect of the screen.

[0007] According to a first aspect, a screen sounding device is provided. The screen sounding device includes:

a screen, a hard substance, and a vibrator, where the hard substance is disposed between the screen and the vibrator, the vibrator is adhered to the screen by using the hard substance, the vibrator drives, by using the hard substance, the screen to vibrate in a direction perpendicular to a surface of the screen, a Young's modulus of the hard substance is greater than a preset value, and an area of a projection of the hard substance on the surface of the screen is greater than an area of a projection of the vibrator on the surface of the screen and is less than an area of the surface of the screen.

[0008] Therefore, in the screen sounding device provided in this embodiment of this application, the vibrator

is disposed under the screen. Compared with a structure in which the vibrator is adhered to a middle frame, because the middle frame does not need to be vibrated to drive the screen to vibrate, a vibration displacement can be increased, an energy loss can be reduced, and vibration of the middle frame and a rear cover can be alleviated, thereby improving a vibration effect. In addition, the vibrator is adhered under the screen by using the hard substance that has a specific Young's modulus and area size. Therefore, in an aspect, the screen can be better supported by using the hard substance. In another aspect, in a process in which the vibrator vibrates the screen by using the hard substance, a vibration area of the screen can be increased by using the hard substance, to enable, as much as possible, most regions of the screen to be vibrated, thereby generating a better vibration effect. This design has better applicability especially for a screen sounding device with a flexible screen. In still another aspect, the vibrator emits heat in the vibration process. If a heat emitting part (for example, a part in which a coil is disposed) of the vibrator is close to a screen side, the hard substance disposed between the screen and the vibrator can alleviate damage to the screen caused by heat emitting of the vibrator.

[0009] Optionally, the screen sounding device further includes the middle frame disposed under the screen, a first hole or a first groove is disposed in the middle frame, and the first hole or the first groove accommodates the vibrator.

[0010] Therefore, in the screen sounding device provided in this embodiment of this application, a groove or a hole (for example, the first groove or the first hole) that can accommodate the vibrator is disposed in the middle frame, to use space of the groove or the hole in a thickness direction of the device to compensate for space occupied by the vibrator in the thickness direction of the device, thereby effectively reducing a size of the device in the thickness direction.

[0011] Optionally, in a thickness direction of the screen, there is a gap between the hard substance and a surface that is of the middle frame and that faces the hard substance.

[0012] Therefore, in the screen sounding device provided in this embodiment of this application, in the thickness direction of the screen, the gap is provided between the hard substance and the middle frame, to enable the hard substance to be not in contact with the middle frame as much as possible in a process of vibrating up and down in the thickness direction of the screen, to reduce noise caused by continuous contact with the middle frame, thereby improving a vibration effect.

[0013] Optionally, a second groove is further disposed in the middle frame, and the second groove accommodates the hard substance.

[0014] Therefore, in the screen sounding device provided in this embodiment of this application, a groove (for example, the second groove) that accommodates the hard substance is disposed in the middle frame, to use

space of the groove in the thickness direction of the device to compensate for space occupied by the hard substance in the thickness direction of the device, thereby effectively reducing the size of the device in the thickness direction.

[0015] Optionally, the first hole is disposed in the middle frame, and the vibrator protrudes from the first hole on a side that is of the middle frame and that is far away from the screen; and

the screen sounding device further includes a support apparatus connected, through fastening, to the side that is of the middle frame and that is far away from the screen, and a surface that is of the vibrator and that protrudes from the first hole is in contact with a surface of the support apparatus.

[0016] Therefore, in the screen sounding device provided in this embodiment of this application, when a hole (for example, the first hole) that accommodates the vibrator is disposed in the middle frame, the support apparatus connected, through fastening, to the middle frame is disposed on the middle frame, so that the vibrator can be better supported.

[0017] Optionally, the vibrator includes a first magnetic component and a second magnetic component that are distributed in the thickness direction of the screen, there is a gap between the first magnetic component and the second magnetic component, the first magnetic component is adhered to the hard substance, the second magnetic component is adhered to the support apparatus, and a polarity of the first magnetic component or the second magnetic component changes based on a first frequency, to enable the first magnetic component and the second magnetic component to meet a characteristic of same-polarity attraction or opposite-polarity repelling based on the first frequency.

[0018] Therefore, in the screen sounding device provided in this embodiment of this application, the second magnetic component is fastened by using the support apparatus, and all energy is enabled, as much as possible by using characteristics of same-polarity attraction and opposite-polarity repelling, to push the first magnetic component to vibrate up and down, to drive, by using the hard substance, the screen to vibrate, thereby effectively improving a vibration effect and improving a listening effect.

[0019] Optionally, the area of the projection of the hard substance on the surface of the screen is less than or equal to half the area of the surface of the screen.

[0020] Therefore, in the screen sounding device provided in this embodiment of this application, the area of the projection of the hard substance on the surface of the screen is enabled to be less than or equal to half the area of the surface of the screen. Therefore, when the groove that can be used to accommodate the hard substance is disposed in the middle frame, a support action of the middle frame for the screen and other components can be maintained as much as possible on a basis that the device can be reduced.

[0021] Optionally, a peripheral region of a lower surface of the screen is adhered to a surface of the middle frame by using an adhesive layer, the adhesive layer includes first regions and second regions, the first regions are close to the hard substance, the second regions are at least some regions of the adhesive layer other than the first regions, a size of the first region in a first direction is smaller than a size of the second region in the first direction, the first direction is a direction that perpendicularly points to an inner side of the adhesive layer from an outer side of the adhesive layer, and the first direction is parallel to the surface of the screen.

[0022] Therefore, in the screen sounding device provided in this embodiment of this application, a relatively narrow size is set for an adhesive layer close to the hard substance in the direction that perpendicularly points to the inner side of the adhesive layer from the outer side of the adhesive layer, so that a binding force between the middle frame and the screen can be reduced to a specific extent, to alleviate constraint on the hard substance to increase a vibration displacement of the hard substance, thereby improving a vibration effect of the screen and improving a listening effect.

[0023] Optionally, the screen sounding device further includes a rear cover disposed on the side that is of the middle frame and that is far away from the screen, a peripheral region of a surface that is of the rear cover and that faces the middle frame is adhered to a surface of the middle frame, the first hole that accommodates the vibrator is disposed in the middle frame, and the vibrator protrudes from the first hole on the side that is of the middle frame and that is far away from the screen; and in the thickness direction of the screen, a distance between a partial region starting from an end portion of the rear cover and the screen is gradually changed, and a distance between the end portion of the rear cover and the screen is the largest; and the vibrator is placed in the partial region.

[0024] Therefore, in the screen sounding device provided in this embodiment of this application, the partial region is used as an inclined part to place the vibrator, so that a distance between another region of the rear cover and the screen does not need to be changed, thereby reducing a thickness of a partial region of the device.

[0025] Optionally, n holes are disposed in a region of the hard substance other than a region that is of the hard substance and that is adhered to the vibrator, and n is a positive integer.

[0026] Therefore, in the screen sounding device provided in this embodiment of this application, a plurality of holes are disposed in the hard substance. Therefore, air in an adhesive substance can be released via the holes in the hard substance, to enable the hard substance to be better adhered to the screen.

[0027] Optionally, the hard substance is a metal object, and a surface that is of the hard substance and that is adhered to the screen and/or a surface that is of the hard substance and that is adhered to the vibrator each are/is

coated with an insulation layer.

[0028] Therefore, in the screen sounding device provided in this embodiment of this application, when the hard substance is a metal substance, the surface of the hard substance is coated with the insulation layer, so that the hard substance can be prevented, as much as possible, from generating a capacitance effect with a component (such as the screen or the middle frame) near the hard substance, thereby ensuring an antenna effect as much as possible.

[0029] Optionally, a coefficient of thermal conductivity of the hard substance is greater than a preset value.

[0030] Therefore, in the screen sounding device provided in this embodiment of this application, a hard substance with a better coefficient of thermal conductivity has a better heat-conducting property. Because the vibrator emits heat in the vibration process, if the heat emitting part of the vibrator is close to the screen side, the heat generated by the vibrator can be rapidly transmitted by using a hard substance with a relatively good heat-conducting property, to enable copper foil in a protective layer of the screen to evenly dissipate the heat, thereby alleviating damage to the screen caused by heat emitting of the vibrator.

[0031] Optionally, a third groove or a second hole is disposed in the protective layer of the screen, and the third groove or the second hole accommodates the hard substance.

[0032] Therefore, in the screen sounding device provided in this embodiment of this application, the groove or the hole is disposed in the protective layer of the screen, so that the hard substance can be accommodated by using the groove or the hole without affecting a function of the screen, thereby reducing a thickness of the device.

[0033] Optionally, a fourth groove that accommodates the vibrator is disposed in the hard substance, the third groove or the second hole in the protective layer of the screen accommodates the fourth groove, and a region of the hard substance other than the fourth groove is adhered under the screen.

[0034] Therefore, in the screen sounding device provided in this embodiment of this application, the hard substance is disposed as a structure that has the groove that can accommodate the vibrator, and the groove is accommodated in the groove or the hole of the screen, to use space of the protective layer of the screen and the hard substance in the thickness direction of the device to compensate for space occupied by the vibrator in the thickness direction of the device, thereby effectively reducing the size of the device in the thickness direction.

[0035] In addition, the vibrator generates heat in the vibration process. For a hard substance with a relatively large coefficient of thermal conductivity, if the hard substance is entirely accommodated in the groove or the hole in the protective layer of the screen, a heat dissipation effect is reduced. The hard substance is disposed as the structure that has the groove that can accommo-

date the vibrator, and the groove is accommodated in the groove or the hole of the screen, to enable the region of the hard substance other than the fourth groove to be adhered under the screen. Therefore, the heat can be dissipated from the copper foil in the protective layer of the screen by using the region that is of the hard substance other than the groove and that is adhered under the screen, thereby reducing the thickness of the device and improving a heat dissipation effect.

[0036] Optionally, the screen sounding device further includes a camera, and the hard substance and the vibrator are disposed close to the camera.

[0037] Therefore, in the screen sounding device provided in this embodiment of this application, the hard substance and the vibrator are disposed close to the camera, so that a usage habit of a user can be met.

[0038] Optionally, the screen sounding device further includes a battery, and the projections of the hard substance and the vibrator on the surface of the screen do not overlap with a projection of the battery on the surface of the screen.

[0039] Optionally, the screen sounding device further includes a screen circuit board adhered under the screen; and

the projections of the vibrator and the hard substance on the surface of the screen do not overlap with a projection of the screen circuit board on the surface of the screen.

[0040] Therefore, in the screen sounding device provided in this embodiment of this application, in the thickness direction of the screen, neither of the two components, namely, the vibrator and the hard substance, is enabled to be stacked with the screen circuit board. Therefore, in an aspect, the thickness of the device can be reduced to a specific extent. In another aspect, a problem that the screen circuit board may be damaged due to vibration of the vibrator and the hard substance is avoided as much as possible. In still another aspect, a problem that a vibration effect of the hard substance and the vibrator is affected due to component stacking is avoided as much as possible.

[0041] Optionally, the screen sounding device further includes a screen circuit board disposed between the screen and the vibrator, and the vibrator is adhered to the screen by using the hard substance and the screen circuit board; and

a projection of the screen circuit board on the surface of the screen at least partially overlaps with the projections of the vibrator and the hard substance on the surface of the screen.

[0042] Therefore, in the screen sounding device provided in this embodiment of this application, both the vibrator and the hard substance are enabled to be stacked with the screen circuit board, so that a use requirement can be met when inner space of the device is limited.

[0043] Optionally, the hard substance is adhered to a side that is of the screen circuit board and that is far away from the screen; or the hard substance is adhered between the screen and the screen circuit board; or

a third hole is disposed in a non-component region of the screen circuit board, and the third hole accommodates the hard substance.

[0044] According to a second aspect, a screen sounding device is provided. The screen sounding device includes:

- a screen;
- a vibrator adhered under the screen; and
- a middle frame disposed under the screen, where a hole or a groove that accommodates the vibrator is disposed in the middle frame, and the vibrator drives the screen to vibrate in a direction perpendicular to a surface of the screen.

[0045] Therefore, in the screen sounding device provided in this embodiment of this application, the vibrator is disposed under the screen. Compared with a structure in which the vibrator is adhered to the middle frame, because the middle frame does not need to be vibrated to drive the screen to vibrate, a vibration displacement can be increased, an energy loss can be reduced, and vibration of a rear cover can be alleviated, thereby improving a vibration effect. In addition, the hole or the groove that can accommodate the vibrator is disposed in the middle frame, so that a thickness of the device can be effectively reduced.

[0046] Optionally, the hole is disposed in the middle frame, and the vibrator protrudes from the hole on a side that is of the middle frame and that is far away from the screen; and

the screen sounding device further includes a support apparatus connected, through fastening, to the side that is of the middle frame and that is far away from the screen, and a surface that is of the vibrator and that protrudes from the hole is in contact with a surface of the support apparatus.

[0047] Therefore, in the screen sounding device provided in this embodiment of this application, when the hole (for example, a first hole) that accommodates the vibrator is disposed in the middle frame, the support apparatus connected, through fastening, to the middle frame is disposed on the middle frame, so that the vibrator can be better supported.

[0048] Optionally, the vibrator includes a first magnetic component and a second magnetic component that are distributed in a thickness direction of the screen, there is a gap between the first magnetic component and the second magnetic component, the first magnetic component is adhered to the screen, the second magnetic component is adhered to the support apparatus, and a polarity of the first magnetic component or the second magnetic component changes based on a first frequency, to enable the first magnetic component and the second magnetic component to meet a characteristic of same-polarity attraction or opposite-polarity repelling based on the first frequency.

[0049] Therefore, in the screen sounding device pro-

vided in this embodiment of this application, the second magnetic component is fastened by using the support apparatus, and all energy is enabled, as much as possible by using characteristics of same-polarity attraction and opposite-polarity repelling, to push the first magnetic component to vibrate up and down, to drive the screen to vibrate, thereby effectively improving a vibration effect and improving a listening effect.

[0050] Optionally, a peripheral region of a lower surface of the screen is adhered to a surface of the middle frame by using an adhesive layer, the adhesive layer includes first regions and second regions, the first regions are close to the vibrator, the second regions are at least some regions of the adhesive layer other than the first regions, a size of the first region in a first direction is smaller than a size of the second region in the first direction, the first direction is a direction that perpendicularly points to an inner side of the adhesive layer from an outer side of the adhesive layer, and the first direction is parallel to the surface of the screen.

[0051] Therefore, in the screen sounding device provided in this embodiment of this application, a relatively narrow size is set for an adhesive layer close to the vibrator in the direction that perpendicularly points to the inner side of the adhesive layer from the outer side of the adhesive layer, so that a binding force between the middle frame and the screen can be reduced to a specific extent, to alleviate constraint on the vibrator to increase a vibration displacement of the vibrator, thereby improving a vibration effect of the screen and improving a listening effect.

[0052] Optionally, the screen sounding device further includes a rear cover disposed on the side that is of the middle frame and that is far away from the screen, a peripheral region of a surface that is of the rear cover and that faces the middle frame is adhered to a surface of the middle frame, the hole that accommodates the vibrator is disposed in the middle frame, and the vibrator protrudes from the hole on the side that is of the middle frame and that is far away from the screen; and in the thickness direction of the screen, a distance between a partial region starting from an end portion of the rear cover and the screen is gradually changed, and a distance between the end portion of the rear cover and the screen is the largest; and the vibrator is placed in the partial region.

[0053] Therefore, in the screen sounding device provided in this embodiment of this application, the partial region is used as an inclined part to place the vibrator, so that a distance between another region of the rear cover and the screen does not need to be changed, thereby reducing a thickness of a partial region of the device.

[0054] Optionally, a groove or a hole is disposed in a protective layer of the screen, and the groove or the hole in the protective layer accommodates the vibrator.

[0055] Therefore, in the screen sounding device provided in this embodiment of this application, the groove or the hole is disposed in the protective layer of the

screen, so that the hard substance can be accommodated by using the groove or the hole without affecting a function of the screen, thereby reducing the thickness of the device.

[0056] Optionally, the screen sounding device further includes a camera, and the vibrator is disposed close to the camera.

[0057] Therefore, in the screen sounding device provided in this embodiment of this application, the vibrator is disposed close to the camera, so that a usage habit of a user can be met.

[0058] Optionally, the screen sounding device further includes a battery, and a projection of the vibrator on the surface of the screen does not overlap with a projection of the battery on the surface of the screen.

[0059] Optionally, the screen sounding device further includes a screen circuit board adhered under the screen; and

the projection of the vibrator on the surface of the screen does not overlap with a projection of the screen circuit board on the surface of the screen.

[0060] Therefore, in the screen sounding device provided in this embodiment of this application, in the thickness direction of the screen, the vibrator is enabled to be not stacked with the screen circuit board. Therefore, in an aspect, the thickness of the device can be reduced to a specific extent. In another aspect, a problem that the screen circuit board may be damaged due to vibration of the vibrator is avoided as much as possible. In still another aspect, a problem that a vibration effect of the vibrator is affected due to component stacking is avoided as much as possible.

[0061] Optionally, the screen sounding device further includes a screen circuit board disposed between the screen and the vibrator, and the vibrator is adhered to the screen by using the screen circuit board; and a projection of the screen circuit board on the surface of the screen at least partially overlaps with the projection of the vibrator on the surface of the screen.

[0062] Therefore, in the screen sounding device provided in this embodiment of this application, the vibrator is enabled to be stacked with the screen circuit board, so that a use requirement can be met when inner space of the device is limited.

[0063] Optionally, the vibrator is adhered to a side that is of the screen circuit board and that is far away from the screen; or

a hole that accommodates the vibrator is disposed in a non-component region of the screen circuit board.

BRIEF DESCRIPTION OF DRAWINGS

[0064]

FIG. 1 is a schematic structural diagram of a screen sounding device in a yz plane according to an embodiment of this application;

FIG. 2 is a schematic structural diagram of a screen

sounding device in an xy plane according to an embodiment of this application;

FIG. 3 is a schematic structural diagram of a hard substance and a vibrator in a yz plane according to an embodiment of this application;

FIG. 4 and FIG. 5 each are another schematic structural diagram of a screen sounding device in an xy plane according to an embodiment of this application;

FIG. 6 is a schematic structural diagram of a middle frame in an xy plane according to an embodiment of this application;

FIG. 7 and FIG. 8 each are another schematic structural diagram of a screen sounding device in a yz plane according to an embodiment of this application;

FIG. 9 is a schematic structural diagram of a local region of a screen sounding device according to an embodiment of this application;

FIG. 10 is another schematic structural diagram of a screen sounding device in a yz plane according to an embodiment of this application;

FIG. 11 is a schematic structural diagram of a support apparatus according to an embodiment of this application;

FIG. 12 is another schematic structural diagram of a screen sounding device in a yz plane according to an embodiment of this application;

FIG. 13 is another schematic structural diagram of a screen sounding device in an xy plane according to an embodiment of this application;

FIG. 14 to FIG. 18 each are another schematic structural diagram of a screen sounding device in a yz plane according to an embodiment of this application;

FIG. 19 is another schematic structural diagram of a screen sounding device in an xy plane according to an embodiment of this application; and

FIG. 20 to FIG. 30 each are another schematic structural diagram of a screen sounding device in a yz plane according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0065] The following describes technical solutions of this application with reference to accompanying drawings.

[0066] A screen sounding device in the embodiments of this application may be configured in or may be any device with a screen. For example, the device may be a mobile phone, a Pad, a notebook computer, or a smart-watch.

[0067] First, a coordinate system in the accompanying drawings in the embodiments of this application is described, x, y, and z directions are perpendicular to each other. Generally, length, width, and thickness directions of a device are consistent with length, width, and thick-

ness directions of a screen. Therefore, in the embodiments of this application, a z direction may be understood as a thickness direction of a device or a screen configured in the device, a y direction may be understood as a length direction of the device or the screen configured in the device, and an x direction may be understood as a width direction of the device or the screen configured in the device.

[0068] The following describes in detail the screen sounding device in the embodiments of this application with reference to FIG. 1 to FIG. 30.

[0069] FIG. 1 is a schematic structural diagram of a screen sounding device in a yz plane according to an embodiment of this application, and FIG. 2 is a schematic structural diagram of a screen sounding device in an xy plane according to an embodiment of this application.

[0070] Referring to FIG. 1 and FIG. 2, a screen sounding device 100 includes a screen 110, a hard substance 120, and a vibrator 130. The hard substance 120 is disposed between the screen 110 and the vibrator 130. The vibrator 130 is adhered to the screen 110 by using the hard substance 120. A Young's modulus of the hard substance 120 is greater than a preset value, and an area of a projection of the hard substance 120 on a surface of the screen 110 is greater than an area of a projection of the vibrator 120 on the surface of the screen 110 and is less than an area of the surface of the screen 110. The vibrator 130 drives, by using the hard substance 120, the screen 110 to vibrate in a direction perpendicular to the surface of the screen 110, to enable the screen 110 to sound.

[0071] That the vibrator 130 is adhered to the screen 110 by using the hard substance 120 may indicate that the vibrator 130 is adhered to the screen 110 by using only the hard substance 120, in other words, an upper surface and a lower surface of the hard substance 120 are respectively adhered to the screen 110 and the vibrator 130; or may indicate that the vibrator 130 is adhered to the screen 110 by using the hard substance 120 and another component (for example, as described below, the vibrator 130 may be adhered to the screen 110 by using a screen circuit board 180 and the hard substance 120). This is not limited in the embodiments of this application.

[0072] In addition, that the hard substance 120 is disposed between the screen 110 and the vibrator 130 may be understood that the two surfaces of the hard substance are respectively adhered to the screen and the vibrator. That the surface of the hard substance is adhered to the screen may indicate that the surface of the hard substance is adhered to a lower surface of the screen, or may indicate that the surface of the hard substance is adhered to a surface of a groove or a hole that is disposed in a protective layer of the screen, as shown in FIG. 15 to FIG. 17. Both the two cases may indicate that the surface of the hard substance is adhered to the screen. This is not limited in the embodiments of this application.

[0073] In the embodiments of this application, the vibrator is disposed under the screen. Compared with a structure in which the vibrator is adhered to a middle frame, because the middle frame does not need to be vibrated to drive the screen to vibrate, a vibration displacement can be increased, an energy loss can be reduced, and vibration of the middle frame and a rear cover can be alleviated, thereby improving a vibration effect. In addition, the vibrator is adhered under the screen by using the hard substance that has a specific Young's modulus and area size. Therefore, in an aspect, the screen can be better supported by using the hard substance. In another aspect, in a process in which the vibrator vibrates the screen by using the hard substance, a vibration area of the screen can be increased by using the hard substance, to enable, as much as possible, most regions of the screen to be vibrated, thereby generating a better vibration effect. This design has better applicability especially for a screen sounding device with a flexible screen. In still another aspect, the vibrator emits heat in the vibration process. If a heat emitting part of the vibrator is close to a screen side, the hard substance disposed between the screen and the vibrator can alleviate damage to the screen caused by heat emitting of the vibrator.

[0074] In the embodiments of this application, components of the screen sounding device are correspondingly designed mainly from a perspective of improving a vibration effect of the screen and reducing a thickness of the device. The following describes the components in detail.

Hard substance 120

[0075] The hard substance 120 may be patterns in various shapes, for example, a square shown in FIG. 2, or may be in any other shape (for example, a pattern in an irregular shape, or a circular light). This is not limited herein.

[0076] The hard substance 120 is a sheet-like solid structure that has a specific Young's modulus, and is not prone to deformation. For example, the Young's modulus of the hard substance 120 is greater than or equal to a preset value. For example, the preset value may be 0.5 Gpa. A material of the hard substance 120 may be metal, or may be a glass fiber material or the like. This is not limited herein, provided that the Young's modulus of the hard substance 120 is greater than the preset value. Optionally, the hard substance 120 may be a steel sheet.

[0077] An area of a projection of the hard substance 120 on an xy plane is greater than an area of a projection of the vibrator 130 on the xy plane and is less than an area of a surface of the screen 110. The projection of the hard substance 120 on the xy plane may completely cover the projection of the vibrator 130 on the xy plane. Specifically, a size of the hard substance 120 in an x direction may be greater than or equal to a size of the vibrator in the x direction, and a size of the hard substance 120 in a y direction may be greater than or equal to a size of

the vibrator in the y direction.

[0078] In the embodiments of this application, the hard substance 120 may be adhered to the screen 110 by using an adhesive substance (for example, glue). Generally, the adherence with the adhesive substance may remain a specific amount of air in the adhesive substance, and consequently the hard substance 120 cannot be well adhered to the screen 110. Therefore, to increase a binding force between the screen 110 and the hard substance 120, referring to FIG. 3, optionally, n holes 121 are disposed in a region of the hard substance 120 other than a region that is of the hard substance 120 and that is adhered to the vibrator 130, and n is a positive integer. It should be understood that the hole in the hard substance 120 may be a hole in any shape, and is not limited to being in a shape shown in FIG. 3. For example, the hole may be a square or various irregular patterns. This is not limited herein.

[0079] In this way, the air in the adhesive substance can be released via the holes in the hard substance 120, to enable the hard substance 120 to be better adhered to the screen 110.

[0080] In the embodiments of this application, a foam layer for cushioning that is in direct contact with the hard substance is not needed on a side that is of the hard substance and that is close to the screen. The foam layer may be a foam layer in a protective layer of the screen, or may be a foam layer under the screen. For example, in a hard screen, no foam layer is needed in the hard screen or under the hard screen; and in a flexible screen, although a foam layer can be disposed on a copper foil layer of the hard screen, the foam layer is not in direct contact with the hard substance.

[0081] As described above, the hard substance 120 may be a metal object, and the hard substance 120 may generate a capacitance effect with a component (such as the middle frame or the screen) near the hard substance 120, affecting an antenna effect. Therefore, optionally, the hard substance 120 is a metal object, and a surface that is of the hard substance 120 and that is adhered to the screen 110 and/or a surface that is of the hard substance 120 and that is adhered to the vibrator 130 each are/is coated with an insulation layer. In this way, the surface of the hard substance 120 is coated with the insulation layer. Therefore, the hard substance 120 can be prevented, as much as possible, from generating the capacitance effect with a component (such as the screen 110) near the hard substance 120, thereby ensuring the antenna effect as much as possible.

[0082] The vibrator 130 emits heat in a vibration process. If a heat emitting part of the vibrator is close to a screen side, more heat may damage the screen 110. Therefore, optionally, a coefficient of thermal conductivity of the hard substance 120 is greater than a preset value.

[0083] The preset value may be a value, or may be a value range. For example, if the material of the hard substance is steel, the preset value may be 15 W/(m°C).

[0084] A hard substance 120 with a better coefficient

of thermal conductivity has a better heat-conducting property. Therefore, the heat generated by the vibrator 130 can be rapidly transmitted by using a hard substance 120 with a relatively good heat-conducting property, to enable copper foil in the protective layer of the screen 110 to evenly dissipate the heat, thereby alleviating damage to the screen 110 caused by heat emitting of the vibrator 130.

10 Vibrator 130

[0085] The vibrator 130 is an exciter of the screen sounding device, and vibration of the screen 110 may be implemented through vibration of the vibrator 130. The vibrator 130 may be a vibrator in any form. This is not limited in the embodiments of this application. For example, the vibrator 130 may be a linear vibrator or a piezoelectric ceramic vibrator.

[0086] For example, FIG. 4 is used as an example to briefly describe a possible vibrator in the embodiments of this application.

[0087] The vibrator 130 may be a magnetic component. The magnetic component may be a magnet, or may be a circuit that has magnetism. This is not limited herein.

25 All components that can generate magnetic fields or that have magnetism may be referred to as magnetic components. As shown in FIG. 4, the vibrator includes a first magnetic component 131 and a second magnetic component 132. There is a gap between the two magnetic components. The second magnetic component 132 may be connected to another component 102 to enable the second magnetic component 132 to be fastened. A polarity of the first magnetic component 131 or a polarity of the second magnetic component 132 is changed based on a specific frequency, to enable the first magnetic component 131 and the second magnetic component 132 to generate effects of same-polarity attraction and opposite-polarity repelling. For example, the polarity of the first magnetic component 131 is kept unchanged, and the polarity of the second magnetic component 132 is constantly changed; or the polarity of the second magnetic component 132 is kept unchanged, and the polarity of the first magnetic component 131 is constantly changed. According to principles of same-polarity attraction and opposite-polarity repelling between magnetic components, when the polarity of the first magnetic component 131 is the same as the polarity of the second magnetic component 132, the first magnetic component 131 is enabled to move toward the screen 110 side to lift up the screen 110; and when the polarity of the first magnetic component 131 is opposite to the polarity of the second magnetic component 132, the first magnetic component 132 is enabled to move far away from the screen 110 side to restore a location of the screen 110. In this way, in cycles, the first magnetic component 131 continuously moves up and down to drive the screen 110 to move up and down, thereby implementing vibration of the screen 110.

[0088] The component 102 may be any component that is configured in the screen sounding device and that can be connected to the vibrator, for example, a rear cover and a middle frame shown in FIG. 5, or a support apparatus shown in FIG. 10. This is described in detail below, and is not limited herein.

Middle frame 140

[0089] The middle frame 140 is disposed under the screen 110 to increase system stiffness while supporting other internal components of the screen sounding device. In the embodiments of this application, as an internal component of the screen sounding device, the vibrator 130 may have a plurality of location relationships with the middle frame 140. The following describes a location relationship between the middle frame 140 and the vibrator 130 with reference to the accompanying drawings from a perspective of reducing a thickness of the device and improving a vibration effect.

[0090] To reduce a size of the device in a z direction, referring to FIG. 5 and FIG. 6, a first hole 1410 is disposed in the middle frame 140, and the vibrator 130 is accommodated in the first hole 1410. In this case, the vibrator 130 protrudes from the first hole 1410 on a side that is of the middle frame 140 and that is far away from the screen 110. Further, to better reduce the size of the device in the z direction, referring to FIG. 6 and FIG. 7, a second groove 142 may be disposed in the middle frame 140 to accommodate the hard substance 120.

[0091] Likewise, to reduce a size of the device in a z direction, referring to FIG. 6 and FIG. 8, a first groove 1411 is disposed in the middle frame 140, and the vibrator 130 is accommodated in the first groove 1411. Further, to better reduce the size of the device in the z direction, referring to FIG. 6 and FIG. 9, a second groove 142 may be disposed in the middle frame 140 to accommodate the hard substance 120.

[0092] It may be understood that a structure in which a hole (for example, the first holes) is disposed in the middle frame 140 reduces the size of the device in a thickness direction to a greater extent than a structure in which a groove (for example, the first groove) is disposed in the middle frame 140.

[0093] When the groove that accommodates the hard substance is disposed in the middle frame 140, to maintain a support action of the middle frame 140 for the screen and components as much as possible, optionally, the area of the projection of the hard substance 120 on the surface of the screen 110 is less than or equal to half the area of the surface of the screen 110.

[0094] From a perspective of improving a vibration effect, relatively large noise may be generated when the support 120 that can vibrate up and down is in contact with the middle frame 140, affecting the vibration effect. Therefore, the hard substance 120 needs to be enabled, as much as possible, to be not in contact with the middle frame 140. Referring to FIG. 9, optionally, in a thickness

direction of the screen 110, there is a gap 101 between the hard substance 120 and a surface that is of the middle frame 140 and that faces the hard substance 120. FIG. 9 is a schematic structural diagram of a local region A shown in FIG. 7.

[0095] It should be understood that the first hole or the first groove (for example, the first groove or the second groove) disposed in the middle frame 140 may be in various shapes, and is not limited to a circular hole or a circular groove shown in FIG. 6. For example, the hole or the groove may be a square or various irregular patterns, provided that the hole or the groove can accommodate the vibrator. This is not limited herein. Likewise, the second groove disposed in the middle frame 140 may be grooves in various shapes, and is not limited to a square groove shown in FIG. 6, provided that the second groove can accommodate the hard substance. This is not limited herein.

[0096] It should be understood that, generally, when the middle frame 140 has the first hole or the first groove, because an area of the hard substance 120 is greater than an area of the vibrator 130, to reduce the thickness of the device, optionally, the second groove that accommodates the hard substance 120 may be disposed in the middle frame 140. Further, to improve the vibration effect, in an installation process, a first gap may be specially reserved between a first middle frame 140 and the hard substance 120, to prevent the hard substance 120 from being in contact with the middle frame 140.

[0097] Optionally, a size of the first gap in the z direction is 0.2 millimeters.

[0098] It should be understood that there is a specific gap between at least a partial region of a side face of the vibrator and the middle frame, so that the vibrator can vibrate up and down. The side face of the vibrator may be a face of the vibrator other than faces perpendicular to the thickness direction of the screen. For example, with reference to FIG. 5 to FIG. 9, a whole region of the side face of the vibrator has a gap with the middle frame without contact. For another example, a region that is of the side face of the vibrator and that is far away from the hard substance may be in contact with the middle frame, and a region that is of the side face of the vibrator and that is close to the hard substance may have a gap with the middle frame without contact.

Support apparatus 170

[0099] For the structure in which the first hole that accommodates the vibrator 140 is disposed in the middle frame 140, to better support and fasten the vibrator 140, optionally, referring to FIG. 10, the screen sounding device further includes the support apparatus 170 connected, through fastening, to the side that is of the middle frame 140 and that is far away from the screen 110, and a surface that is of the vibrator 130 and that protrudes from the first hole 1140 on the side that is of the middle frame 140 and that is far away from the screen 110 is in

contact with a surface of the support apparatus 170. For example, the support apparatus 170 may be fastened to the middle frame 140 by using any structure that can fasten a plurality of components, such as a screw, welding, or a rivet. This is not limited in the embodiments of this application.

[0100] The support apparatus 170 may be apparatuses of various structures. Optionally, referring to FIG. 11, in a left-side figure in FIG. 11, the support apparatus 170 may include a cylindrical structure 171 having an opening, and fastening end portions 172 that protrude outward, the vibrator 130 is placed in the cylindrical structure 171, and the fastening end portions 172 are fastened to the middle frame 140. In a right-side figure in FIG. 11, the support apparatus 170 may alternatively include a sheet-like structure 171 and fastening end portions 172 that protrude outward, the vibrator 130 may be adhered to the sheet-like structure 171 by using an adhesive material, and the fastening end portions 172 are fastened to the middle frame 140.

[0101] As described above, the vibrator 130 may be the vibrator shown in FIG. 4. In the vibrator of this structure, an upper surface of the first magnetic component 131 is adhered to a lower surface of the hard substance 120, there is the gap between the first magnetic component 131 and the second magnetic component 132, and a lower surface of the second magnetic component 132 is adhered to the surface of the support apparatus 170. The second magnetic component 132 is fastened by using the support apparatus 170, and all energy is enabled, as much as possible by using characteristics of same-polarity attraction and opposite-polarity repelling, to push the first magnetic component 131 to vibrate up and down, to drive, by using the hard substance 120, the screen 110 to vibrate, thereby effectively improving a vibration effect and improving a listening effect.

[0102] It should be noted that, as a possible variant, the middle frame 140 may be designed as a structure including the support apparatus 170; in other words, the support apparatus 170 and the middle frame 140 may be used as a whole structure. This is not limited in the embodiments of this application.

[0103] The foregoing all describes the structure in which the groove or the hole is disposed in the middle frame 140 to reduce the thickness of the device. As an example rather than a limitation, if the thickness of the device is not considered, referring to FIG. 12, the vibrator 130 may be disposed between the middle frame 140 and the hard substance 120, and an upper surface and a lower surface of the vibrator 130 are respectively adhered to the hard substance 120 and the middle frame 140.

Adhesive layer 150

[0104] In the embodiments of this application, the middle frame 140 and another component (for example, the screen) may be adhered together by using an adhesive substance (for example, glue). For ease of description,

a structure made of the adhesive substance may be denoted as the adhesive layer 150. Specifically, still referring to FIG. 5 to FIG. 12 and FIG. 13, a peripheral region of a lower surface of the screen 110 is adhered to a surface of the middle frame 140 by using the adhesive layer 150.

[0105] To improve a vibration effect of the screen, optionally, still referring to FIG. 13, the adhesive layer 150 includes first regions 151 (for example, a region 151-1 and a region 151-2 in FIG. 13) and second regions 152. The first regions 151 are close to the hard substance 120, and the second regions 152 are at least some regions of the adhesive layer 150 other than the first regions 151. A size of the first region 151 in a first direction is smaller than a size of the second region 152 in the first direction. The first direction is a direction that perpendicularly points to an inner side of the adhesive layer 150 from an outer side of the adhesive layer 150, and the first direction is parallel to the surface of the screen 110. The at least some regions of the adhesive layer 150 other than the first regions 151 indicate some regions or all regions of the adhesive layer 150 other than the first regions 151. For example, FIG. 13 shows only a case of all the regions. A right-side figure in FIG. 13 is a schematic structural diagram of a local region B in a left-side figure in FIG. 13, and the first direction is a y direction or an x direction shown in FIG. 13.

[0106] It can be seen from the right-side figure in FIG. 13 that, when the middle frame 140 is adhered to the screen 110 in the x direction by using the adhesive layer 150, the first direction is the y direction, a size of an adhesive layer (for example, the region 151-1) close to the hard substance 120 in the y direction is smaller than a size of an adhesive layer (for example, the second region 152) far away from the hard substance 120 in the y direction; and when the middle frame 140 is adhered to the screen 110 in the y direction by using the adhesive layer 150, the first direction is the x direction, and a size of an adhesive layer (for example, the region 151-2) close to the hard substance 120 in the x direction is smaller than a size of an adhesive layer (for example, the second region 152) far away from the hard substance 120 in the x direction.

[0107] In this way, a relatively narrow size is set for the adhesive layer close to the hard substance in the direction that perpendicularly points to the inner side of the adhesive layer from the outer side of the adhesive layer, so that a binding force between the middle frame and the screen can be reduced to a specific extent, to alleviate constraint on the hard substance to increase a vibration displacement of the hard substance, thereby improving a vibration effect of the screen and improving a listening effect.

Rear cover 160

[0108] The rear cover 160 is configured to protect the device, and is disposed on the side that is of the middle

frame 140 and that is far away from the screen 110. A peripheral region of a surface that is of the rear cover 160 and that faces the middle frame 140 is adhered to a surface of the middle frame 140. Referring to FIG. 5 to FIG. 12, the rear cover 160 and the middle frame 141 may be adhered together by using an adhesive substance, to form the adhesive layer 150 between the rear cover 160 and the middle frame 140.

[0109] From a perspective of reducing the thickness of the device, a related design may also be performed on the rear cover 160 in the embodiments of this application. Referring to FIG. 14, optionally, the first hole 1410 that accommodates the vibrator 130 is disposed in the middle frame 140, and the vibrator 130 protrudes from the first hole 1410 on the side that is of the middle frame 140 and that is far away from the screen 110. In addition, in the thickness direction of the screen 110, a distance between a partial region 161 starting from an end portion of the rear cover 160 and the screen 110 is gradually changed, and a distance between the end portion of the rear cover 160 and the screen 110 is the largest; and the vibrator 130 is placed in the partial region 161.

[0110] The end portion of the rear cover 160 may be an end portion of the rear cover 160 in the x direction or the y direction. For a specific design, refer to a location of the vibrator 130. This is not limited herein. In the embodiments of this application, the rear cover 160 may be divided into the region 161 and a region 162. The region 161 may be understood as a markedly inclined region in the rear cover 160, the region 162 may be understood as a relatively flat region in the rear cover 160, and the vibrator 140 that protrudes from the first hole 1410 of the middle frame 140 is placed in the region 161. It may be learned that the region 161 is used as an inclined part to place the vibrator 130, so that a distance between another region of the rear cover 160 and the screen 110 does not need to be changed, thereby reducing a thickness of a partial region of the device.

[0111] Optionally, a lower surface of the vibrator 140 may be adhered to an upper surface of the region 161, and the rear cover 140 may be used as a support apparatus of the vibrator 130 to support the vibrator 130. In addition, when the vibrator 130 is the vibrator that includes the two magnetic components and that is shown in FIG. 4, a vibration effect can also be effectively improved.

Screen 110

[0112] The screen 110 may be a flexible screen or a hard screen. This is not limited herein.

[0113] In the embodiments of this application, from a perspective of reducing the thickness of the device, a related design of the screen 110 may have the following possible implementations.

[0114] Referring to FIG. 15, optionally, a third groove or a second hole is disposed in a protective layer 111 of the screen 110, and the third groove or the second hole

accommodates the hard substance 120. The protective layer of the screen 110 may include at least one layer that protects a component layer 112 of the screen 110, such as a copper foil layer or a foam layer.

[0115] In this way, the groove or the hole is disposed in the protective layer 111 of the screen 110, so that the hard substance 120 can be accommodated without affecting a function of the screen 110, thereby reducing the thickness of the device.

[0116] Referring to FIG. 16, optionally, a fourth groove that accommodates the vibrator 130 is disposed in the hard substance 120, the third groove or the second hole in the protective layer 111 of the screen 110 accommodates the fourth groove 121, and a region 122 of the hard substance 120 other than the fourth groove 121 is adhered under the screen 110.

[0117] Perpendicular to the thickness direction of the screen 110, the fourth groove 121 is adhered to two opposite surfaces of the screen 110, and the region of the hard substance 120 other than the fourth groove 121 is adhered to two opposite surfaces of the screen 110.

[0118] In this way, the hard substance 120 is disposed as a structure that has the groove 121 that can accommodate the vibrator 130, and the groove 121 is accommodated in the groove or the hole of the screen 110, to use space of the protective layer of the screen 110 and the hard substance 120 in the thickness direction of the device to compensate for space occupied by the vibrator 130 in the thickness direction of the device, thereby effectively reducing the size of the device in the thickness direction.

[0119] Generally, a hard substance with a relatively large coefficient of thermal conductivity has a relatively soft material. To ensure strength of the hard substance, a hard substance with a relatively large thickness may be designed. Further, to reduce the thickness of the device, for example, a device shown in FIG. 15 may be designed, that is, the hard substance may be accommodated in the protective layer of the screen. However, there may be some problems in this case, and heat generated by the vibrator cannot be dissipated from copper foil in the protective layer of the screen. Therefore, the hard substance is disposed as a structure that has the groove that can accommodate the vibrator, and the groove is accommodated in the groove or the hole of the screen, to enable the region of the hard substance other than the fourth groove to be adhered under the screen, so that the heat can be dissipated from the copper foil in the protective layer of the screen by using the region that is of the hard substance other than the groove and that is adhered under the screen, thereby reducing the thickness of the device and improving a heat dissipation effect.

[0120] The foregoing describes the main components in the embodiments of this application in detail. Structures of the components may be jointly designed, or may be separately designed. This is not limited in the embodiments of this application. For example, referring to FIG. 17, grooves or holes that accommodate the vibrator and

the hard substance may be disposed in the middle frame, and a groove or a hole that accommodates the hard substance may be disposed in the screen. For another example, referring to FIG. 18, grooves or holes that accommodate the vibrator and the hard substance may be disposed in the middle frame while an inclined region is disposed in the rear cover. For another example, a groove or a hole that accommodates the hard substance may be disposed in the screen circuit board, and grooves or holes that accommodate the hard substance and the vibrator are disposed in the middle frame.

[0121] The following describes other designs of the screen sounding device by combining the foregoing components.

[0122] In the embodiments of this application, the hard substance 120 and the vibrator 130 may be placed in any locations in the device, provided that normal operation of other components is not affected.

[0123] Generally, to meet a usage habit of a user, optionally, the screen sounding device includes a camera, and the hard substance 120 and the vibrator 130 are disposed close to the camera.

[0124] Generally, the camera is disposed in an upper half region and a lower half region of the screen on the xy plane. Assuming that a region in which the camera is disposed is denoted as the upper half region, the vibrator 130 may also be disposed in the upper half region.

[0125] Therefore, the hard substance and the vibrator are disposed close to the camera, so that the usage habit of the user can be met.

[0126] Referring to FIG. 5 to FIG. 12, the screen sounding device further includes a screen circuit board 180 adhered under the screen 110. Generally, the screen circuit board 180 is disposed in the lower half region of the screen 110. In an optional manner, the hard substance 120 and the vibrator 130 may be disposed close to the screen circuit board 180.

[0127] The following describes in detail a structure in which the hard substance 120 and the vibrator 130 are disposed close to the screen circuit board 180.

[0128] In a possible implementation, referring to FIG. 19, the projections of the vibrator 130 and the hard substance 120 on the surface of the screen 110 do not overlap with a projection of the screen circuit board 180 on the surface of the screen 110.

[0129] That is, neither of the two components, namely, the vibrator 130 and the hard substance 120, is stacked with the screen circuit board 180 in the z direction. Therefore, in an aspect, the thickness of the device can be reduced to a specific extent. In another aspect, a problem that the screen circuit board may be damaged due to vibration of the vibrator and the hard substance is avoided as much as possible. In still another aspect, a problem that a vibration effect of the hard substance and the vibrator is affected due to component stacking is avoided as much as possible.

[0130] In another possible implementation, the screen sounding device further includes a screen circuit board

180 disposed between the screen 110 and the vibrator 130. The vibrator 130 is adhered to the screen 110 by using the hard substance 120 and the screen circuit board 180, and a projection of the screen circuit board 180 on the surface of the screen 110 at least partially overlaps with the projections of the vibrator 130 and the hard substance 120 on the surface of the screen 110.

[0131] The at least partially overlapping indicates partially overlapping and completely overlapping. The completely overlapping may indicate that the projection of the screen circuit board 180 on the surface of the screen 110 surrounds the projections of the vibrator 130 and the hard substance 120 on the surface of the screen 110, or may indicate that the projection of the screen circuit board 180 on the surface of the screen 110 completely overlaps with the projection of the vibrator 130 or the hard substance 120 on the surface of the screen 110. That is, in contrast to the first design manner, both the two components, namely, the vibrator 130 and the hard substance 120, are stacked with the screen circuit board 180 in the z direction. In this structure, the screen circuit board 180 is disposed between the screen 110 and the vibrator 130, and the vibrator 130 is adhered to the screen 110 by using the hard substance 120 and the screen circuit board 180.

[0132] Therefore, both the vibrator and the hard substance are enabled to be stacked with the screen circuit board, so that a use requirement can be met when inner space of the device is limited.

[0133] With reference to FIG. 20 to FIG. 22, the following describes the structure in which both the vibrator 130 and the hard substance 120 are stacked with the screen circuit board 180 in the z direction.

[0134] Referring to FIG. 20, optionally, the hard substance 120 is adhered to a side that is of the screen circuit board 180 and that is far away from the screen 110.

[0135] The side that is of the screen circuit board 180 and that is far away from the screen 110 indicates a lower surface of the screen circuit board 180, and an upper surface of the hard substance 120 is adhered to the lower surface of the screen circuit board 180.

[0136] Optionally, the hard substance 120 is adhered to a non-component region of the screen circuit board 180, to prevent a component of the screen circuit board 180 from being damaged due to vibration of the hard substance 120.

[0137] Referring to FIG. 21, optionally, the hard substance 120 is adhered between the screen 110 and the screen circuit board 180.

[0138] That is, an upper surface of the hard substance 120 is adhered to the screen 110, and a lower surface of the hard substance 120 is adhered to the vibrator 130.

[0139] Optionally, the hard substance 120 is adhered to a non-component region of the screen circuit board 180, to prevent a component of the screen circuit board 180 from being damaged due to vibration of the hard substance 120.

[0140] Referring to FIG. 22, a third hole is disposed in

a non-component region of the screen circuit board 180, and the third hole accommodates the hard substance 120.

[0141] In this structure, the third hole may be first disposed in the screen circuit board 180, and a component and cabling are disposed in a region other than the third hole.

[0142] A location relationship that is between the third hole and the hard substance and the vibrator and that is shown in FIG. 22 is merely an example for description. For example, if a size of the screen circuit board 180 in the z direction is greater than a size of the hard substance 120 in the z direction, the hard substance 120 completely extends into the screen circuit board 180, and a part of the vibrator 130 may also be extended into the third hole.

[0143] It should be noted that, in the structure in which both the hard substance 120 and the vibrator 130 are stacked with the screen circuit board 280 in the z direction, for location relationships and connection relationships between the hard substance 120 and the vibrator 130 and other components such as the middle frame 140, the rear cover 160, and the adhesive layer 150, all refer to the location relationships and connection relationships between the components in the foregoing embodiments corresponding to FIG. 2 to FIG. 18. This is not limited in the embodiments of this application. For details, refer to the foregoing related descriptions. For brevity, the details are not described again. For example, referring to FIG. 23, location relationships and connection relationships between the hard substance 120 and the vibrator 130 and the middle frame 140 and the support apparatus 170 may correspond to the relationships between the components in FIG. 10.

[0144] In the embodiments of this application, the screen sounding device may include a plurality of vibrators and a plurality of hard substances. One vibrator corresponds to one hard substance. For a location relationship and a connection relationship between each vibrator and a corresponding hard substance, refer to the foregoing embodiments, and for location relationships and connection relationships between each vibrator and a corresponding hard substance and other components (such as the screen, the middle frame, the rear cover, and the support apparatus), all refer to the foregoing embodiments. For example, referring to FIG. 24, one hard substance 120 and one vibrator 130 may be disposed on each of two sides of a center line of the device in the y direction. For designs of each hard substance 120 and each vibrator 130 and designs of the hard substance 120 and the vibrator 130 and other components (such as the middle frame 140, the rear cover 160, and the support apparatus 170), all refer to the designs in the embodiments corresponding to FIG. 1 to FIG. 22. This is not limited in the embodiments of this application.

[0145] It should be noted that, in a structure in which the screen sounding device includes the plurality of hard substances and the plurality of vibrators, when structure space is limited, some hard substances and vibrators

may be disposed close to the screen circuit board. Still referring to FIG. 24, if a region on one side of the center line is denoted as an upper half region of the device, a region on the other side of the center line is denoted as a lower half region of the device, one hard substance 120 and one vibrator 130 are disposed in the upper half region, and one hard substance 120 and one vibrator 130 are disposed in the lower half region. Assuming that the screen circuit board 180 is located in the lower half region, and the hard substance 120 and the vibrator 130 are inevitably close to the screen circuit board 180, location relationships and connection relationships between the hard substance 120 and the vibrator 130 and the screen circuit board 180 may be set with reference to the embodiments corresponding to FIG. 19 to FIG. 22, and relationships between the hard substance 120 and the vibrator 130 and components such as the middle frame 140, the adhesive layer 150, the rear cover 160, and the support apparatus 170 may be set with reference to the location relationships and the connection relationships between the components in FIG. 2 to FIG. 18.

[0146] The foregoing describes the screen sounding device in the embodiments of this application in detail with reference to FIG. 1 to FIG. 24. The following describes another screen sounding device in the embodiments of this application in detail with reference to FIG. 25 to FIG. 30. A largest difference between the screen sounding device corresponding to FIG. 25 to FIG. 30 and the screen sounding device corresponding to FIG. 1 to FIG. 24 lies in no hard substance.

[0147] Referring to FIG. 25 and FIG. 26, a screen sounding device 200 includes a screen 210, a vibrator 230 adhered under the screen 210, and a middle frame 240 disposed under the screen 210, a hole or a groove that accommodates the vibrator 230 is disposed in the middle frame 240, and the vibrator 230 drives the screen 210 to vibrate in a direction perpendicular to a surface of the screen 210. FIG. 25 shows a structure in which the hole is disposed in the middle frame 240, and FIG. 26 shows a structure in which the groove is disposed in the middle frame 240.

[0148] In this way, the vibrator is disposed under the screen. Compared with a structure in which the vibrator is adhered to the middle frame, because the middle frame does not need to be vibrated to drive the screen to vibrate, a vibration displacement can be increased, an energy loss can be reduced, and vibration of a rear cover can be alleviated, thereby improving a vibration effect. In addition, the hole or the groove that can accommodate the vibrator is disposed in the middle frame, so that a thickness of the device can be effectively reduced.

[0149] To better support and fasten the vibrator 240, referring to FIG. 27, optionally, the hole is disposed in the middle frame 240, and the vibrator 230 protrudes from the hole on a side that is of the middle frame 240 and that is far away from the screen 210.

[0150] The screen sounding device further includes a support apparatus 270 connected, through fastening, to

the side that is of the middle frame 240 and that is far away from the screen 210, and a surface that is of the vibrator 240 and that protrudes from the hole is in contact with a surface of the support apparatus 270.

[0151] For details of the vibrator and the support apparatus, refer to the foregoing related descriptions. For brevity, the details are not described again.

[0152] Still referring to FIG. 25 to FIG. 27 and FIG. 13, to improve a vibration effect of the screen, optionally, a peripheral region of a lower surface of the screen 210 is adhered to a surface of the middle frame 240 by using an adhesive layer 250. The adhesive layer 250 includes first regions and second regions, the first regions are close to the vibrator 230, and the second regions are at least some regions of the adhesive layer 250 other than the first regions. A size of the first region in a first direction is smaller than a size of the second region in the first direction. The first direction is a direction that perpendicularly points to an inner side of the adhesive layer 250 from an outer side of the adhesive layer 250, and the first direction is parallel to the surface of the screen 210.

[0153] For details of the adhesive layer, refer to the foregoing related descriptions. The first region of the adhesive layer 250 may correspond to the foregoing first region 251 of the adhesive layer 150, and the second region of the adhesive layer 250 may correspond to the foregoing second region 252 of the adhesive layer 150. For brevity, the details are not described again.

[0154] To reduce the thickness of the device, optionally, the screen sounding device further includes the rear cover disposed on the side that is of the middle frame 240 and that is far away from the screen 210. A peripheral region of a surface that is of the rear cover and that faces the middle frame 240 is adhered to a surface of the middle frame 240. The hole that accommodates the vibrator 230 is disposed in the middle frame 240. The vibrator 230 protrudes from the hole on the side that is of the middle frame 240 and that is far away from the screen 210. In a thickness direction of the screen 210, a distance between a partial region starting from an end portion of the rear cover and the screen 210 is gradually changed, and a distance between the end portion of the rear cover and the screen 20 is the largest; and the vibrator 23 is placed in the partial region.

[0155] The rear cover may correspond to the foregoing rear cover 160 corresponding to FIG. 14, and the partial region of the rear cover may correspond to the partial region 161 of the rear cover 160 corresponding to FIG. 14. For details of relationships between the rear cover, the vibrator, and the middle frame, refer to the foregoing related descriptions. For brevity, the details are not described again.

[0156] To reduce the thickness of the device, referring to FIG. 28, optionally, a groove or a hole is disposed in a protective layer 212 of the screen 210, and the groove or the hole in the protective layer 212 accommodates the vibrator 230. The protective layer of the screen 210 may include at least one layer that protects a component layer

212 of the screen 210, such as a copper foil layer or a foam layer.

[0157] In the embodiments of this application, the vibrator 230 may be placed in any location in the device, provided that normal operation of other components is not affected.

[0158] Optionally, the screen sounding device includes a camera, and the vibrator 230 is disposed close to the camera.

[0159] For details of a relationship between the camera and the vibrator, refer to the foregoing related descriptions. For brevity, the details are not described herein again.

[0160] Still referring to FIG. 25 to FIG. 27, the screen sounding device further includes a screen circuit board 280 adhered under the screen 210. In an optional manner, the vibrator 230 may be disposed close to the screen circuit board 280.

[0161] The following describes in detail a structure in which the hard substance 220 and the vibrator 230 are disposed close to the screen circuit board 280.

[0162] In a possible implementation, still referring to FIG. 19, the screen sounding device further includes a screen circuit board 280 adhered under the screen 210, and a projection of the vibrator 230 on the surface of the screen 210 does not overlap with a projection of the screen circuit board 280 on the surface of the screen 210.

[0163] That is, the vibrator 230 is not stacked with the screen circuit board 280 in a z direction. Therefore, in an aspect, the thickness of the device can be reduced to a specific extent. In another aspect, a problem that the screen circuit board may be damaged due to vibration of the vibrator is alleviated. In still another aspect, a problem that a vibration effect of the vibrator is affected due to component stacking is alleviated.

[0164] The vibrator, the screen, and the screen circuit board in FIG. 19 may be respectively analogous to the vibrator 230, the screen 210, and the screen circuit board 280 herein.

[0165] In another possible implementation, the screen sounding device further includes a screen circuit board 280 disposed between the screen 210 and the vibrator 230. The vibrator 230 is adhered to the screen 210 by using the screen circuit board 280, and a projection of the vibrator 230 on the surface of the screen 210 at least partially overlaps with a projection of the screen circuit board 280 on the surface of the screen 210.

[0166] That is, in contrast to the first design manner, the vibrator 230 is stacked with the screen circuit board 280 in a z direction. The at least partially overlapping indicates partially overlapping and completely overlapping. The completely overlapping may indicate that the projection of the screen circuit board 280 on the surface of the screen 210 surrounds the projection of the vibrator 230 on the surface of the screen 210, or may indicate that the projection of the screen circuit board 280 on the surface of the screen 210 completely overlaps with the projection of the vibrator 230 on the surface of the screen

210. In this structure, the screen circuit board 280 is disposed between the screen 210 and the vibrator 230, and the vibrator 230 is adhered to the screen 210 by using the screen circuit board 280.

[0167] Therefore, the vibrator is enabled to be stacked with the screen circuit board, so that a use requirement can be met when inner space of the device is limited.

[0168] With reference to FIG. 29 and FIG. 30, the following describes a structure in which the vibrator 230 is stacked with the screen circuit board 280 in the z direction.

[0169] Referring to FIG. 29, optionally, the vibrator 230 is adhered to a side that is of the screen circuit board 280 and that is far away from the screen 210.

[0170] The side that is of the screen circuit board 280 and that is far away from the screen 210 indicates a lower surface of the screen circuit board 280, and an upper surface of the vibrator 230 is adhered to the lower surface of the screen circuit board 280.

[0171] Optionally, the vibrator 230 is adhered to a non-component region of the screen circuit board 280, to prevent a component of the screen circuit board 280 from being damaged due to vibration of the vibrator 230.

[0172] Referring to FIG. 30, optionally, a hole that accommodates the vibrator 230 is disposed in a non-component region of the screen circuit board 280.

[0173] In this structure, the hole may be first disposed in the screen circuit board 280, and a component and cabling are disposed in a region other than the hole.

[0174] It should be noted that, in the structure in which the vibrator is stacked with the screen circuit board in the z direction, for location relationships and connection relationships between the vibrator and other components such as the middle frame, the rear cover, and the adhesive layer, all refer to the foregoing location relationships and connection relationships between the components. This is not limited in the embodiments of this application. For details, refer to the foregoing related descriptions. For brevity, the details are not described again.

[0175] Likewise, the screen sounding device may include a plurality of vibrators. For location relationships and connection relationships between each vibrator and other components (such as the screen, the middle frame, the rear cover, and the support apparatus), all refer to the foregoing embodiments. For example, one vibrator may be disposed on each of two sides of a center line of the device in a y direction. For a design of the vibrator and designs of the vibrator and other components (such as the screen, the middle frame, the rear cover, and the support apparatus), all refer to the designs in the embodiments corresponding to FIG. 25 to FIG. 30. This is not limited in the embodiments of this application.

[0176] It should be noted that, in a structure in which the screen sounding device includes the plurality of vibrators, when structure space is limited, some vibrators may be disposed close to the screen circuit board. It is assumed that the screen sounding device includes two vibrators. If a region on one side of the center line is

denoted as an upper half region of the device, and a region on the other side of the center line is denoted as a lower half region of the device, one vibrator is disposed in the upper half region, and the other vibrator is disposed in the lower half region. Assuming that the screen circuit board is located in the lower half region, and the vibrator is inevitably close to the screen circuit board, a location relationship and a connection relationship between the vibrator and the screen circuit board may be set with reference to the embodiments corresponding to FIG. 29 and FIG. 30, and relationships between the vibrator and components such as the middle frame, the adhesive layer, the rear cover, and the support apparatus may be set with reference to the location relationships and the connection relationships between the components in FIG. 25 to FIG. 28.

[0177] 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 readily figured out by a person skilled in the art 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 screen sounding device, wherein the screen sounding device comprises:
 - a screen, a hard substance, and a vibrator, wherein
 - the hard substance is disposed between the screen and the vibrator, the vibrator is adhered to the screen by using the hard substance, the vibrator drives, by using the hard substance, the screen to vibrate in a direction perpendicular to a surface of the screen, a Young's modulus of the hard substance is greater than a preset value, and an area of a projection of the hard substance on the surface of the screen is greater than an area of a projection of the vibrator on the surface of the screen and is less than an area of the surface of the screen.
2. The screen sounding device according to claim 1, wherein the screen sounding device further comprises a middle frame disposed under the screen, a first hole or a first groove is disposed in the middle frame, and the first hole or the first groove accommodates the vibrator.
3. The screen sounding device according to claim 2, wherein in a thickness direction of the screen, there is a gap between the hard substance and a surface that is of the middle frame and that faces the hard

substance.

4. The screen sounding device according to claim 2 or 3, wherein a second groove is further disposed in the middle frame, and the second groove accommodates the hard substance.
5. The screen sounding device according to any one of claims 2 to 4, wherein the first hole is disposed in the middle frame, and the vibrator protrudes from the first hole on a side that is of the middle frame and that is far away from the screen; and the screen sounding device further comprises a support apparatus connected, through fastening, to the side that is of the middle frame and that is far away from the screen, and a surface that is of the vibrator and that protrudes from the first hole is in contact with a surface of the support apparatus.
6. The screen sounding device according to any one of claims 1 to 5, wherein the area of the projection of the hard substance on the surface of the screen is less than or equal to half the area of the surface of the screen.
7. The screen sounding device according to any one of claims 2 to 6, wherein
a peripheral region of a lower surface of the screen is adhered to a surface of the middle frame by using an adhesive layer, the adhesive layer comprises first regions and second regions, the first regions are close to the hard substance, the second regions are at least some regions of the adhesive layer other than the first regions, a size of the first region in a first direction is smaller than a size of the second region in the first direction, the first direction is a direction that perpendicularly points to an inner side of the adhesive layer from an outer side of the adhesive layer, and the first direction is parallel to the surface of the screen.
8. The screen sounding device according to any one of claims 2 to 7, wherein the screen sounding device further comprises a rear cover disposed on the side that is of the middle frame and that is far away from the screen, a peripheral region of a surface that is of the rear cover and that faces the middle frame is adhered to a surface of the middle frame, the first hole that accommodates the vibrator is disposed in the middle frame, and the vibrator protrudes from the first hole on the side that is of the middle frame and that is far away from the screen; and in the thickness direction of the screen, a distance between a partial region starting from an end portion of the rear cover and the screen is gradually changed, and a distance between the end portion of the rear cover and the screen is the largest; and the vibrator is placed in the partial region.

9. The screen sounding device according to any one of claims 1 to 8, wherein n holes are disposed in a region of the hard substance other than a region that is of the hard substance and that is adhered to the vibrator, and n is a positive integer.
10. The screen sounding device according to any one of claims 1 to 9, wherein the hard substance is a metal object, and a surface that is of the hard substance and that is adhered to the screen and/or a surface that is of the hard substance and that is adhered to the vibrator each are/is coated with an insulation layer.
11. The screen sounding device according to any one of claims 1 to 10, wherein a coefficient of thermal conductivity of the hard substance is greater than a preset value.
12. The screen sounding device according to any one of claims 1 to 11, wherein a third groove or a second hole is disposed in a protective layer of the screen, and the third groove or the second hole accommodates the hard substance.
13. The screen sounding device according to claim 12, wherein a fourth groove that accommodates the vibrator is disposed in the hard substance, the third groove or the second hole in the protective layer of the screen accommodates the fourth groove, and a region of the hard substance other than the fourth groove is adhered under the screen.
14. The screen sounding device according to any one of claims 1 to 13, wherein the screen sounding device further comprises a camera, and the hard substance and the vibrator are disposed close to the camera.
15. The screen sounding device according to any one of claims 1 to 14, wherein the screen sounding device further comprises a screen circuit board adhered under the screen; and the projections of the vibrator and the hard substance on the surface of the screen do not overlap with a projection of the screen circuit board on the surface of the screen.
16. The screen sounding device according to any one of claims 1 to 14, wherein the screen sounding device further comprises a screen circuit board disposed between the screen and the vibrator, and the vibrator is adhered to the screen by using the hard substance and the screen circuit board; and a projection of the screen circuit board on the surface of the screen at least partially overlaps with the projections of the vibrator and the hard substance on the surface of the screen.

17. The screen sounding device according to claim 16, wherein

the hard substance is adhered to a side that is of the screen circuit board and that is far away from the screen; or

the hard substance is adhered between the screen and the screen circuit board; or

a third hole is disposed in a non-component region of the screen circuit board, and the third hole accommodates the hard substance.

18. A screen sounding device, wherein the screen sounding device comprises:

a screen;

a vibrator adhered under the screen; and

a middle frame disposed under the screen, wherein a hole or a groove that accommodates the vibrator is disposed in the middle frame, and the vibrator drives the screen to vibrate in a direction perpendicular to a surface of the screen.

19. The screen sounding device according to claim 18, wherein the hole is disposed in the middle frame, and the vibrator protrudes from the hole on a side that is of the middle frame and that is far away from the screen; and

the screen sounding device further comprises a support apparatus connected, through fastening, to the side that is of the middle frame and that is far away from the screen, and a surface that is of the vibrator and that protrudes from the hole is in contact with a surface of the support apparatus.

20. The screen sounding device according to claim 18 or 19, wherein

a peripheral region of a lower surface of the screen is adhered to a surface of the middle frame by using an adhesive layer, the adhesive layer comprises first regions and second regions, the first regions are close to the vibrator, the second regions are at least some regions of the adhesive layer other than the first regions, a size of the first region in a first direction is smaller than a size of the second region in the first direction, the first direction is a direction that perpendicularly points to an inner side of the adhesive layer from an outer side of the adhesive layer, and the first direction is parallel to the surface of the screen.

21. The screen sounding device according to any one of claims 18 to 20, wherein the screen sounding device further comprises a rear cover disposed on the side that is of the middle frame and that is far away from the screen, a peripheral region of a surface that is of the rear cover and that faces the middle frame is adhered to a surface of the middle frame, the hole that accommodates the vibrator is disposed in the

middle frame, and the vibrator protrudes from the hole on the side that is of the middle frame and that is far away from the screen; and

in a thickness direction of the screen, a distance between a partial region starting from an end portion of the rear cover and the screen is gradually changed, and a distance between the end portion of the rear cover and the screen is the largest; and the vibrator is placed in the partial region.

22. The screen sounding device according to any one of claims 18 to 21, wherein a groove or a hole is disposed in a protective layer of the screen, and the groove or the hole in the protective layer accommodates the vibrator.

23. The screen sounding device according to any one of claims 18 to 22, wherein the screen sounding device further comprises a camera, and the vibrator is disposed close to the camera.

24. The screen sounding device according to any one of claims 18 to 23, wherein the screen sounding device further comprises a screen circuit board adhered under the screen; and a projection of the vibrator on the surface of the screen does not overlap with a projection of the screen circuit board on the surface of the screen.

25. The screen sounding device according to any one of claims 18 to 23, wherein the screen sounding device further comprises a screen circuit board disposed between the screen and the vibrator, and the vibrator is adhered to the screen by using the screen circuit board; and a projection of the screen circuit board on the surface of the screen at least partially overlaps with a projection of the vibrator on the surface of the screen.

26. The screen sounding device according to claim 25, wherein

the vibrator is adhered to a side that is of the screen circuit board and that is far away from the screen; or

a hole that accommodates the vibrator is disposed in a non-component region of the screen circuit board.

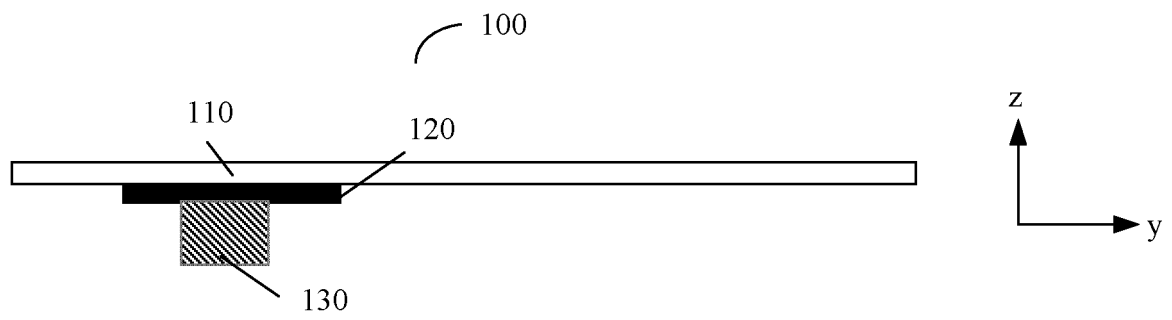


FIG. 1

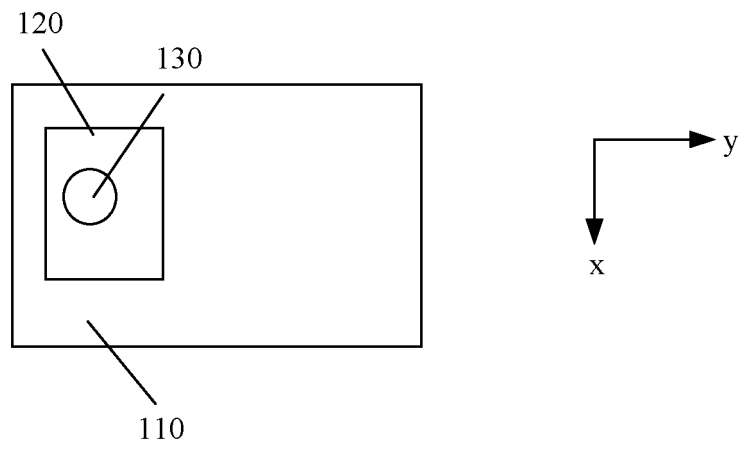


FIG. 2

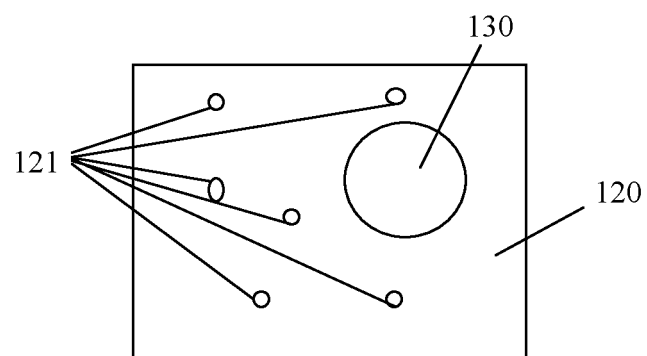


FIG. 3

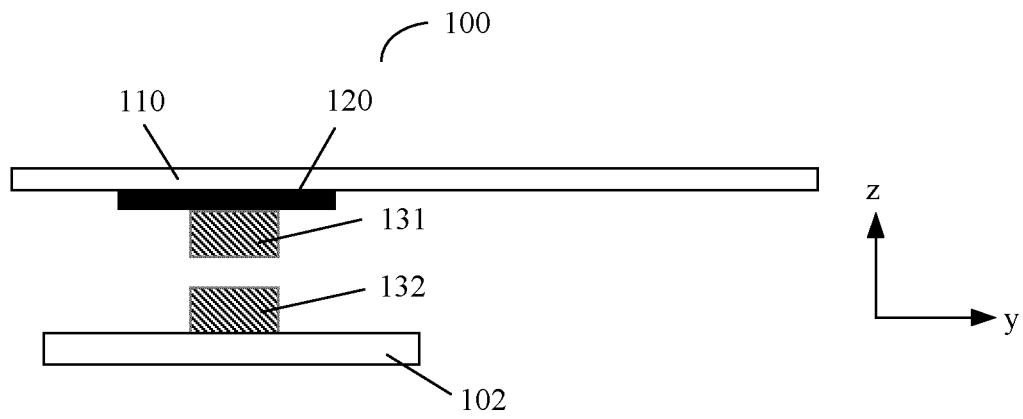


FIG. 4

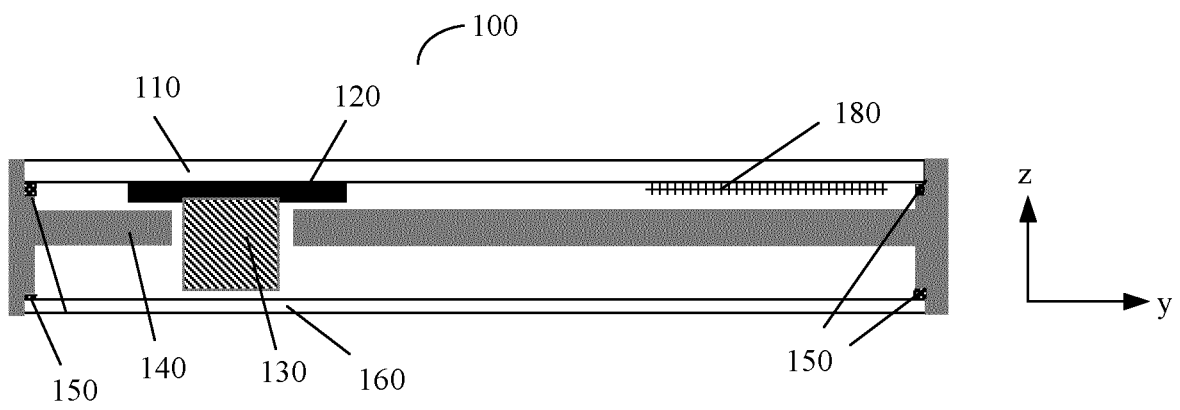


FIG. 5

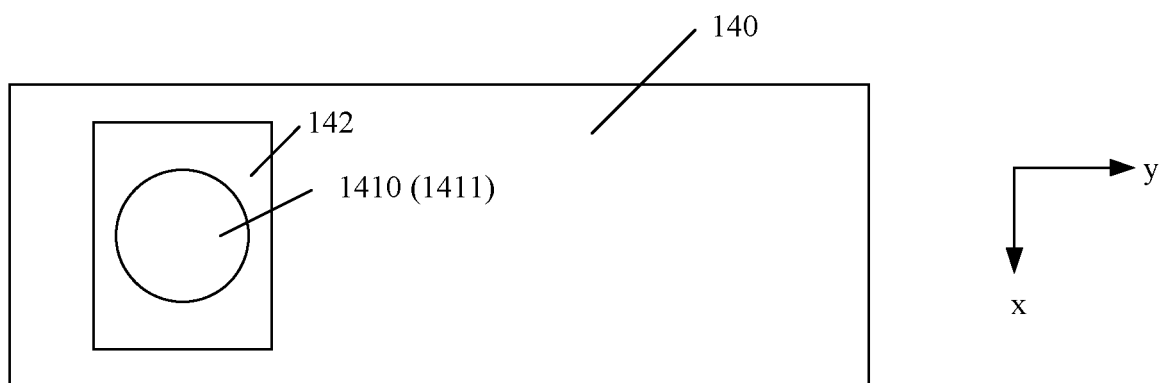


FIG. 6

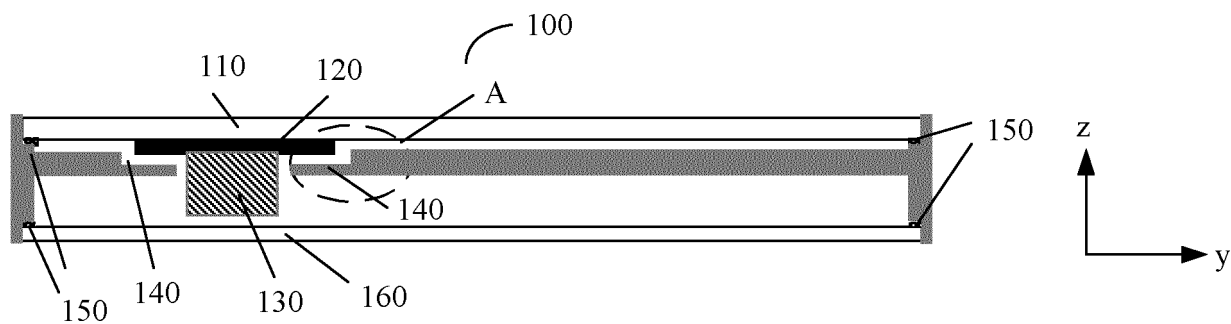


FIG. 7

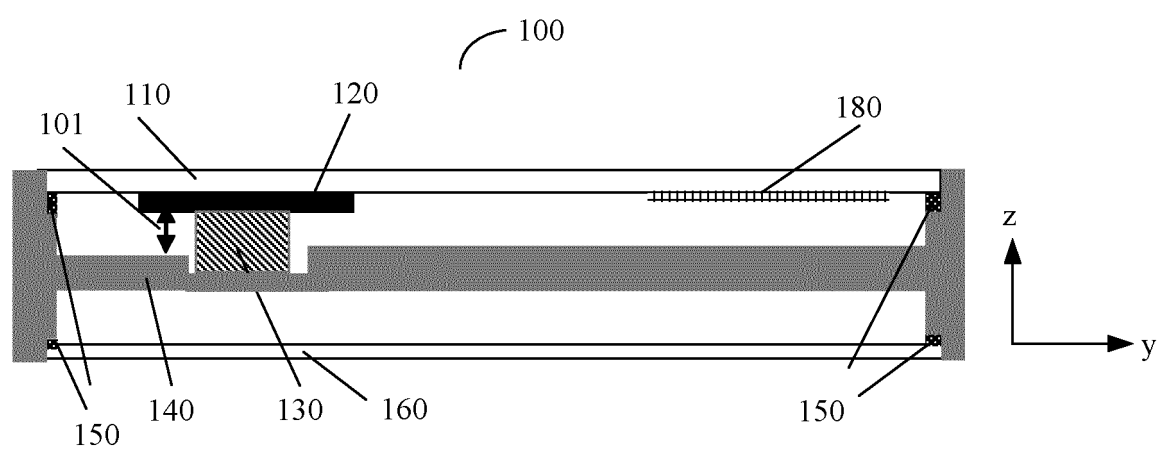


FIG. 8

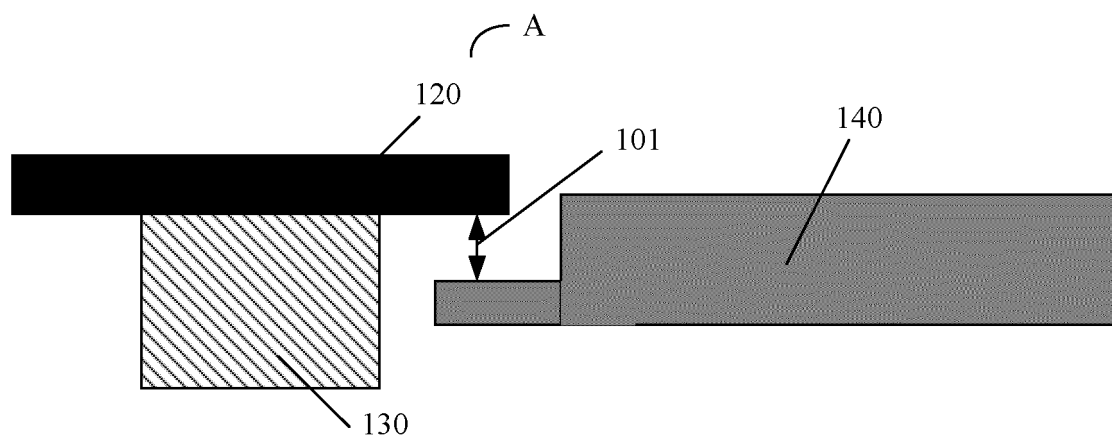


FIG. 9

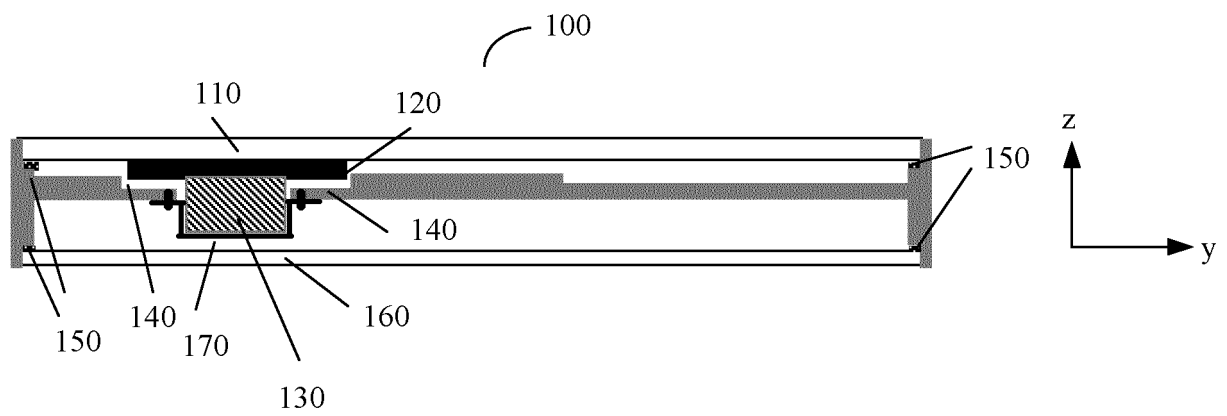


FIG. 10

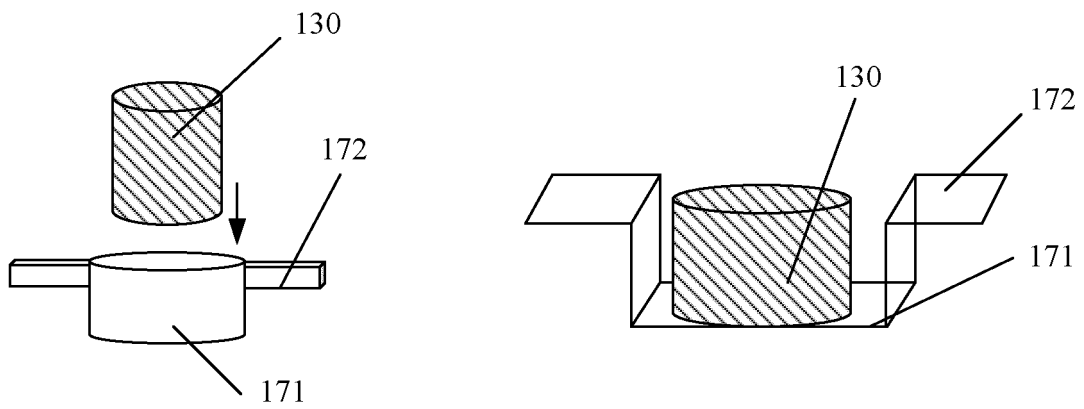


FIG. 11

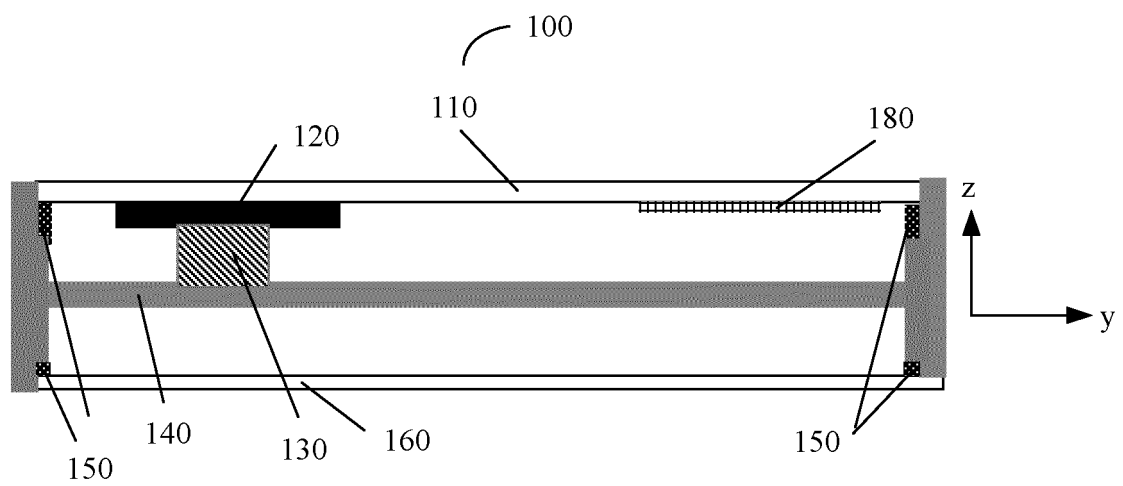
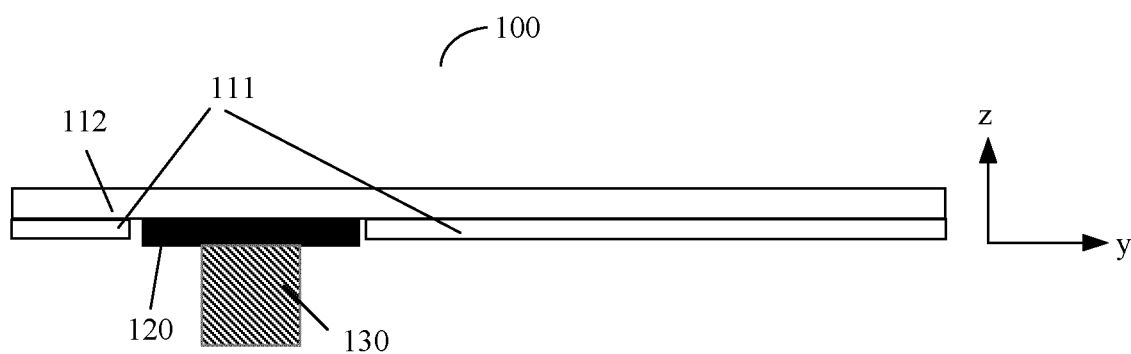
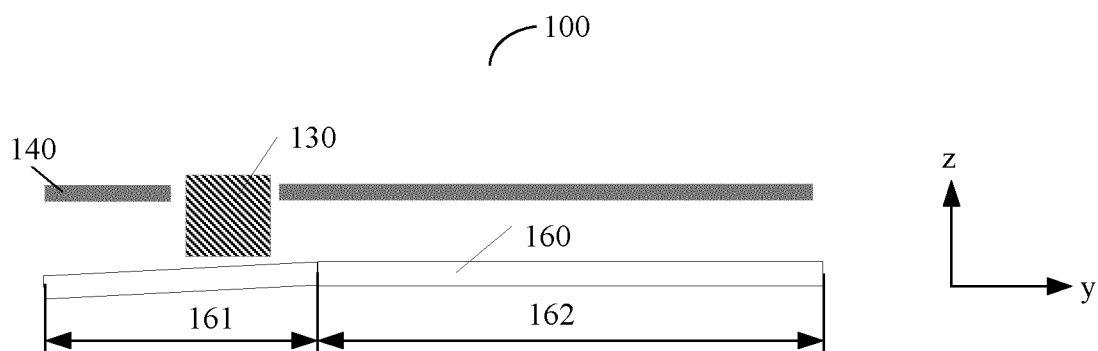
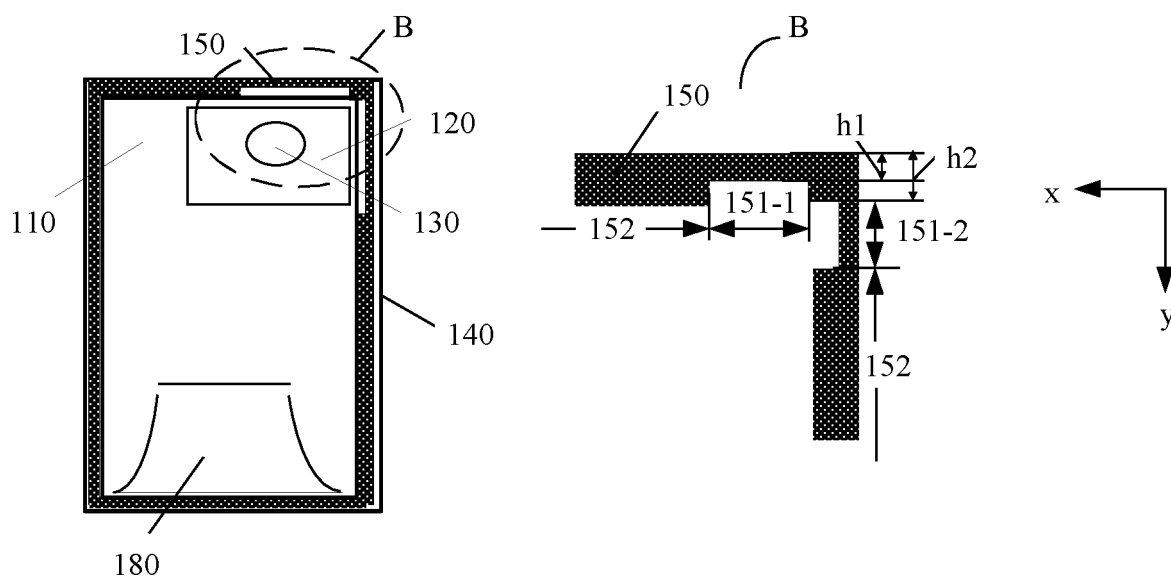


FIG. 12



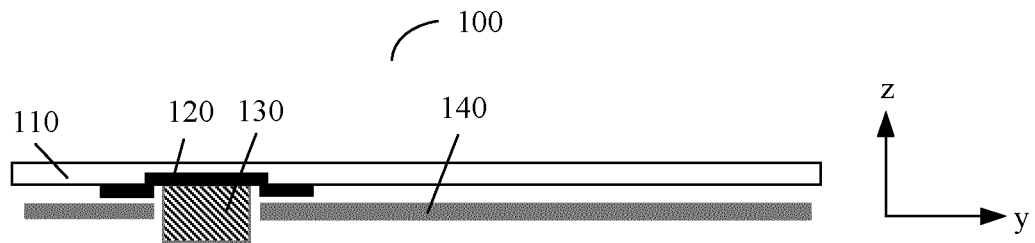


FIG. 16

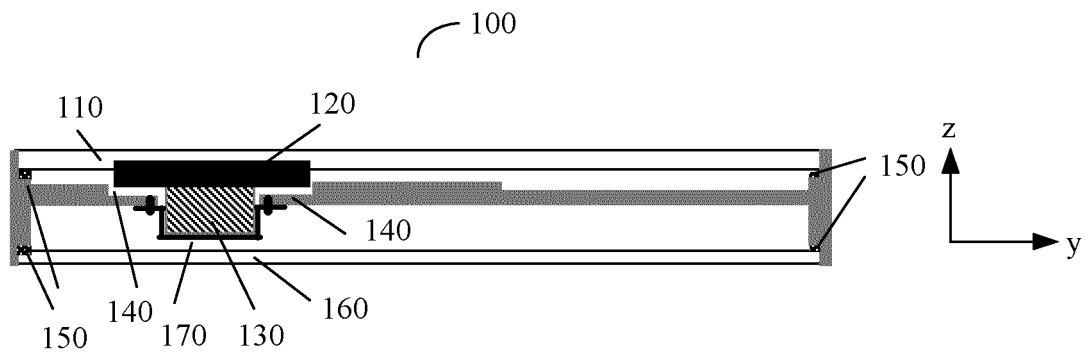


FIG. 17

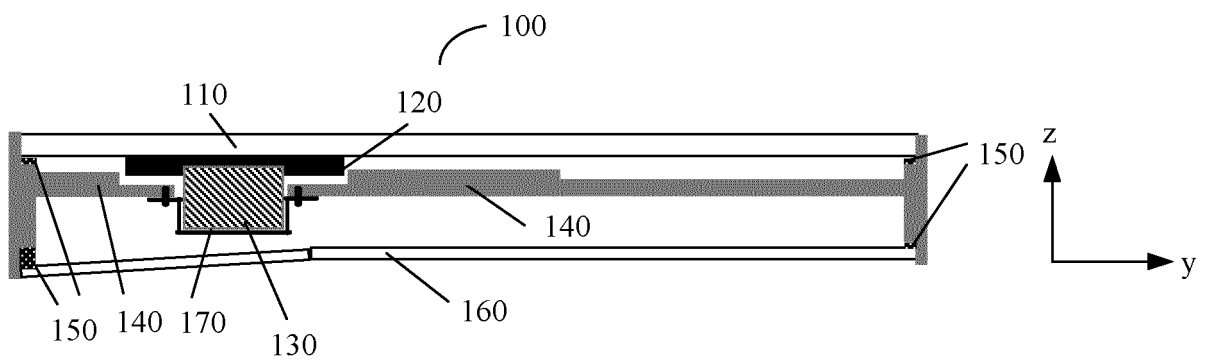


FIG. 18

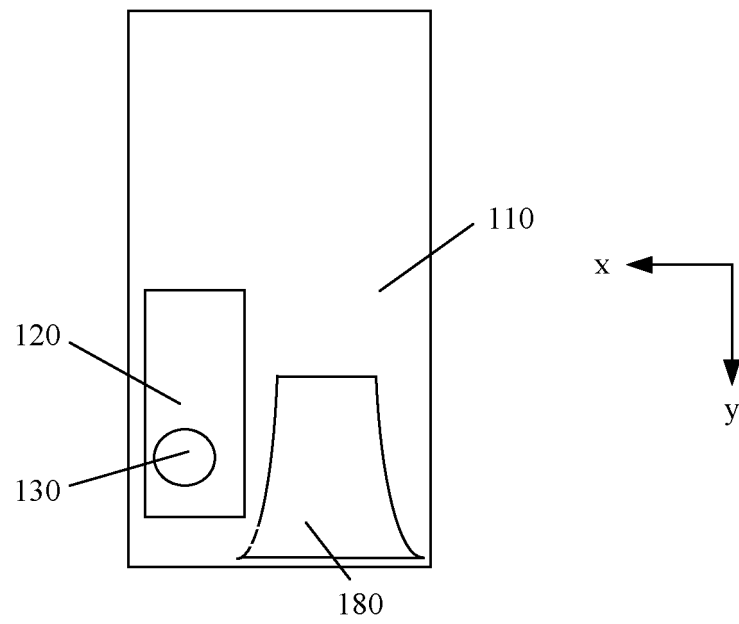


FIG. 19

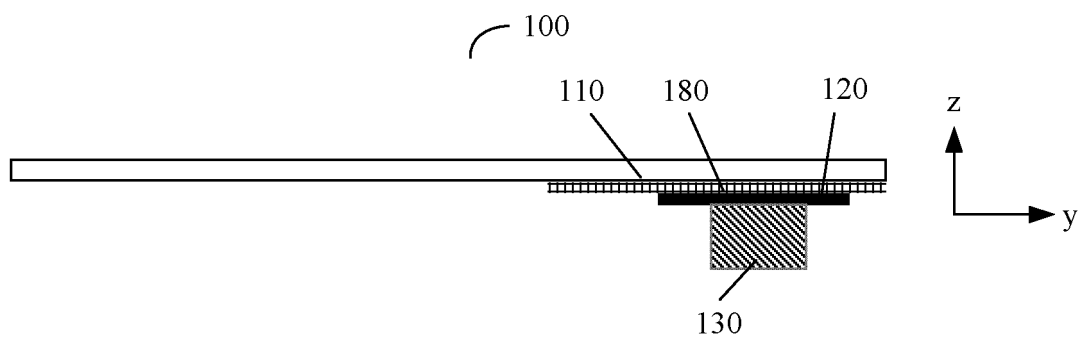


FIG. 20

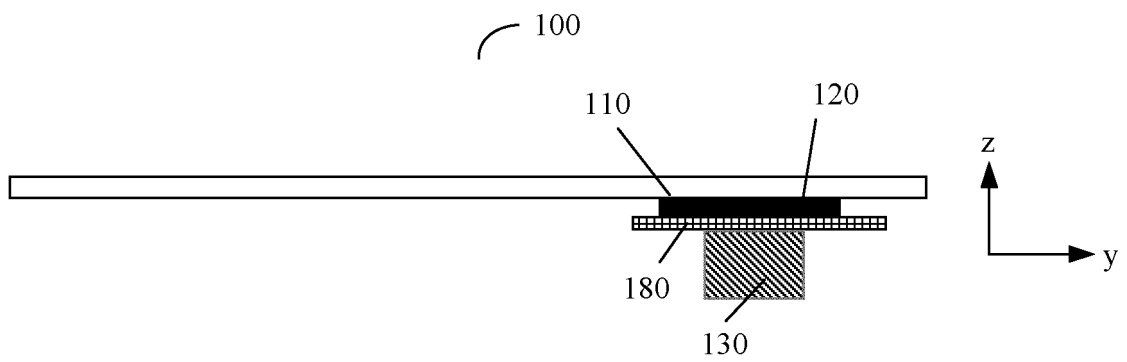


FIG. 21

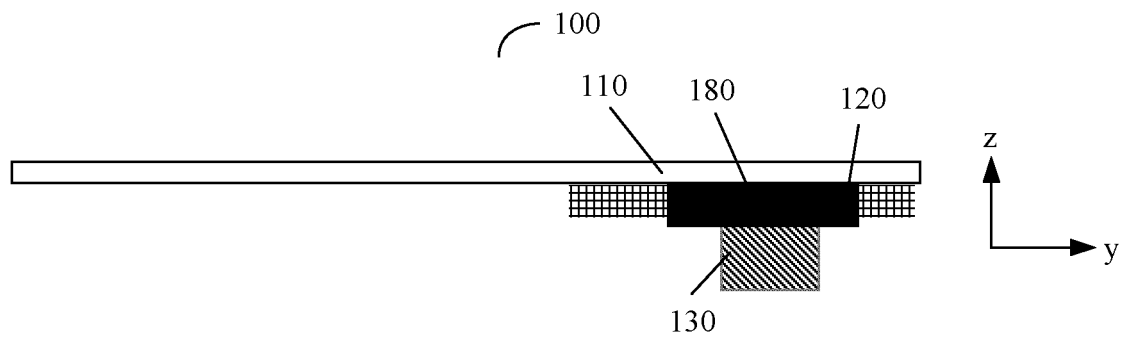


FIG. 22

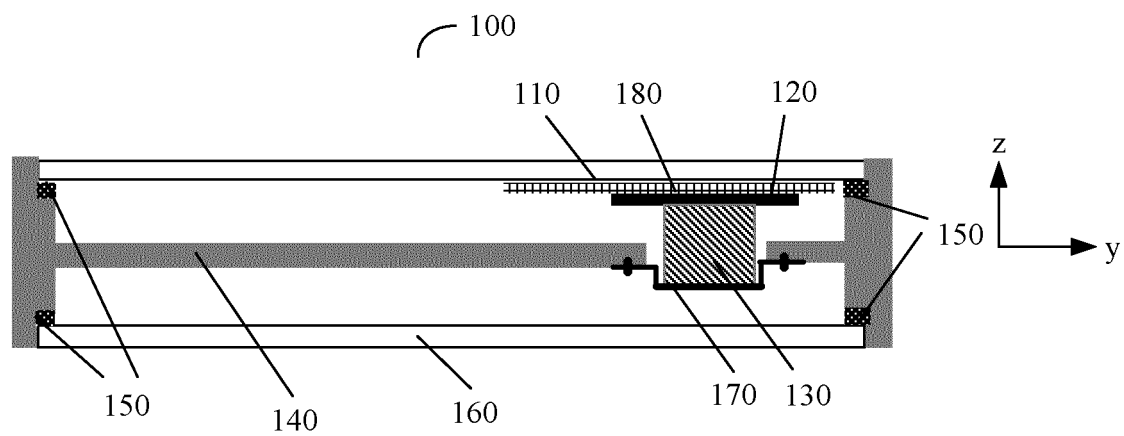


FIG. 23

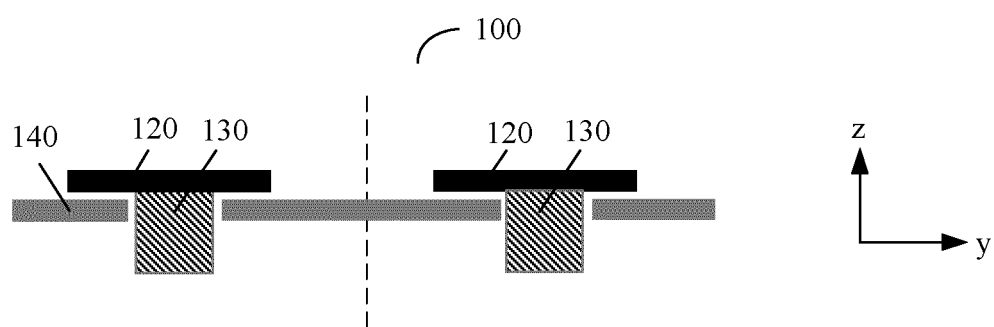


FIG. 24

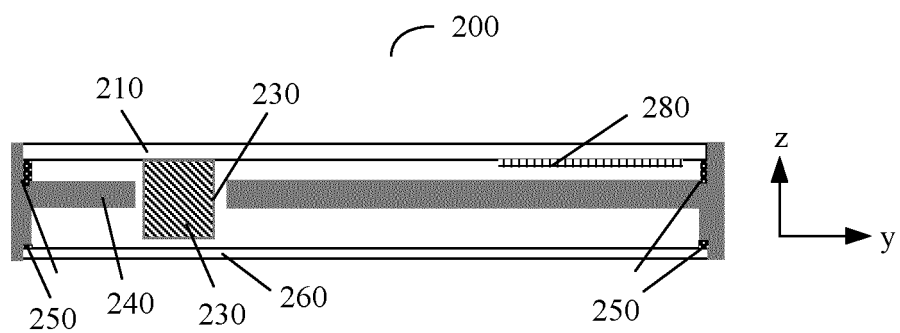


FIG. 25

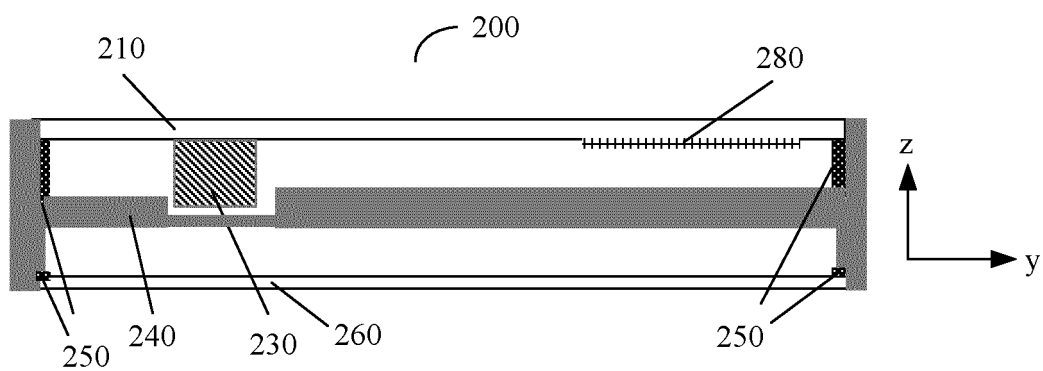


FIG. 26

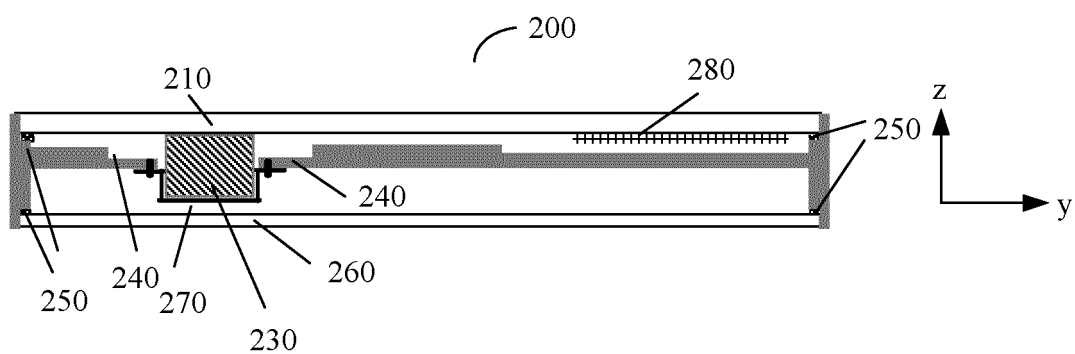


FIG. 27

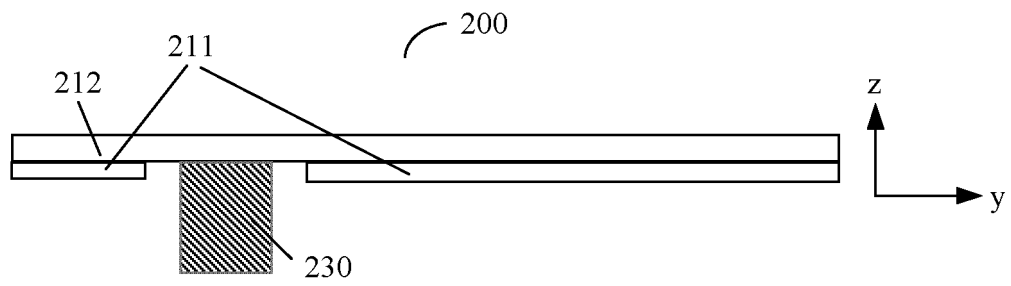


FIG. 28

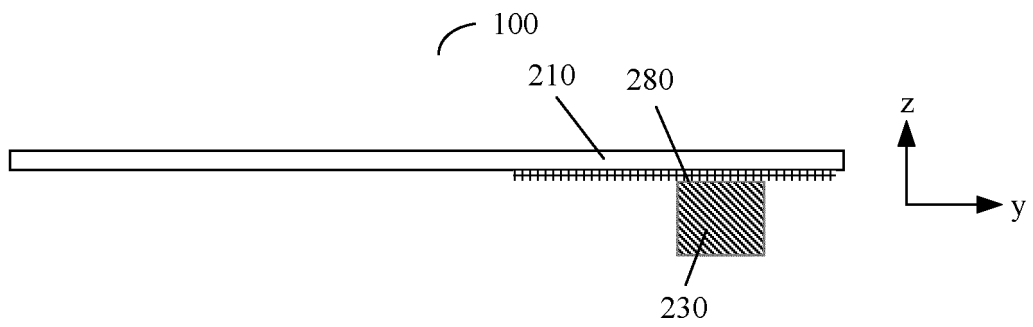


FIG. 29

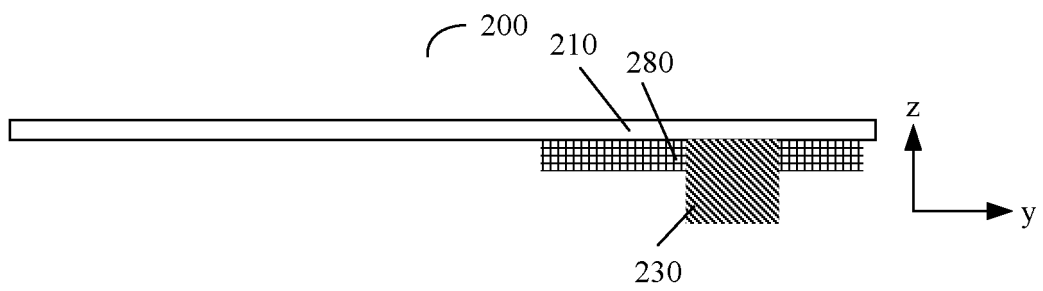


FIG. 30

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/079386

A. CLASSIFICATION OF SUBJECT MATTER

H04R 9/06(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)

H04R

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)

CNPAT; CNKI; EPODOC; WPI; GOOGLE: 屏幕, 显示, 发声, 振动, 震动, screen, display, sound, vibrat+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 110087172 A (HUAWEI TECHNOLOGIES CO., LTD.) 02 August 2019 (2019-08-02) claims 1-26	1-26
X	CN 109032257 A (LIU, Bowen) 18 December 2018 (2018-12-18) description, paragraphs [0023]-[0054], and figures 1-3	1-17
X	CN 108881523 A (GOERTEK INC.) 23 November 2018 (2018-11-23) description, paragraphs [0035]-[0057], and figures 1-4	18-26
A	CN 203352639 U (AAC TECHNOLOGIES (NANJING) CO., LTD.) 18 December 2013 (2013-12-18) entire document	1-26
A	CN 108810765 A (LIU, Bowen) 13 November 2018 (2018-11-13) entire document	1-26
A	CN 203086644 U (AAC TECHNOLOGIES (NANJING) CO., LTD.) 24 July 2013 (2013-07-24) entire document	1-26
A	CN 203206465 U (AAC TECHNOLOGIES (NANJING) CO., LTD.) 18 September 2013 (2013-09-18) entire document	1-26

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

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“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“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

“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

“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

“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

“&” document member of the same patent family

Date of the actual completion of the international search

27 April 2020

Date of mailing of the international search report

15 June 2020

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
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China

Authorized officer

Facsimile No. (86-10)62019451

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/079386

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 108566592 A (GOERTEK INC.) 21 September 2018 (2018-09-21) entire document	1-26
A	WO 2015199140 A1 (KYOCERA CORPORATION) 30 December 2015 (2015-12-30) entire document	1-26

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2020/079386

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	110087172	A	02 August 2019	None			
CN	109032257	A	18 December 2018	None			
CN	108881523	A	23 November 2018	None			
CN	203352639	U	18 December 2013	None			
CN	108810765	A	13 November 2018	None			
CN	203086644	U	24 July 2013	None			
CN	203206465	U	18 September 2013	None			
CN	108566592	A	21 September 2018	None			
WO	2015199140	A1	30 December 2015	US	2017105294	A1	13 April 2017
				JP	2016010105	A	18 January 2016

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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