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(71) Applicant: **Shenzhen Shokz Co., Ltd.**
Shenzhen, Guangdong 518108 (CN)

(72) Inventors:
• **ZHOU, Wenbing**
Shenzhen, Guangdong 518108 (CN)
• **ZHANG, Lei**
Shenzhen, Guangdong 518108 (CN)
• **GUO, Burui**
Shenzhen, Guangdong 518108 (CN)
• **LIU CHUN, Zhiqing**
Shenzhen, Guangdong 518108 (CN)
• **QI, Xin**
Shenzhen, Guangdong 518108 (CN)

(74) Representative: **Wang, Bo**
Panovision IP
Ebersberger Straße 3
85570 Markt Schwaben (DE)

(54) **LOUDSPEAKER AND EARPHONE**

(57) One or more embodiments of the present description relate to a loudspeaker, comprising: a magnetic circuit assembly; a voice coil assembly, at least part of the voice coil being located in a magnetic gap of the magnetic circuit assembly; and a first diaphragm and a second diaphragm, the first diaphragm and the second diaphragm being spaced apart in a vibration direction, at least one of the first diaphragm and the second diaphragm being connected to a voice coil assembly, and the voice coil assembly being configured to drive the first diaphragm and the second diaphragm to synchronously vibrate in the same direction. The voice coil assembly comprises a first voice coil and a second voice coil arranged in the vibration direction, the first diaphragm is connected to the first voice coil, the second diaphragm is connected to the second voice coil, the first voice coil and the second voice coil are connected via a connector, and the first voice coil and the second voice coil respectively drive the first diaphragm and the second diaphragm to synchronously vibrate in the same direction. By means of the cooperation between the magnetic circuit assembly and the voice coil assembly, and by means of connect-

ing the two voice coils via the connector, it can be better ensured that the first diaphragm and the second diaphragm synchronously vibrate in the same direction, thereby improving the output effect of an earphone.

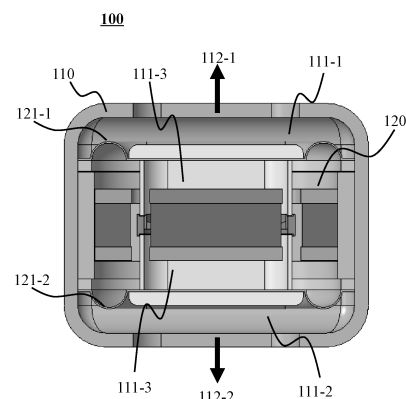


FIG. 4

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese Patent Application No. 202410966001.5, filed on July 17, 2024, and Chinese Patent Application No. 202520976939.5, filed on May 16, 2025, the entire contents of each of which are hereby incorporated by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of acoustic technology, and in particular to a speaker and an earphone.

BACKGROUND

[0003] As people's requirements for daily life continue to increase, consumer demands for earphones are also increasing. In addition to stable output performance, it is also required to shield environmental noise and perform normal listening in noisy or even high-noise environments. Consequently, a noise reduction performance of earphones has a great impact on user comfort.

[0004] Therefore, it is necessary to provide a speaker and an earphone to improve a noise reduction effect of an acoustic device.

SUMMARY

[0005] One or more embodiments of the present disclosure provide a speaker, comprising: a magnetic circuit assembly; a voice coil assembly, at least a portion of a voice coil being located within a magnetic gap of the magnetic circuit assembly; a first diaphragm and a second diaphragm, the first diaphragm and the second diaphragm being spaced apart in a vibration direction; at least one of the first diaphragm and the second diaphragm is connected to the voice coil assembly, the voice coil assembly being configured to drive the first diaphragm and the second diaphragm to vibrate synchronously in the same direction; wherein the voice coil assembly includes a first voice coil and a second voice coil arranged along the vibration direction, the first diaphragm is connected to the first voice coil, the second diaphragm is connected to the second voice coil, the first voice coil and the second voice coil are connected via a third connecting member, and the first voice coil and the second voice coil respectively drive the first diaphragm and the second diaphragm to vibrate synchronously in the same direction.

[0006] One or more embodiments of the present disclosure also provide an earphone, comprising the speaker as described above, the earphone further comprising: a first housing, the speaker being arranged

within the first housing; in a wearing state, wherein the first housing includes an inner side wall on a side facing an external auditory canal, and an outer side wall opposite to the inner side wall and on a side away from the external auditory canal, the inner side wall is provided with a first sound outlet hole, and the outer side wall is provided with a second sound outlet hole; the first diaphragm of the speaker and the inner side wall form a first acoustic cavity communicating with the first sound outlet hole, and the second diaphragm of the speaker and the outer side wall form a second acoustic cavity communicating with the second sound outlet hole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present disclosure is further illustrated in terms of exemplary embodiments, which are described in detail with reference to the accompanying drawings. These embodiments are not restrictive, and in these embodiments, the same numbering indicates the same structure, wherein:

FIG. 1 is a schematic diagram illustrating an exemplary physiological structure of an ear according to some embodiments of the present disclosure;

FIG. 2 is a schematic diagram illustrating a wearing state of an earphone when worn on an ear according to some embodiments of the present disclosure;

FIG. 3 is a block diagram illustrating a sound generating portion according to some embodiments of the present disclosure;

FIG. 4 is a schematic diagram illustrating an internal structure of a sound generating portion according to some embodiments of the present disclosure;

FIG. 5 is a schematic diagram illustrating frequency response curves of an earphone corresponding to different diaphragms according to some embodiments of the present disclosure;

FIG. 6 is a schematic diagram illustrating a structure of a diaphragm assembly according to some embodiments of the present disclosure;

FIG. 7 is an enlarged schematic diagram illustrating a partial structure of the diaphragm assembly in FIG. 6;

FIG. 8 is a schematic diagram illustrating a dimension of the structure shown in FIG. 7;

FIG. 9 is a schematic diagram illustrating driving force coefficients of a speaker corresponding to different moving distances of a voice coil assembly according to some embodiments of the present disclosure;

FIG. 10 is a schematic diagram illustrating KM curves of a diaphragm assembly corresponding to different first ratios according to some embodiments of the present disclosure;

FIG. 11 is a schematic diagram illustrating another

dimension of the structure shown in FIG. 7;
 FIG. 12 is a schematic diagram illustrating KMs
 curves of a diaphragm assembly corresponding to
 different second ratios according to some embodi-
 ments of the present disclosure; 5
 FIG. 13 is a schematic diagram illustrating another
 dimension of the structure shown in FIG. 7;
 FIG. 14 is a schematic diagram illustrating KMs
 curves of a diaphragm assembly corresponding to
 different third ratios according to some embodi-
 ments of the present disclosure; 10
 FIG. 15 is a schematic diagram illustrating another
 dimension of the structure shown in FIG. 7;
 FIG. 16 is a schematic diagram illustrating KMs
 curves of a diaphragm assembly corresponding to
 different fourth ratios according to some embodi-
 ments of the present disclosure; 15
 FIG. 17 is a schematic diagram illustrating another
 dimension of the structure shown in FIG. 7;
 FIG. 18 is a schematic diagram illustrating KMs 20
 curves of a diaphragm assembly corresponding to
 different fifth ratios according to some embodi-
 ments of the present disclosure;
 FIG. 19 is a schematic diagram illustrating a struc-
 ture of a center patch according to some embodi-
 ments of the present disclosure; 25
 FIG. 20 is a schematic diagram illustrating a cross-
 sectional structure of a sound generating portion in
 a short axis direction according to some embodi-
 ments of the present disclosure; 30
 FIG. 21 is a schematic diagram illustrating a struc-
 ture decomposition of a sound generating portion
 according to some embodiments of the present
 disclosure;
 FIG. 22 is a schematic diagram illustrating a struc- 35
 ture of a sound generating assembly in a sound
 generating portion according to some embodi-
 ments of the present disclosure;
 FIG. 23 is a schematic diagram illustrating a struc-
 ture decomposition of a sound generating assem- 40
 bly according to some embodiments of the present
 disclosure;
 FIG. 24 is a schematic diagram illustrating a cross-
 sectional structure of a sound generating assembly 45
 according to some embodiments of the present
 disclosure;
 FIG. 25 is a schematic diagram illustrating fre-
 quency response curves of a speaker correspond-
 ing to sound outlet holes of different sizes accord-
 ing to some embodiments of the present disclo- 50
 sure;
 FIGS. 26A-26C are schematic diagrams illustrating
 different positions of sound outlet holes according
 to some embodiments of the present disclosure;
 FIG. 27 is a schematic diagram illustrating fre- 55
 quency response curves of a speaker correspond-
 ing to sound outlet holes at different positions ac-
 cording to some embodiments of the present dis-

closure;
 FIGS. 28A-28B are schematic diagrams illustrating
 different relative positions of a first sound outlet
 hole and a second sound outlet hole according to
 some embodiments of the present disclosure;
 FIG. 29 is a schematic diagram illustrating fre-
 quency response curves of a speaker correspond-
 ing to a first sound outlet hole and a second sound
 outlet hole disposed at different positions accord-
 ing to some embodiments of the present disclo-
 sure;
 FIG. 30 is a schematic diagram illustrating a first
 sound outlet hole and a second sound outlet hole
 of different sizes according to some embodiments
 of the present disclosure;
 FIG. 31 is a schematic diagram illustrating fre-
 quency response curves of a speaker correspond-
 ing to a first sound outlet hole and a second sound
 outlet hole of different sizes according to some em-
 bodiments of the present disclosure;
 FIGS. 32A-32B are schematic diagrams illustrating
 acoustic holes of different shapes according to
 some embodiments of the present disclosure;
 FIG. 33 is a schematic diagram illustrating fre-
 quency response curves of a speaker correspond-
 ing to acoustic holes of different shapes according
 to some embodiments of the present disclosure;
 FIGS. 34A-34B are schematic diagrams illustrating
 different quantities of acoustic holes according to
 some embodiments of the present disclosure;
 FIG. 35 is a schematic diagram illustrating fre-
 quency response curves of a speaker correspond-
 ing to acoustic holes with different opening shapes
 and different quantities according to some embodi-
 ments of the present disclosure;
 FIGS. 36A-36F are schematic diagrams illustrating
 different distributions of non-single concentrated
 openings of sound outlet holes according to some
 embodiments of the present disclosure;
 FIG. 37 is a schematic diagram illustrating fre-
 quency response curves of a sound generating
 portion corresponding to sound outlet holes with
 different distributions of non-single concentrated
 openings according to some embodiments of the
 present disclosure;
 FIG. 38 is a schematic diagram illustrating a rela-
 tive position between a first sound outlet hole and
 a sound tuning hole according to some embodiments
 of the present disclosure;
 FIG. 39 is a schematic diagram illustrating fre-
 quency response curves of a sound generating
 portion corresponding to different distances be-
 tween any two holes or between any hole and a
 boundary of an acoustic cavity in FIG. 38;
 FIG. 40 is a schematic diagram illustrating fre-
 quency response curves of a sound generating
 portion corresponding to different area ratios of a
 first sound outlet hole and a sound tuning hole in

FIG. 38;

FIG. 41 is a schematic diagram illustrating an internal structure of a speaker according to some embodiments of the present disclosure;

FIG. 42 is schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure;

FIG. 43A is a schematic diagram illustrating an exploded view of a speaker according to some embodiments of the present disclosure;

FIG. 43B is schematic diagram illustrating another exploded view of a speaker according to some embodiments of the present disclosure;

FIGS. 44A-46B are schematic diagrams illustrating different structures of a speaker according to some embodiments of the present disclosure;

FIG. 47 is a schematic diagram illustrating driving force coefficients of a speaker including inner magnets of different dimensions according to some embodiments of the present disclosure;

FIG. 48 is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure;

FIG. 49 is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure;

FIG. 50 is a schematic diagram illustrating another perspective of the internal structure of the speaker shown in FIG. 49;

FIG. 51 is schematic diagram illustrating an exploded view of the speaker shown in FIG. 49;

FIG. 52 is a schematic diagram illustrating force factors of a speaker corresponding to through holes of different sizes according to some embodiments of the present disclosure;

FIG. 53 is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure;

FIG. 54A is a schematic diagram illustrating another exemplary structure of a speaker according to some embodiments of the present disclosure;

FIG. 54B is a schematic diagram illustrating another perspective of the structure of the speaker shown in FIG. 54A;

FIG. 55 is a schematic diagram illustrating another connection structure of a first voice coil and a second voice coil according to some embodiments of the present disclosure;

FIG. 56 is a schematic diagram illustrating another exemplary structure of a speaker according to some embodiments of the present disclosure;

FIG. 57 is a schematic diagram illustrating a frame according to some embodiments of the present disclosure;

FIG. 58 is a schematic diagram illustrating another frame according to some embodiments of the present disclosure;

FIG. 59 is a schematic diagram illustrating fre-

quency response curves of a speaker shown in FIG. 58;

FIG. 60 is a schematic diagram illustrating a structure of a magnetic shield according to some embodiments of the present disclosure;

FIGS. 61A-61G are schematic diagrams illustrating different exemplary structures of a speaker according to some embodiments of the present disclosure;

FIG. 62 is a schematic diagram illustrating frequency response curves of a speaker corresponding to inner and outer magnets of different sizes according to some embodiments of the present disclosure;

FIG. 63 is a schematic diagram illustrating another structure of a speaker according to some embodiments of the present disclosure;

FIGS. 64A-64B are schematic diagrams illustrating frequency response curves of a speaker corresponding to a magnet and a magnetic shield of different sizes in FIG. 63;

FIG. 65 is a schematic diagram illustrating another cross-sectional structure of a sound generating assembly according to some embodiments of the present disclosure;

FIG. 66 is a schematic structural diagram illustrating a structure decomposition of a speaker according to some embodiments of the present disclosure;

FIG. 67A is a schematic diagram illustrating another exploded view of a speaker according to some embodiments of the present disclosure;

FIG. 67B is a schematic diagram illustrating a cross-section of the speaker shown in FIG. 67A along a width direction;

FIG. 67C is a schematic diagram illustrating a cross-section of the speaker shown in FIG. 67A along a length direction;

FIG. 68A is schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure;

FIG. 68B is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure;

FIG. 69A is a schematic diagram illustrating a structure of a speaker including a magnetic circuit fixing ring according to some embodiments of the present disclosure;

FIG. 69B is a schematic diagram illustrating a structure of the speaker shown in FIG. 69A from another perspective;

FIG. 70A is a schematic diagram illustrating another structure of a speaker including a magnetic circuit fixing ring according to some embodiments of the present disclosure; and

FIG. 70B is a schematic diagram illustrating a structure of the speaker shown in FIG. 70A from another perspective.

DETAILED DESCRIPTION

[0008] In order to more clearly describe technical solutions of the embodiments of the present disclosure, a brief introduction to drawings to be used in a description of the embodiments will be provided below. It is apparent that the drawings in the following descriptions are merely some examples or embodiments of the present disclosure, and a person of ordinary skill in the art may apply the present disclosure to other similar scenarios based on the drawings without inventive effort. Unless otherwise apparent from the context or stated otherwise, the same reference numerals in the drawings represent the same structures or operations.

[0009] It should be understood that the words 'system', 'device', 'unit', and/or 'module' as used herein are a manner configured to distinguish between different components, elements, parts, portions, or assemblies of different levels. However, if other words may achieve the same purpose, the words may be replaced by other expressions.

[0010] As shown in the present disclosure and claims, unless the context clearly indicates otherwise, words such as 'a', 'an', and/or 'the' are not specifically limited to the singular, but may also include the plural. Generally speaking, terms 'comprising' and 'including' merely suggest inclusion of explicitly identified steps and elements, and these steps and elements do not constitute an exclusive list, and a manner or a device may also include other steps or elements.

[0011] Flowcharts are used in the present disclosure to illustrate operations performed by a system according to embodiments of the present disclosure. It should be understood that the preceding or subsequent operations are not necessarily performed in the exact order. Instead, the steps may be processed in reverse order or simultaneously. Meanwhile, other operations may also be added to these processes, or one or more steps may be removed from these processes.

[0012] FIG. 1 is a schematic diagram illustrating an exemplary physiological structure of an ear according to some embodiments of the present disclosure. Referring to FIG. 1, the ear includes physiological parts such as an external auditory canal 11, a concha cavity 12, a cavum concha 13, a triangular fossa 14, an antihelix 15, a scapha 16, a helix 17, an earlobe 18, a crus of helix 19, or the like. Although the external auditory canal 11 has a certain depth and extends to an eardrum of the ear, in the absence of specific instructions, the external auditory canal 11 may be understood as an opening away from the eardrum (that is, an earhole or an ear canal opening). Further, the physiological parts such as the concha cavity 12, the cavum concha 13, and the triangular fossa 14 have a certain volume and depth in a three-dimensional space, and the concha cavity 12 is in direct communication with the external auditory canal 11, that is, it may be simply regarded that the aforementioned ear canal opening is located

at a bottom of the concha cavity 12.

[0013] Since the physiological parts such as the external auditory canal 11, the concha cavity 12, the cavum concha 13, and the triangular fossa 14 have a certain depth and volume in a three-dimensional space, regarding an earphone provided in some embodiments of the present disclosure, stable wearing of the earphone may be achieved with the aid of one or more physiological parts of the ear.

[0014] Exemplarily, with the aid of other physiological parts of the ear except the external auditory canal 11 (e.g., the cavum concha 13, the triangular fossa 14, the antihelix 15, the scapha 16, the helix 17, or the like, or a combination thereof), the wearing of the earphone is achieved. For example, in a wearing state, an overall structure or a partial structure of the earphone may be in contact with an upper portion of the external auditory canal 11 (e.g., one or more physiological parts such as the cavum concha 13, the triangular fossa 14, the antihelix 15, the scapha 16, the helix 17, the crus of helix 19, or the like). Alternatively, in the wearing state, an overall structure or a partial structure of the earphone may be located within a first region P1 enclosed by dashed lines in FIG. 1 and at least including the cavum concha 13 and the triangular fossa 14, or may be located within a second region P2 enclosed by dashed lines in FIG. 1 and at least including the concha cavity 12. In addition, the overall structure or the partial structure of the earphone may be located at a front side of the crus of helix 19 (that is, within a third region P3 enclosed by dashed lines in FIG. 1).

[0015] By virtue of other physiological parts of the ear, except the external auditory canal 11, the wearing of the earphone and transmission of sound are achieved, which not only may free the external auditory canal and reduce an impact of the earphone on ear health of a user, but also may effectively improve user experience of the earphone. For example, when the user wears the earphone on a road, the earphone will not block the external auditory canal 11. In this way, the user may both receive a sound from the earphone and receive ambient sounds (e.g., horn sounds, bicycle bell sounds, surrounding human voices, traffic command sounds, or the like), thereby being capable of effectively reducing the occurrence of traffic accidents.

[0016] Since different users may have individual differences, resulting in dimension differences, such as different shapes, sizes, or the like, in the ear. To facilitate description and understanding and to reduce or even eliminate individual differences of different users, unless otherwise specified, the present disclosure primarily describes structures of earphones in different embodiments and their wearing manners on an ear model with standard shape and dimensions, by taking the ear model as a reference. For example, a simulator including a head and its (left and right) ears (e.g., GRAS 45BC KEMAR) may be prepared based on the ANSI:S3.36, S3.25, and IEC:60318-7 standards, as a

reference for wearing the earphone, thereby presenting scenarios where most users normally wear earphones.

[0017] The descriptions in the present disclosure such as 'user wearing', 'in a wearing state', and 'under a wearing state' refer to the earphone described in the present disclosure being worn on an ear of the aforementioned simulator. Of course, considering that different users have individual differences, the structures, shapes, sizes, thicknesses, or the like of one or more ear parts may be differentially designed according to ears of different shapes and dimensions. These differentiated designs may be manifested as characteristic parameters of one or more parts of the earphone having values in different ranges, so as to adapt to different ears.

[0018] It should be noted that, in fields such as medicine, anatomy, or the like, three basic sections, namely a sagittal plane, a coronal plane, and a horizontal plane, and three basic axes, namely a sagittal axis, a coronal axis, and a vertical axis, may be defined for a human body. The sagittal plane refers to a section made along an anterior-posterior direction of the body and perpendicular to the ground, which divides the human body into left and right parts. The coronal plane refers to a section made along a left-right direction of the body and perpendicular to the ground, which divides the human body into anterior and posterior parts. The horizontal plane refers to a section made along a superior-inferior direction of the body and parallel to the ground, which divides the human body into upper and lower parts. Correspondingly, the sagittal axis refers to an axis along the anterior-posterior direction of the body and perpendicular to the coronal plane. The coronal axis refers to an axis along the left-right direction of the body and perpendicular to the sagittal plane. The vertical axis refers to an axis along the superior-inferior direction of the body and perpendicular to the horizontal plane.

[0019] Further, the 'front side of the ear' described in the present disclosure is a concept relative to the 'rear side of the ear', where the former refers to a side of the ear away from the head, and the latter refers to a side of the ear facing the head. Both are for the user's ear. When the ear of the aforementioned simulator is observed along a direction where the coronal axis of the human body is located, a schematic diagram illustrating a front side contour of the ear shown in FIG. 1 may be obtained.

[0020] It should be noted that the above description regarding the ear is merely for the purpose of illustration and is not intended to limit the scope of the present disclosure. For those skilled in the art, various changes and modifications may be made according to the description of the present disclosure (e.g., a partial structure of the earphone may cover a portion or all of the external auditory canal 11). These changes and modifications still fall within the protection scope of the present disclosure.

[0021] With continuous improvement of people's living demands, consumers' demands for earphones are also increasing. In addition to needing to have stable output performance, earphones also need to be capable of blocking ambient noise in a noisy or even high-noise environment to perform normal listening. For in-ear earphones, a sound outlet hole is located within the user's external auditory canal, and the user's listening is louder. Meanwhile, a portion of ambient noise will be blocked outside the ear canal opening. At this time, it is only necessary to utilize the noise reduction sound generated by the earphone to perform active noise reduction on the ambient noise transmitted into the ear canal. For open-ear earphones that are not inserted into the external auditory canal, given that a sound generating portion of the open-ear earphone has a certain distance from the external auditory canal and is unable to form a closed sound transmission channel with the external auditory canal, more ambient noise will be transmitted into the external auditory canal, which will have a more significant impact on the user's listening experience. In addition, since there is an open-type structure and a certain distance between the sound outlet hole of the open-ear earphone and the user's ear canal opening, it may also cause the sound output by the earphone to leak to the surrounding environment, resulting in obvious sound leakage. To improve the user experience of open-ear earphones, e.g., to improve active noise reduction effect, sound output effect, sound leakage reduction effect, or the like, it is necessary to allow the earphone to provide higher-intensity output and have lower distortion while taking into account miniaturization and lightweighting, and at the same time make amplitude frequency response and phase frequency response of the earphone more stable and have smaller fluctuations, and enable the earphone to have a relatively flat output within a relatively wide frequency band range, to provide higher sound output and/or meet the demands for better noise reduction effects.

[0022] The present disclosure provides an earphone that, in the context of open-ear earphones, improves sound generation efficiency and enables the earphone to have a relatively flat output over a wider frequency range, thereby enhancing the sound output effect and/or the active noise reduction effect.

[0023] FIG. 2 is a schematic diagram illustrating a wearing state of an earphone when worn on an ear according to some embodiments of the present disclosure. FIG. 3 is a block diagram illustrating a sound generating portion according to some embodiments of the present disclosure.

[0024] Referring to FIG. 2 and FIG. 3, in some embodiments of the present disclosure, an open-ear earphone (hereinafter referred to as the earphone) is provided, which includes a sound generating portion 100 and an ear hook. The ear hook is configured to place the sound generating portion 100 at a position in a vicinity of the ear, but not blocking the external auditory

canal 11. It should be pointed out that, since different users have individual differences, when the earphone is worn by different users, the sound generating portion 100 may partially cover the external auditory canal 11, but the external auditory canal 11 is still not blocked. Detailed descriptions will be provided below.

[0025] The sound generating portion 100 includes a first housing 110, a sound generating assembly, a microphone assembly 140, or the like. The sound generating assembly is arranged within the first housing 110. The sound generating assembly may include a speaker 120. The speaker 120 can convert an electrical signal into a corresponding mechanical vibration, thereby generating a sound output (e.g., a noise reduction sound, an audio played by the earphone, or the like). Exemplarily, the sound generated by the speaker 120 may include the noise reduction sound. The noise reduction sound output to the exterior of the first housing 110 may have the same amplitude and opposite phase as ambient noise in the vicinity of the external auditory canal 11, to eliminate the ambient noise in the vicinity of the external auditory canal 11, thereby achieving active noise reduction. The sound generated by the speaker 120 may also include a call sound, a played audio, a notification sound, or the like. After these sounds are output to the exterior of the first housing 110, they may be directed to the external auditory canal 11 to ensure the user's listening effect.

[0026] In some embodiments, the sound generating assembly further includes a limiting assembly 130. The limiting assembly 130 is configured to position and limit the speaker 120 within the interior of the first housing 110. On the one hand, by fixing the speaker 120 within the interior of the first housing 110 with the limiting assembly 130, it may ensure that the sound generated by the speaker 120 is stably output to the exterior of the first housing 110 through an acoustic hole arranged on the first housing 110. On the other hand, by limiting the speaker 120 with the limiting assembly 130, it may avoid the speaker 120 shaking relative to the first housing 110 during vibration, thereby ensuring sound output performance of the sound generating portion 100.

[0027] The microphone assembly 140 may be configured to collect sound signals (e.g., a user's voice, ambient sound, or the like). Exemplarily, based on the ambient noise collected by the microphone assembly 140, an output of the speaker 120 may be adjusted to cause the sound output by the speaker 120 to include a sound signal that cancels out the ambient noise, thereby achieving active noise reduction by the earphone on the ambient noise.

[0028] In some embodiments, the ear hook may include an ear hook housing and a battery assembly, a circuit board assembly, or the like, disposed inside the ear hook housing. Structures such as the battery assembly, the speaker 120, and the microphone assembly are electrically connected to the circuit board assembly. The circuit board assembly may be understood

as a collection of a main control board or a main board of the earphone and related components. The circuit board assembly plays a regulatory and management role for all or a portion of functional components in the earphone. For example, the circuit board assembly is configured to perform conversion processing on electrical signals in the earphone to support the realization of various functions of the earphone (e.g., supporting the earphone to realize power on/off, playback content switching, volume increase/decrease, or the like)

[0029] Referring to FIG. 2, in some embodiments, the ear hook may be divided into two portions along its length direction, namely a battery portion 200 and a transfer portion 300. The transfer portion 300 is connected between the battery portion 200 and the sound generating portion 100. In the wearing state, a portion of the battery portion 200 (e.g., a portion occupied by the battery assembly and the circuit board assembly) is hooked between an auricle and the head. Another portion of the battery portion 200 extends towards a side of the auricle away from the head and is connected to the transfer portion 300. The sound generating portion 100 is worn at a position in the vicinity of the external auditory canal 11, but not blocking the external auditory canal 11, to cause the earphone to function as an open-ear earphone. Further, the battery assembly, the circuit board assembly, or the like, may be arranged in the battery portion 200. The transfer portion 300 may be provided with earphone buttons and with components such as a transfer board, which are configured to electrically connect the circuit board assembly with the speaker 120 and the microphone assembly 140. In some embodiments, the battery assembly, the circuit board assembly, or the like, may be arranged at an end of the battery portion 200 away from the transfer portion 300, to balance the center of the earphone and improve the wearing comfort of the earphone.

[0030] In some embodiments, to improve stability of the earphone in the wearing state, the earphone may adopt any one or any combination of the following manners. First, at least a portion of the ear hook is configured as a conforming structure (e.g., an arc-shaped barb-like shape) that conforms to at least one of the rear side of the ear and the head, to increase the contact area between the ear hook and the ear or the head, thereby increasing the resistance of the earphone detaching from the ear. Second, at least a portion of the ear hook is configured as an elastic structure, thereby causing the ear hook to have a certain elastic deformation amount in the wearing state, to increase a pressure of the ear hook on the ear or the head, thereby increasing the resistance of the earphone detaching from the ear. Third, at least a portion of the ear hook is configured to abut against the head in the wearing state, thereby causing the ear hook to form a reaction force for pressing the ear, to cause the sound generating portion 100 to be pressed against the front side of the ear, thereby increasing the resis-

tance of the earphone detaching from the ear. Fourth, the sound generating portion 100 and the ear hook are configured to respectively clamp physiological parts such as a region where the helix 17 is located and a region where the concha cavity 12 is located, from the front and rear sides of the ear in the wearing state, thereby increasing the resistance of the earphone detaching from the ear. Fifth, the sound generating portion 100 is configured to at least partially extend into physiological parts such as the concha cavity 12, the cavum concha 13, the triangular fossa 14, and the scapha 16 in the wearing state, thereby increasing the resistance of the earphone detaching from the ear.

[0031] In some embodiments, the earphone may be combined with products such as glasses, headsets, head-mounted display devices, augmented reality (AR)/virtual reality (VR) helmets, or the like. For example, the ear hook may be omitted or retained, and the sound generating portion 100 is worn in a vicinity of a user's ear by manners such as suspension, clamping, or the like.

[0032] FIG. 4 is a schematic diagram illustrating an internal structure of a sound generating portion according to some embodiments of the present disclosure.

[0033] Referring to FIG. 2, the sound generating portion 100 may have a long axis direction and a short axis direction that are perpendicular to a thickness direction and orthogonal to each other. The long axis direction may be defined as a direction having a maximum extension dimension in a shape of a two-dimensional projection plane of the sound generating portion 100 (e.g., a projection of the sound generating portion 100 on a plane where its outer side surface is located or on the sagittal plane). For example, when the projection shape is a rectangle or an approximately rectangular shape, the long axis direction is the length direction of the rectangle or the approximately rectangular shape. The short axis direction may be defined as a direction perpendicular to the long axis direction in the shape of the projection of the sound generating portion 100 on the sagittal plane. For example, when the projection shape is a rectangle or an approximately rectangular shape, the short axis direction is the width direction of the rectangle or the approximately rectangular shape. The thickness direction may be defined as a direction perpendicular to the two-dimensional projection plane. For example, the thickness direction may be consistent with a direction of the coronal axis, both pointing to the left and right sides of the body. In some embodiments, the thickness direction may also be defined as a direction in which a housing approaches or moves away from the ear in the wearing state. In some embodiments, when the sound generating portion 100 is in an inclined state in the wearing state, the long axis direction and the short axis direction may still be parallel or approximately parallel to the sagittal plane. The long axis direction may have a certain angle with a direction of the sagittal axis, that is, the long axis direction is

accordingly inclined. The short axis direction may have a certain angle with a direction of the vertical axis, that is, the short axis direction is accordingly inclined. In some embodiments, a whole or partial structure of the housing of the sound generating portion 100 may extend into the concha cavity 12, that is to say, a projection of the housing of the sound generating portion 100 on the sagittal plane may have an overlapping portion with a projection of the concha cavity 12 on the sagittal plane. In some embodiments, the long axis direction and the short axis direction of the speaker 120 are consistent with the long axis direction and the short axis direction of the sound generating portion 100.

[0034] Referring to FIG. 2 and FIG. 4, in some embodiments, the first housing 110 of the sound generating portion 100 may include a plurality of different housing walls, such as an inner side wall 110a, an outer side wall 110b, an upper side wall 110c, a lower side wall 110d, a front side wall 110e, or the like. The inner side wall 110a is a housing side wall on a side of the first housing 110 facing the ear (e.g., the external auditory canal 11) in the thickness direction in the wearing state. The outer side wall 110b is a housing side wall on a side of the first housing 110 away from the ear (e.g., the external auditory canal 11) in the thickness direction in the wearing state. The upper side wall 110c is a housing side wall on a side of the first housing 110 close to a top of the head in the short axis direction in the wearing state. The lower side wall 110d is a housing side wall on a side of the first housing 110 away from the top of the head in the short axis direction in the wearing state. The front side wall 110e is a housing side wall on a side of the first housing 110 facing a rear side of the ear in the long axis direction in the wearing state. It may be understood that the plurality of different housing walls may jointly enclose an accommodating cavity of the sound generating portion 100, and a sound generating assembly (e.g., the speaker 120, or the like) is received and arranged within the accommodating cavity.

[0035] Referring to FIG. 4, in some embodiments, inside the first housing 110, a first acoustic cavity 111-1 is formed between the speaker 120 and one side wall of the first housing 110, and a second acoustic cavity 111-2 is formed between the speaker 120 and another side wall opposite to the aforementioned side wall. The one side wall is penetratingly provided with a first sound outlet hole 112-1 acoustically communicated with the speaker 120 through the first acoustic cavity, and the another side wall opposite to the one side wall is penetratingly provided with a second sound outlet hole 112-2 acoustically communicated with the speaker 120 through the second acoustic cavity. Hereinafter, the sound generating portion 100 is described by taking, merely by way of example, that the first acoustic cavity 111-1 is formed between the speaker 120 and the inner side wall, the second acoustic cavity 111-2 is formed between the speaker 120 and the outer side

wall, the inner side wall is provided with the first sound outlet hole 112-1, and the outer side wall is provided with the second sound outlet hole 112-2.

[0036] In some embodiments, in the wearing state, at least a portion of the first housing 110 may be located within the concha cavity 12, the inner side wall cooperates with the concha cavity 12 to form an auxiliary cavity communicated with the external auditory canal 11, the auxiliary cavity is generally in a semi-open state, and the first sound outlet hole 112-1 is located within the auxiliary cavity. In this way, the sound output through the first sound outlet hole 112-1 may be restricted by the auxiliary cavity and converged. Most of the sound will propagate into the external auditory canal 11, and a small portion of the sound propagated outside the external auditory canal 11 (e.g., a noise reduction sound) may be subjected to antiphase cancellation with ambient noise near the external auditory canal 11, thereby not only facilitating improvement of a listening effect and enhancement of an active noise reduction effect, but also facilitating reduction of a problem of sound leakage.

[0037] To effectively enhance the active noise reduction effect of the earphone in an open-type application scenario, the earphone may be designed to have a relatively flat output in a relatively wide frequency band range. In some embodiments, the frequency response curve of the sound output from the earphone to an outside of the first housing 110 has a first resonance peak and a second resonance peak, and the peak resonance frequency of the first resonance peak is less than the peak resonance frequency of the second resonance peak. In some embodiments, the earphone mainly outputs through a sound outlet hole (e.g., a first acoustic hole arranged on the inner side wall of the first housing), and the output of the earphone may be measured by a test microphone arranged at a position 2 mm away from the sound outlet hole. In some embodiments, the first resonance peak and the second resonance peak refer to two adjacent and continuous resonance peaks on the frequency response curve. Between the two resonance peaks, the frequency response curve has a flat region. In some embodiments, the first resonance peak may be generated by a hardware structure in the sound generating portion 100, and the peak resonance frequency thereof is mainly affected by acoustic components in the speaker 120, (e.g., a diaphragm, a magnetic circuit assembly, and a voice coil assembly). In some embodiments, as the frequency gradually increases, the frequency response curve output by the first sound outlet hole 112-1 may have a plurality of rising segments, and the first resonance peak may refer to a first one of the rising segments. Merely by way of example, the peak resonance frequency of the first resonance peak may be set to be not greater than 300 Hz. By utilizing a communication relationship between the first acoustic cavity 111-1 and the first sound outlet hole 112-1, a first Helmholtz reso-

nance cavity model may be formed, and by utilizing the second acoustic cavity 111-2 and the second sound outlet hole 112-2, a second Helmholtz resonance cavity model may be formed. The first sound outlet hole 112-1 and the second sound outlet hole 112-2 serve as the respective necks of the corresponding Helmholtz resonance cavity models. The second resonance peak may be generated by the first Helmholtz resonance cavity model, and the peak resonance frequency of the second resonance peak is approximately equal to the resonance frequency of the first Helmholtz resonance cavity model. The flat region with a relatively stable sound pressure level may be formed between the first resonance peak and the second resonance peak, and a peak sound pressure level of the second resonance peak is higher than the sound pressure level of the flat region. In some embodiments, the peak sound pressure level of the second resonance peak may be higher than the sound pressure level of the flat region by more than 2 dB (the test conditions may be set based on IEC 60268-7; e.g., the measurement may be performed in a free field, using a 1/2 inch standard microphone, and under conditions where the microphone is 2 mm away from the sound outlet hole of the earphone).

[0038] In the frequency band range corresponding to the flat region between the first resonance peak and the second resonance peak, the earphone has a relatively high active noise reduction effect. Designing the first resonance peak and the second resonance peak may affect a frequency range of active noise reduction of the earphone. Designing the flat region (e.g., flatness, a curve height of the flat region, or the like) may affect the effect of the active noise reduction. For example, the flatness of the flat region may reflect a stability of the sound output from the earphone. The more stable the output of the earphone, the more convenient it is for active noise reduction, and the better the active noise reduction effect. Furthermore, for example, the curve height of the flat region may reflect a magnitude of the sound that the earphone can output. The louder the sound that the earphone can output, the greater the noise it can reduce, and the better the active noise reduction effect.

[0039] To design the first resonance peak and the second resonance peak and the flat region therebetween, in some embodiments, the speaker 120 may include a magnetic circuit assembly 122, a voice coil assembly 123, a first diaphragm 121-1, and a second diaphragm 121-2. The voice coil assembly 123 is configured to drive the first diaphragm 121-1 and the second diaphragm 121-2 to vibrate synchronously in the same direction. At least a portion of the voice coil assembly 123 is located within a magnetic gap of the magnetic circuit assembly 122. The first diaphragm 121-1 and the second diaphragm 121-2 are spaced apart in the vibration direction, and at least one of the first diaphragm 121-1 and the second diaphragm 121-2 is connected to the voice coil assembly 123. The voice

coil assembly 123 is configured to drive the first diaphragm 121-1 and the second diaphragm 121-2 to vibrate synchronously in the same direction. The first diaphragm 121-1 and the inner side wall of the first housing 110 are spaced apart and relatively arranged in the vibration direction (which is also the thickness direction) to form the first acoustic cavity 111-1. The second diaphragm 121-2 and the outer side wall of the first housing 110 are spaced apart and relatively arranged in the vibration direction to form the second acoustic cavity 111-2. A common cavity 111-3 is formed between the first diaphragm 121-1 and the second diaphragm 121-2.

[0040] It should be noted that the vibration synchronously in the same direction of the first diaphragm 121-1 and the second diaphragm 121-2 refers to that the first diaphragm 121-1 and the second diaphragm 121-2 vibrate in a same direction with a same amplitude of vibration at any moment. Specifically, 'in the same direction' refers to that the vibration directions of the first diaphragm 121-1 and the second diaphragm 121-2 are consistent. 'Synchronous' refers to that the vibration states of the first diaphragm 121-1 and the second diaphragm 121-2 are consistent in time. That is, the vibration phases of the first diaphragm 121-1 and the second diaphragm 121-2 are consistent. Affected by various factors such as processing and manufacturing, it is difficult to achieve complete consistency in the vibration phases of the first diaphragm 121-1 and the second diaphragm 121-2 in an ideal situation. Therefore, 'consistency in vibration phase' described in the present disclosure may refer to that the phase difference between the first diaphragm 121-1 and the second diaphragm 121-2 at different frequencies is always less than 35° at least within an audio frequency band between the first resonance peak and the second resonance peak. Merely by way of example, the test conditions for the phase difference between the first diaphragm 121-1 and the second diaphragm 121-2 may be set based on IEC 60268-7. For example, one 1/2 inch standard microphone may be placed near the first sound outlet hole 112-1, and another 1/2 inch standard microphone may be placed near the second sound outlet hole 112-2, to determine the phase difference between the first diaphragm 121-1 and the second diaphragm 121-2 based on sound signals collected by the two standard microphones.

[0041] A connection configuration of the first acoustic cavity 111-1 and the first sound outlet hole 112-1 may be approximately equivalent to the first Helmholtz resonance cavity model. A connection configuration of the second acoustic cavity 111-2 and the second sound outlet hole 112-2 may be approximately equivalent to the second Helmholtz resonance cavity model. The first sound outlet hole 112-1 and the second sound outlet hole 112-2 serve as the respective neck openings of the corresponding Helmholtz resonance cavity models. When the speaker 120 vibrates and outputs a sound,

the first sound outlet hole 112-1 outputs a first sound, and the second sound outlet hole 112-2 outputs a second sound, and the first sound and the second sound are superposed to form the sound output by the earphone.

[0042] The first resonance peak is related to the flexibility of the first diaphragm 121-1 and the second diaphragm 121-2 along the vibration direction, the second resonance peak is related to the first acoustic cavity 111-1 and the second acoustic cavity 111-2, and the flat region is related to the vibration of the first diaphragm 121-1 and the second diaphragm 121-2. Specifically, the flexibility of the first diaphragm 121-1 and the second diaphragm 121-2 along the vibration direction corresponds to an elastic coefficient K for their vibration along the vibration direction. Under conditions where the load remains unchanged, the smaller the K value, the lower the frequency of the first resonance peak. A magnitude of the second resonance peak corresponds to the resonance frequency of the first Helmholtz resonance cavity model (or the second Helmholtz resonance cavity model). The resonance frequency depends on the configuration of the first acoustic cavity 111-1 (or the second acoustic cavity 111-2) and the first sound outlet hole 112-1 (or the second sound outlet hole 112-2). The flatness of the flat region is related to the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, and a curve height of the flat region is related to the driving force of the first diaphragm 121-1 and the second diaphragm 121-2. In some embodiments, in order to improve the sound output effect and/or the active noise reduction effect of the earphone in a wider frequency band, the resonance frequency of the first resonance peak and the resonance frequency of the second resonance peak may be designed to increase the width of the flat region of the frequency response curve of the sound output by the earphone. For example, the first diaphragm 121-1 and the second diaphragm 121-2 may be designed (e.g., the material, the structure, or the like), thereby lowering the resonance frequency of the first resonance peak. For example, the first acoustic cavity 111-1 and the second acoustic cavity 111-2 may be designed, thereby increasing the resonance frequency of the second resonance peak. In some embodiments, an arrangement configuration of the first diaphragm 121-1 and the second diaphragm 121-2 may be designed to improve the vibration consistency and the driving force of the first diaphragm 121-1 and the second diaphragm 121-2, reduce vibration modes, improve the output, and enhance the flatness and the curve height of the flat region of the frequency response curve between the first resonance peak and the second resonance peak. More descriptions regarding the diaphragm, the acoustic cavity, the sound outlet hole, or the like may be found in the following related descriptions.

[0043] In some embodiments, a ratio of the peak re-

sonance frequency of the second resonance peak to the peak resonance frequency of the first resonance peak is not less than 3, thereby effectively increasing the width of the flat region of the frequency response curve of the sound output by the speaker 120, providing support for the earphone to perform active noise reduction in a wider frequency band range, and simultaneously improving the output effect of the earphone.

[0044] In some embodiments, the ratio of the peak resonance frequency of the second resonance peak to the peak resonance frequency of the first resonance peak may be set to not less than 13, to further increase the width of the flat region of the frequency response curve of the sound output by the earphone, allowing the earphone to perform active noise reduction in a wider frequency band range, and improving the sound output effect of the earphone. Further, in some embodiments, the ratio of the peak resonance frequency of the second resonance peak to the peak resonance frequency of the first resonance peak may be set to not less than 20, to enable the sound output by the earphone to have a flatter frequency response curve and a phase curve with a smaller amplitude variation in a wider frequency band range, further enhancing the active noise reduction effect of the earphone, and improving the sound output effect of the earphone.

[0045] In some embodiments, the peak resonance frequency of the first resonance peak may be set to not greater than 300 Hz; the peak resonance frequency of the second resonance peak may be set to not less than 1 kHz, e.g., not less than 3.65 kHz, not less than 4.5 kHz, not less than 5.8 kHz, not less than 6.7 kHz, not less than 7.5 kHz, not less than 7.75 kHz, not less than 8.75 kHz, not less than 9.25 kHz, or not less than 9.5 kHz. By designing the positions of the first resonance peak and the second resonance peak, the sound output by the earphone (specifically, such as the sound output through the first sound outlet hole 112-1) may ultimately be caused to have a flat frequency response curve and a phase curve with a smaller amplitude variation in a wider frequency band range, thereby facilitating the earphone to achieve an active noise reduction effect in a wider frequency band range, and also enabling the earphone to have a flatter output in a wider frequency band range.

[0046] In some embodiments, by designing the first diaphragm 121-1 and the second diaphragm 121-2, the first diaphragm 121-1 and the second diaphragm 121-2 are designed to be relatively 'soft', i.e., having a relatively small K value, thereby causing the first resonance peak to move to a low frequency band as much as possible. However, the small K value of the first diaphragm 121-1 and the second diaphragm 121-2 may lead to a plurality of modes possibly appearing in a radial direction when the first diaphragm 121-1 and the second diaphragm 121-2 vibrate, affecting the vibration stability of the first diaphragm 121-1 and the second diaphragm 121-2, and affecting the flatness of the flat

region. By means of a special structural design (e.g., a 'connecting member' described elsewhere in the present disclosure), it may be ensured that the first diaphragm 121-1 and the second diaphragm 121-2 vibrate synchronously in the same direction, improving the vibration stability and the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2. In this case, even if the first diaphragm 121-1 and the second diaphragm 121-2 are designed to be relatively 'soft', i.e., having a relatively small K value, the speaker may still have a higher stability. By designing the sound outlet holes and the acoustic cavities, the second resonance peak may be caused to move to a high frequency band as much as possible. The first resonance peak with a smaller frequency and the second resonance peak with a larger frequency contribute to widening the flat region of the frequency response curve of the sound output by the earphone, thereby improving a sound quality of the earphone in a wider frequency band range, and also providing support for the earphone to perform active noise reduction in a wider frequency band range.

[0047] In some embodiments, by designing the speaker 120 (e.g., the magnetic circuit, the voice coil, the diaphragm, and the structural relationship therebetween) and/or the quantity, the shape, the dimension, the position, or the like of one or more acoustic structures (e.g., the sound outlet hole or the acoustic cavity), the output of the earphone (specifically, such as the first sound outlet hole 112-1) may be optimized.

[0048] In some embodiments, the first diaphragm 121-1 and the second diaphragm 121-2 may be designed to lower the K value of the first diaphragm 121-1 and the second diaphragm 121-2, thereby causing the first resonance peak to move to a low frequency band as much as possible, increasing the width of the flat region of the frequency response curve of the sound output by the earphone, thereby improving a sound effect of the earphone in a wider frequency band range, and also providing support for the earphone to perform active noise reduction in a wider frequency band range.

[0049] In some embodiments, in order to improve the low-frequency output of the speaker 120, and further improve the active noise reduction effect of the earphone on the low-frequency ambient noise, the first resonance peak of the speaker 120 at low frequencies (e.g., 100 Hz to 300 Hz) may be adjusted. By designing the material and the thickness of the diaphragm (e.g., the first diaphragm 121-1 and the second diaphragm 121-2) to lower the K value of the diaphragm (e.g., the first diaphragm 121-1 and the second diaphragm 121-2), the first resonance frequency of the speaker 120 may be adjusted. In some embodiments, in order to lower the K value of the diaphragm (e.g., the first diaphragm 121-1 and the second diaphragm 121-2), the material of the diaphragm (e.g., the first diaphragm 121-1 and the second diaphragm 121-2) may be a

polyurethane (PU) material or a liquid silicone material.

[0050] FIG. 5 is a schematic diagram illustrating frequency response curves of an earphone corresponding to different diaphragms according to some embodiments of the present disclosure. The curve L401 represents the frequency response of the earphone when the diaphragm is a PU material and has a thickness of 0.35 mm. The curve L402 represents the frequency response of the earphone when the diaphragm is a PU material and has a thickness of 0.45 mm. The curve L403 represents the frequency response of the earphone when the diaphragm is a PU material and has a thickness of 0.55 mm. As shown in FIG. 5, the low-frequency resonance peak of the curve L401 is at approximately 145 Hz, the low-frequency resonance peak of the curve L402 is at approximately 185 Hz, and the low-frequency resonance peak of the curve L403 is at approximately 230 Hz. Comparing the curve L401, the curve L402, and the curve L403, the resonance frequency corresponding to the low-frequency resonance peaks of the three curves gradually decreases as the diaphragm thickness decreases. When the thickness of the diaphragm is too large, the corresponding first resonance frequency is larger, and the flat region of the frequency response curve of the sound output by the earphone is narrower. When the thickness of the diaphragm is too small, it may lead to lower structural strength of the diaphragm and make the diaphragm prone to failure. Therefore, in some embodiments, when the material of the diaphragm is a PU material, in order to enable the speaker 120 to have a flatter output in a wide frequency band range, improve the output of the speaker 120, and further improve the active noise reduction effect of the earphone on the low-frequency ambient noise, the low-frequency resonance frequency of the speaker 120 may be between 100 Hz and 300 Hz, and the thickness of the diaphragm may be 0.02 mm to 0.07 mm. In some embodiments, when the material of the diaphragm is a PU material, in order to further lower the low-frequency resonance frequency of the speaker 120, the thickness of the diaphragm may be 0.035 mm to 0.055 mm.

[0051] In some embodiments, in order to further reduce the K value of the diaphragm, the material of the diaphragm may use liquid silicone having a smaller elastic modulus. In some embodiments, when the material of the diaphragm is liquid silicone, in order to lower the resonance frequency of the speaker 120 at low frequencies (e.g., below 300 Hz), enable the speaker 120 to have a flatter output in a wider frequency band range, improve the low-frequency output of the speaker 120, and further improve the active noise reduction effect of the earphone on the low-frequency ambient noise, the thickness of the diaphragm may be 0.055 mm to 0.1 mm. It should be noted that the aforementioned material of the diaphragm refers to the material of the entirety of the diaphragm, e.g., the material of the surround, the center patch, or the like structures of the

diaphragm.

[0052] In some embodiments, in order to reduce distortion caused by vibration instability of the first diaphragm 121-1 or the second diaphragm 121-2, a component structure may be used to optimize the stability of the structural connection between the first diaphragm 121-1 or the second diaphragm 121-2 and related components. Hereinafter, the structure of the diaphragm is described by taking the first diaphragm 121-1 as an example. It should be noted that, since the speaker 120 is a dual diaphragm speaker, the component structure of the second diaphragm 121-2 is the same as or similar to the component structure of the first diaphragm 121-1, and details thereof will not be repeated.

[0053] FIG. 6 is a schematic diagram illustrating a structure of a diaphragm assembly according to some embodiments of the present disclosure.

[0054] Referring to FIG. 6, the first diaphragm 121-1 includes a surround 1211, a center patch 1212, and a fixing ring 1213. The surround 1211 is connected around the outer periphery of the center patch 1212. The center patch 1212 is connected to the voice coil assembly (e.g., the center patch 1212 of the first diaphragm 121-1 is adhered or welded and fixed to the first voice coil 123-1). A portion of the surround 1211 away from the center patch 1212 in the radial direction is connected to the fixing ring 1213. A bracket assembly is fixedly connected to the fixing ring 1213 (e.g., the fixing ring 1213 of the first diaphragm 121-1 is adhered or welded and fixed to a first bracket). More descriptions regarding the bracket assembly may be found elsewhere in the present disclosure (e.g., FIGS. 65 to 66 and related descriptions thereof).

[0055] It should be noted that the first diaphragm 121-1, which is assembled by a combination of the surround 1211, the center patch 1212, the fixing ring 1213, or the like, may be understood as an assembly structure, i.e., the first diaphragm 121-1 may be referred to as a first diaphragm assembly. The region occupied by the center patch 1212 on the first diaphragm 121-1 or the center patch 1212 itself may be regarded as a main region of the first diaphragm 121-1, and the region occupied by the surround 1211 on the first diaphragm 121-1 or the surround 1211 itself may be regarded as a surround region of the first diaphragm 121-1.

[0056] In some embodiments, the surround 1211 may be made of a liquid silicone material. In some embodiments, the material of the center patch 1212 may include at least one of magnesium-aluminum alloy, carbon fiber, aluminum-coated polymethacrylimide (PMI), and aluminum-coated polyethylene naphthalate (PEN).

[0057] With such an arrangement, based on the silicone material having high temperature stability being used as the surround 1211 or the surround region of the diaphragm assembly, a temperature stability of the diaphragm assembly may be effectively improved, providing a guarantee for the sound output effect and/or

the active noise reduction effect of the speaker 120. Meanwhile, by using the center patch 1212 having strong adhesion and high mechanical strength to establish a structural connection relationship between the voice coil assembly 123 and the surround 1211, and by using the fixing ring 1213 to establish a structural connection relationship between the bracket assembly and the surround 1211, the structural stability between the diaphragm assembly and the voice coil assembly 123 may be effectively enhanced, overcoming the problem of poor adhesive performance of the silicone material, and while ensuring stable vibration of the diaphragm assembly and the voice coil assembly 123 to generate a sound, preventing mutual detachment of the voice coil assembly 123 and the diaphragm assembly during the vibration process.

[0058] Due to the poor adhesive performance of the silicone material, it is difficult to use an adhesive to adhere and fix the surround 1211 to the center patch 1212 and the fixing ring 1213. In some embodiments, the diaphragm assembly (i.e., the first diaphragm 121-1) may be an integral structure. For example, the surround 1211, the center patch 1212, and the fixing ring 1213 may be integrally injection molded, which may effectively enhance the robustness of the structural connection between the components of the diaphragm assembly itself.

[0059] FIG. 7 is an enlarged schematic diagram illustrating a partial structure of the diaphragm assembly in FIG. 6; and FIG. 8 is a schematic diagram illustrating a dimension of the structure shown in FIG. 7.

[0060] Referring to FIG. 7 and FIG. 8, in some embodiments, the surround 1211 may include a first connecting portion 1211-1, a surround portion 1211-2, and a second connecting portion 1211-3. The first connecting portion 1211-1, the surround portion 1211-2, and the second connecting portion 1211-3 are sequentially connected from inside to outside along the radial direction, that is, the surround portion 1211-2 is connected around an outer periphery of the first connecting portion 1211-1, and the second connecting portion 1211-3 is connected around an outer periphery of the surround portion 1211-2.

[0061] Furthermore, in some embodiments, the surround 1211 further includes a third connecting portion 1211-4 and a fourth connecting portion 1211-5. One end of the third connecting portion 1211-4 in the vibration direction is connected to a junction of the surround portion 1211-2 and the first connecting portion 1211-1; it may also be understood that an end of the surround portion 1211-2, which is close to the first connecting portion 1211-1 or the center patch 1212 in the radial direction, extends a certain length along the vibration direction toward a side facing the magnetic circuit assembly, thereby forming the third connecting portion 1211-4. One end of the fourth connecting portion 1211-5 in the vibration direction is connected to a junction of the surround portion 1211-2 and the second con-

necting portion 1211-3. It may also be understood that an end of the surround portion 1211-2, which is close to the second connecting portion 1211-3 or the fixing ring 1213 in the radial direction, extends a certain length along the vibration direction toward the side facing the magnetic circuit assembly, thereby forming the fourth connecting portion 1211-5.

[0062] In the vibration direction, an inner surface of the first connecting portion 1211-1 facing the voice coil assembly is attached and connected to an outer surface of the center patch 1212 facing away from the voice coil assembly, and an inner surface of the second connecting portion 1211-3 facing the voice coil assembly is attached and connected to an outer surface of the fixing ring 1213. In the radial direction, an inner circumferential surface of the third connecting portion 1211-4 facing the voice coil assembly is attached and connected to a circumferential surface of the center patch 1212, and an outer circumferential surface of the fourth connecting portion 1211-5 away from the voice coil assembly 123 is attached and connected to an inner circumferential surface of the fixing ring 1213 facing the voice coil assembly.

[0063] To facilitate distinction and description, in the present disclosure, the inner surface refers to a surface on a side close to the magnetic circuit assembly in the vibration direction, the outer surface refers to a surface on a side away from the magnetic circuit assembly in the vibration direction, the inner circumferential surface refers to a surface close to a center point of the surround 1211 in the radial direction, and the outer circumferential surface refers to a surface away from the center point of the surround 1211 in the radial direction. By way of example, the inner surface of the first connecting portion 1211-1 is defined as a first surface P1, the inner surface of the second connecting portion 1211-3 is defined as a second surface P2, the inner circumferential surface of the third connecting portion 1211-4 is defined as a third surface P3, the outer circumferential surface of the fourth connecting portion 1211-5 is defined as a fourth surface P4, and the outer circumferential surface of the third connecting portion 1211-4 is defined as a fifth surface P5.

[0064] With this arrangement, based on the first surface P1 and the third surface P3, the surround 1211 covers and attaches to the outer surface and the outer circumferential surface of the center patch 1212, thereby not only effectively increasing a connection area between the surround 1211 and the center patch 1212 and enhancing a connection strength between the surround 1211 and the center patch 1212, but also providing support for a structural connection between an inner surface of the center patch 1212 and the voice coil assembly.

[0065] In some embodiments, when the first surface P1 is attached and connected to the outer surface of the center patch 1212, the outer surface of the center patch 1212 may be entirely covered and attached by

the first connecting portion 1211-1 or the first surface P1, or the first connecting portion 1211-1 or the first surface P1 may also annularly cover and attach to a portion of the outer surface of the center patch 1212. In other embodiments, one or both of the third connecting portion 1211-4 and the fourth connecting portion 1211-5 may also be omitted.

[0066] In some embodiments, in a case where the outer surface and the outer circumferential surface of the center patch 1212 are covered and attached by the surround 1211, a lower surface of the center patch 1212 may also be covered and attached by the surround 1211, to further enhance a connection stability of the surround 1211 and the center patch 1212.

[0067] Specifically, the surround 1211 further has a fifth connecting portion; the fifth connecting portion is spaced apart from the first connecting portion 1211-1 in the vibration direction, and the third connecting portion 1211-4 is connected between the fifth connecting portion and the surround portion 1211-2 in the vibration direction. In the vibration direction, an outer surface of the fifth connecting portion is attached and connected to an edge region of the inner surface of the center patch 1212, and a portion of the inner surface of the center patch 1212 not covered by the fifth connecting portion is connected to the voice coil assembly. In this way, utilizing the fifth connecting portion may further enhance a structural connection stability of the surround 1211 and the center patch 1212. At this time, to avoid a negative impact of a diaphragm 121b on a connection between the voice coil assembly and the center patch 1212, a minimum distance between the fifth connecting portion and the voice coil assembly in the radial direction may be set to be not less than 0.5 mm.

[0068] In some embodiments, referring to FIG. 7, the surround portion 1211-2 adopts an arched structure protruding relative to the outer surface of the center patch 1212 or the outer surface of the fixing ring 1213. For example, the surround portion 1211-2 is curved and arched along the vibration direction relative to the first connecting portion 1211-1 toward a side away from the voice coil assembly 123. In this way, in terms of the speaker 120 as a whole, the surround portion 1211-2 is equivalent to being arched toward the outside of the speaker 120. This may not only provide sufficient space for the magnetic circuit assembly 122 inside the speaker 120, allowing the magnetic circuit assembly 122 to have a larger design dimension, thereby facilitating enhancing a driving force of the magnetic circuit assembly 122 and the voice coil assembly 123 on the diaphragm assembly. Furthermore, it may also avoid interference of the surround 1211 with sound generating structures such as the magnetic circuit assembly 122, due to deformation during vibration of the surround 1211, thereby ensuring the quality of the sound output.

[0069] FIG. 9 is a schematic diagram illustrating driving force coefficients of a speaker corresponding to different moving distances of a voice coil assembly ac-

cording to some embodiments of the present disclosure. Specifically, FIG. 9 shows a BLx curve indicating a change in a product (BL) of a magnetic flux density (B) of the speaker 120 and a voice coil length (L) with respect to a movement distance (x) of the voice coil assembly 123. Referring to FIG. 9, when the voice coil assembly 123 moves to ± 0.6 mm, the BLx curve changes by approximately 17%, and when the voice coil assembly 123 moves to ± 0.8 mm, the BLx curve changes by approximately 25%. Considering that a KMs curve of the diaphragm assembly 123 is one of key parameters affecting a distortion of the speaker 120, when a proportion of change of the corresponding KMs curve is within a similar range in a movement distance range of the voice coil assembly, this may provide better matching between the BLx curve of the speaker 120 and the KMs curve of the diaphragm assembly, which is conducive to providing the speaker 120 with a lower distortion. For example, when a shape of the KMs curve of the diaphragm assembly and a shape of the BLx curve are matching 'n' shapes, the speaker 120 has a lower distortion. Therefore, by designing a structure of the diaphragm assembly and its dimensional relationships, the KMs curve of the diaphragm assembly may be adjusted to match the BLx curve of the speaker 120, so as to obtain the speaker 120 with a lower distortion, thereby providing support for enhancing active noise reduction of the earphone. This will be described in detail below.

[0070] In some embodiments, referring to FIG. 8, the minimum distance between the fifth surface P5 and the third surface P3 in the radial direction is defined as a first width Ldc, the minimum distance between the fifth surface P5 and the fourth surface P4 in the radial direction is defined as a second width Lm, and the ratio of the first width Ldc to the second width Lm is defined as a first ratio LL; the first ratio LL may be between 0.04 and 0.32, which may allow the KMs curve of the diaphragm assembly to match the BLx curve of the speaker 120, thereby providing the speaker 120 with a lower distortion.

[0071] Specifically, with a change in the second width Lm, different values of the first width Ldc may lead to significant changes in the KMs curve shape of the diaphragm assembly, thereby affecting the distortion of the final speaker 120.

[0072] FIG. 10 is a schematic diagram illustrating KMs curves of a diaphragm assembly corresponding to different first ratios according to some embodiments of the present disclosure. Referring to FIG. 10, when the first ratio LL is relatively small (that is, when a connection region of the surround portion 1211-2 and the center patch 1212 is closer to an arc end point of an inner side surface of the surround portion 1211-2), the KMs curve of the diaphragm assembly is 'U'-shaped; and with an increase in the first ratio LL, the KMs curve of the diaphragm assembly gradually transitions from 'U'-shaped to 'n'-shaped, thereby matching the KMs

curve with the BLx curve. When the LL is 0.04, although the KMs curve is 'U'-shaped, the curve is relatively flat, indicating that the distortion of the speaker 120 is still relatively small at this time. When the LL is 0.32, the 'n'-shaped curve presented by the KMs curve matches the BLx curve of the speaker 120 better, indicating that the distortion of the speaker 120 is relatively small at this time.

[0073] Therefore, setting the first ratio LL of the surround 1211 to be between 0.04 and 0.32 may effectively reduce the distortion of the speaker 120 and ensure that the speaker 120 can provide support for active noise reduction of the earphone during application.

[0074] Furthermore, in some embodiments, the LL may be set to 0.16 to enhance the matching between the KMs curve of the first diaphragm 121-1 and the KMs curve of the second diaphragm 121-2 and the BLx curve of the speaker 120 to obtain a dual-diaphragm speaker with lower distortion, thereby providing support for improving the active noise reduction effect of the earphone.

[0075] FIG. 11 is a schematic diagram illustrating another dimension of the structure shown in FIG. 7.

[0076] In some embodiments, referring to FIG. 11, the minimum distance between the third surface P3 and the fourth surface P4 in the radial direction (that is, equivalent to a width or span of the surround portion 1211-2 in the radial direction) is defined as a third width Lmar, and the ratio of an average wall thickness Tmar of the surround portion 1211-2 to the third width Lmar is defined as a second ratio TL. Considering that a relationship between the width of the surround portion 1211-2 and a wall thickness of the surround portion 1211-2 may not only affect a compliance (S) of the diaphragm assembly, thereby affecting an f0 (that is, a resonance frequency) of the speaker 120, but also may affect the KMs curve; therefore, the second ratio TL may be not greater than 0.12.

[0077] FIG. 12 is a schematic diagram illustrating KMs curves of a diaphragm assembly corresponding to different second ratios according to some embodiments of the present disclosure. Referring to FIG. 12, the smaller the second ratio TL (that is, the thinner the average wall thickness of the surround portion 1211-2), the flatter the corresponding KMs curve. When the second ratio TL changes from 0.12 to 0.06, the corresponding KMs curve shape also changes from 'U'-shaped to 'n'-shaped. For example, when the voice coil assembly moves to ± 0.6 mm and the second ratio TL is 0.12, the KMs curve changes by about 12%, which is an acceptable state. Therefore, setting the second ratio TL of the surround 1211 to be not greater than 0.12 may enable the KMs curve to match the BLx curve, which is conducive to providing the speaker 120 with a lower distortion. By way of example, the TL may be set to 0.1, may also be set to 0.06, or may also be set to other values less than 0.12.

[0078] FIG. 13 is a schematic diagram illustrating another dimension of the structure shown in FIG. 7.

other dimension of the structure shown in FIG. 7.

[0079] In some embodiments, referring to FIG. 13, the distance from the first surface P1 to a plane where the second surface P2 is located (or a height difference between the first surface P1 and the second surface P2 in the vibration direction) is defined as a first height H0, and the ratio of the first height H0 to the third width Lmar is defined as a third ratio HLO. Considering that a relationship between the width of the surround portion 1211-2 and a height difference between inner and outer ends of the surround portion 1211-2 in the radial direction may affect the KMs curve, thereby affecting the distortion of the speaker 120; therefore, the third ratio HLO may be not greater than 0.232.

[0080] FIG. 14 is a schematic diagram illustrating KMs curves of a diaphragm assembly corresponding to different third ratios according to some embodiments of the present disclosure. Referring to FIG. 14, the smaller the third ratio HLO, the flatter the corresponding KMs curve. When the HLO changes from 0.232 to 0.072, the corresponding KMs curve shape gradually becomes flatter. For example, when the voice coil assembly 123 moves to ± 0.6 mm and the third ratio HLO is 0.232, the KMs curve changes by about 15%, which is an acceptable state. Therefore, setting the third ratio HLO of the surround 1211 to be not greater than 0.232 may enable the KMs curve to match the BLx curve, thereby obtaining the speaker 120 with a lower distortion.

[0081] FIG. 15 is a schematic diagram illustrating another dimension of the structure shown in FIG. 7.

[0082] In some embodiments, referring to FIG. 15, the distance from an apex of the surround portion 1211-2 to a plane where the second surface P2 is located (it may also be understood as an arch height of the surround portion 1211-2) is defined as a second height Hm, and the ratio of the first height H0 to the second height Hm is defined as a fourth ratio HTO. Considering that a relationship between the arch height of the surround portion 1211-2 and the height difference between inner and outer ends of the surround portion 1211-2 in the radial direction may also affect the KMs curve, thereby affecting the distortion of the speaker 120; therefore, the fourth ratio HTO may be not greater than 0.36.

[0083] FIG. 16 is a schematic diagram illustrating KMs curves of a diaphragm assembly corresponding to different fourth ratios according to some embodiments of the present disclosure. Referring to FIG. 16, the smaller the fourth ratio HTO, the flatter the corresponding KMs curve. When the fourth ratio HTO changes from 0.36 to 0.11, the corresponding KMs curve shape gradually becomes flatter. For example, when the voice coil assembly 123 moves to ± 0.6 mm and the fourth ratio HTO is 0.36, the KMs curve changes by about 17%, which is an acceptable state. Therefore, by setting the fourth ratio HTO of the surround 1211 to be not greater than 0.36, the KMs curve

may be enabled to match the BLx curve, thereby obtaining the speaker 120 with a lower distortion.

[0084] Furthermore, in some embodiments, the fourth ratio HTO may be set in a range from 0.36 to 0.11, for example, the fourth ratio HTO is 0.18, 0.24, 0.3, or the like; at this time, the KMs curve is flatter, and the distortion of the speaker 120 is lower, providing support for the earphone to perform active noise reduction in a wider frequency band range.

[0085] FIG. 17 is a schematic diagram illustrating another dimension of the structure shown in FIG. 7.

[0086] In some embodiments, referring to FIG. 17, the surround portion 1211-2 is equally divided into a first arc region A1, a second arc region A2, and a third arc region A3 in sequence by arc length in the radial direction, that is, the arc length of each arc region is one third of the arc length of the surround portion 1211-2. The first arc region A1 is a region of the surround portion 1211-2 close to the fixing ring 1213 or connected to the second connecting portion 1211-3, and the third arc region A3 is a region of the surround portion 1211-2 close to the center patch 1212 or connected to the second connecting portion 1211-3. The ratio of an average wall thickness of the first arc region A1 to an average wall thickness of the second arc region A2, and a ratio of an average wall thickness of the third arc region A3 to the average wall thickness of the second arc region A2 are both defined as a fifth ratio TT. Considering that a relationship between wall thicknesses of different regions of the surround portion 1211-2 significantly affects the KMs curve shape; therefore, the fifth ratio TT may be not greater than 1.2.

[0087] FIG. 18 is a schematic diagram illustrating KMs curves of a diaphragm assembly corresponding to different fifth ratios according to some embodiments of the present disclosure. Referring to FIG. 18, when the fifth ratio TT changes from 1.2 to 0.8, the corresponding KMs curve shape gradually becomes flatter. For example, when the voice coil assembly moves to ± 0.6 mm and the fifth ratio TT is 1.2, the KMs curve changes by about 18%, which is an acceptable state. Therefore, by setting the fifth ratio TT of the surround 1211 to be not greater than 1.2 (e.g., 1.1, 1.0, 0.9, 0.8, or the like), a KMs curve may be enabled to match a BLx curve, thereby obtaining the speaker 120 with low distortion. When the speaker 120 is applied to an open-type earphone, this may provide support for the earphone to perform active noise reduction in a wide frequency band range.

[0088] In some embodiments, the fifth ratio TT may be set to be not greater than 1.0, that is, the wall thickness of the first arc region A1 and the wall thickness of the third arc region A3 may be less than the wall thickness of the second arc region A2; thereby making the corresponding KMs curve flatter, and the KMs curve may also match the BLx curve more closely.

[0089] In some embodiments, the center patch 1212 with higher strength and height may be provided to im-

prove high-frequency vibration characteristics of the speaker 120, thereby facilitating the earphone to perform active noise reduction in a wide frequency band range. In some embodiments, the center patch 1212 may employ an arc-shaped structure to allow the center patch 1212 to have higher strength and height, which is beneficial for improving high-frequency vibration characteristics of the speaker 120, thereby facilitating the earphone to perform active noise reduction in a wide frequency band range.

[0090] FIG. 19 is a schematic diagram illustrating a structure of a center patch according to some embodiments of the present disclosure.

[0091] In some embodiments, referring to FIG. 6 and FIG. 19, the center patch 1212 may employ an arc-shaped structure convex toward a side away from the voice coil assembly along the vibration direction. Specifically, the center patch 1212 includes a central region 1212-1, a connection region 1212-2, and an edge region 1212-3 sequentially connected from an inner side to an outer side along the radial direction. It may also be understood that the connection region 1212-2 is connected around an outer periphery of the central region 1212-1, and the edge region 1212-3 is connected around an outer periphery of the connection region 1212-2. The connection region 1212-2 is inclined with respect to the edge region 1212-3 and the central region 1212-1 in the vibration direction, such that a height difference exists between a geometric center of the central region 1212-1 and a plane where the edge region 1212-3 is located in the vibration direction, thereby forming the center patch 1212 with an arched structure. The edge region 1212-3 is connected to the surround 1211 and the voice coil assembly. For example, a first connecting portion 1211-1 is attached and connected to the outer surface of the edge region 1212-3 in the vibration direction, and the voice coil assembly is connected to the inner surface of the edge region 1212-3 in the vibration direction. Illustratively, the center patch 1212 may be made of a carbon fiber material.

[0092] Further, in some embodiments, the edge region 1212-3 may be a planar structure perpendicular to the vibration direction, the central region 1212-1 may be an arc surface structure convex toward a side away from the voice coil assembly in the vibration direction, and the connection region 1212-2 is adaptively connected between the edge region 1212-3 and the central region 1212-1.

[0093] The arc-shaped center patch 1212 may also prevent the surround 1211 from shaking during large amplitude vibration, thereby ensuring that the voice coil assembly and the magnetic circuit assembly do not collide to generate sound. In addition, the edge region 1212-3 may provide sufficient connection area for the voice coil assembly and the surround 1211, to ensure that the voice coil assembly and the surround 1211 can be stably connected to the center patch 1212.

[0094] In other embodiments, the center patch 1212

may also employ other suitable arc-shaped structures. For example, the connection region 1212-2 may be omitted, the central region 1212-1 may employ an arc surface structure convex toward a side away from the voice coil assembly in the vibration direction, and the edge region 1212-3 is connected around an outer periphery of the central region 1212-1 at an edge of the central region 1212-1. Various examples are available, and details are not repeatedly described herein. It should be noted that a diaphragm having the component structure described in the above embodiments may be applied to the speaker 120 of any one of the embodiments provided in the present disclosure as needed.

[0095] In some embodiments, the sound generating assembly may include the speaker 120 and the limiting assembly 130. The limiting assembly 130 may be configured to position and limit the speaker 120 within the first housing 110. In addition, the limiting assembly 130 may also be configured to cooperate with the speaker 120 and a corresponding side wall of the first housing 110 to form an acoustic cavity. Specifically, the speaker 120 is spaced apart from the inner side wall 110a and the outer side wall 110b along the vibration direction, and the limiting assembly 130 positions and limits the speaker 120 between the inner side wall 110a and the outer side wall 110b, thereby cooperating with the speaker 120 and the inner side wall 110a to form the first acoustic cavity 111-1, and cooperating with the speaker 120 and the outer side wall 110b to form the second acoustic cavity 111-2.

[0096] The limiting assembly 130 not only affects a structural relationship between the speaker 120 and the first housing 110, but also affects the structure of the acoustic cavity, thereby affecting the second resonance frequency of the sound output by the earphone, and further influencing active noise reduction of the earphone in a wide frequency band range.

[0097] FIG. 20 is a schematic diagram illustrating a cross-sectional structure of a sound generating portion in a short axis direction according to some embodiments of the present disclosure; FIG. 21 is a schematic diagram illustrating a structure decomposition of a sound generating portion according to some embodiments of the present disclosure; FIG. 22 is a schematic diagram illustrating a structure of a sound generating assembly in a sound generating portion according to some embodiments of the present disclosure; FIG. 23 is a schematic diagram illustrating a structure decomposition of a sound generating assembly according to some embodiments of the present disclosure; and FIG. 24 is a schematic diagram illustrating a cross-sectional structure of a sound generating assembly according to some embodiments of the present disclosure. Hereinafter, the limiting assembly 130 and related structures thereof will be described with reference to FIGS. 20 to 24.

[0098] In some embodiments, the limiting assembly

130 is connected between the speaker 120 and the first housing 110. Illustratively, a portion of the limiting assembly 130 connects the speaker 120 and the inner side wall 110a of the first housing 110, and another portion connects the speaker 120 and the outer side wall 110b of the first housing 110.

[0099] When the speaker 120 is installed together with the limiting assembly 130 within the first housing 110, a connection relationship between the limiting assembly 130 and a side wall of the first housing 110 may be utilized (it should be noted that the connection may be adhesive bonding, snap fitting, elastic abutment, or the like) to allow the first diaphragm 121-1 and the inner side wall 110a to be relatively arranged in the vibration direction, and to cooperate with the speaker 120 and the inner side wall 110a to form the first acoustic cavity 111-1 communicating with the first sound outlet hole 112-1 and a sound tuning hole 113-3. The limiting assembly 130 may also allow the second diaphragm 121-2 and the outer side wall 110b to be relatively arranged in the vibration direction, and to cooperate with the speaker 120 and the outer side wall 110b to form the second acoustic cavity 111-2 communicating with the second sound outlet hole 112-2.

[0100] Based on this, the speaker 120 may be stably limited in a predetermined position within the first housing 110 by means of the limiting assembly 130, thereby allowing a corresponding acoustic cavity to be formed between the speaker 120 and the first housing 110, and creating conditions for improving output performance of the earphone. Meanwhile, the limiting assembly 130 may also be combined with the speaker 120 to form a functionally integrated component with a relatively complete structure (i.e., the sound generating assembly), which is beneficial for disassembly and maintenance of the sound generating portion 100, and also beneficial for designing related structures of the first housing 110 (e.g., sound outlet holes, the sound tuning hole 113-3, or the like) to meet a need for the earphone to perform active noise reduction in a wider frequency band range.

[0101] In some embodiments, the limiting assembly 130 may be sealingly connected between the speaker 120 and the first housing 110. Specifically, a portion of the limiting assembly 130 is sealingly connected to the speaker 120, and another portion is sealingly connected to the first housing 110. Meanwhile, a sealingly enclosed structure is formed between the inner side wall 110a and the first diaphragm 121-1, and a sealingly enclosed structure is formed between the outer side wall 110b and the second diaphragm 121-2. Illustratively, the limiting assembly 130 is an annular structure provided with a sound guide hole in the center. In the vibration direction, the sound guide hole of the limiting assembly 130, the first sound outlet hole 112-1, the second sound outlet hole 112-2, the first diaphragm 121-1, and the second diaphragm may at least partially overlap. The sound guide hole may communicate the cavity spaces on two sides of the limiting assembly 130

to form a complete acoustic cavity.

[0102] In some embodiments, the limiting assembly 130 and the speaker 120 are fixedly connected to form an integral structure; and the limiting assembly 130 is in elastic abutment with the first housing 110. Illustratively, an end of the limiting assembly 130 close to the inner side wall 110a in the vibration direction is in elastic abutment with the inner side wall 110a, and an end close to the outer side wall 110b is in elastic abutment with the outer side wall 110b. Thus, the limiting assembly 130 may be combined with the speaker 120 to form a functional structure relatively independent of the first housing 110, which is beneficial for reducing difficulty of disassembly and assembly of the sound generating portion 100.

[0103] In some embodiments, referring to FIGS. 22 to 24, the limiting assembly 130 includes a second housing and a sealing ring. The second housing is disposed inside the first housing 110. The speaker 120 is disposed inside the second housing and is fixedly connected to the second housing. The sealing ring is connected between the second housing and the first housing 110. In some embodiments, the sealing ring includes a first sealing ring 131 and a second sealing ring 132; and the speaker 120 is sealingly engaged and connected to the second housing. The second housing is provided with a sound guide hole. In some embodiments, the first housing 110 and/or the second housing may be provided with a sound guide hole. The sound guide hole on the second housing may communicate the cavity spaces on two sides of the second housing, and the sound guide hole on the first housing 110 may communicate the cavity spaces on two sides of the first housing 110, to form a complete acoustic cavity.

[0104] For convenience of distinction and description, a housing wall of the second housing which is spaced opposite to the inner side wall 110a in the vibration direction is defined as a first transverse side wall, a housing wall of the second housing which is spaced opposite to the outer side wall 110b in the vibration direction is defined as a second transverse side wall, and a housing wall of the second housing which surrounds the vibration direction is defined as a longitudinal side wall. It may also be understood that the first transverse side wall is arranged in the first acoustic cavity 111-1 facing the inner side wall (or the speaker 120), the second transverse side wall is arranged in the second acoustic cavity 111-2 facing the outer side wall 110b (or the speaker 120), and the speaker 120 is located between the first transverse side wall and the second transverse side wall in the vibration direction. In addition, one end of the first sealing ring 131 in the vibration direction is fixed to the first transverse side wall, and the other end abuts against the inner side wall 110a. One end of the second sealing ring 131 in the vibration direction is fixed to the second transverse side wall, and the other end abuts against the outer side wall 110b.

[0105] The sound guide hole of the limiting assembly 130 includes a first sound guide hole 130-1 penetrating through the first transverse side wall and the first sealing ring 131, and a second sound guide hole 130-2 penetrating through the second transverse side wall and the second sealing ring 132. The first sound guide hole 130-1 communicates the first acoustic cavity 111-1. It may also be understood that the first acoustic cavity 111-1 includes a cavity space between the first transverse side wall and the inner side wall 110a, and a cavity space between the first transverse side wall and the speaker 120 (e.g., the second diaphragm 121-1). The two cavity spaces located on two sides of the first transverse side wall are communicated through the first sound guide hole 130-1 to form the complete first acoustic cavity 111-1. Based on the same principle, the second sound guide hole 130-2 communicates the second acoustic cavity 111-2.

[0106] Based on this, by using the second housing as a peripheral protective structural member of the speaker 120, a relatively stable structural assembly space may be provided for the speaker, which not only facilitates configuring the sound generating assembly as a complete functionally integrated component, but also facilitates miniaturization and lightweighting of the sound generating assembly or the sound generating portion 100. For example, the second housing may be made of a metal material, thereby allowing the housing wall of the second housing to be thinner and lighter while ensuring mechanical strength of the second housing. At the same time, it is also beneficial for designing an internal acoustic structure of the sound generating portion 100, to provide support for active noise reduction, or the like.

[0107] In some embodiments, on the reference plane perpendicular to the vibration direction, projections of the sound guide hole of the limiting assembly 130, the first sound outlet hole 112-1, the second sound outlet hole 112-2, the first diaphragm 121-1, and the second diaphragm 121-2 at least partially overlap, to ensure that the sound from the speaker 120 is output to an outside of the first housing 110.

[0108] Illustratively, in some embodiments, on the reference plane perpendicular to the vibration direction, the projection of the first sound outlet hole 112-1 falls within the projection of the first sound guide hole 130-1. Alternatively, in some embodiments, on the reference plane perpendicular to the vibration direction, a projected area of an overlapping region between the projection of the first sound outlet hole 112-1 and the projection of the first sound guide hole 130-1 is not less than 80% of the projected area of the projection of the first sound guide hole 130-1. Since the sound generated by the first diaphragm 121-1 in the first acoustic cavity 111-3 communicates through the first sound guide hole 130-1 and the first sound outlet hole 112-1, and then is output to the outside of the first housing 110 through the first sound outlet hole 112-1, an overlap-

ping region of the first sound outlet hole 112-1 and the first sound guide hole 130-1 may be regarded as a neck of the first Helmholtz resonant cavity model corresponding to the first acoustic cavity 111-3. With such a configuration, by designing a ratio of the area of the overlapping region to the area of the first sound guide hole 130-1, the resonance frequency of the first acoustic cavity 111-3 may be adjusted, which may allow air pushed by the diaphragm in the sound guide hole of the limiting assembly 130 to be smoothly ejected from the first sound outlet hole 112-1, ensuring acoustic output of the speaker 120, and providing support for the peak resonance frequency of the second resonance peak to move toward a high frequency band as much as possible. Preferably, in some embodiments, on the reference plane perpendicular to the vibration direction, the projection of the second sound outlet hole 112-2 falls within the projection of the second sound guide hole 130-2. Alternatively, in some embodiments, on the reference plane perpendicular to the vibration direction, a projected area of an overlapping region between the projection of the second sound outlet hole 112-2 and the projection of the second sound guide hole 130-2 is not less than 80% of the projected area of the projection of the second sound guide hole 130-2. With such a configuration, air pushed by the diaphragm in the sound guide hole of the limiting assembly 130 may be smoothly ejected from the second sound outlet hole 112-2, ensuring acoustic output of the speaker 120.

[0109] Similarly, in some embodiments, on the reference plane perpendicular to the vibration direction, the projection of the first diaphragm 121-1 falls within the projection of the first sound guide hole 130-1. Alternatively, in some embodiments, on the reference plane perpendicular to the vibration direction, a projected area of an overlapping region between the projection of the first diaphragm 121-1 and the projection of the first sound guide hole 130-1 is not less than 80% of the projected area of the projection of the first diaphragm 121-1. With such a configuration, when the first diaphragm 121-1 vibrates, air pushed by the first diaphragm 121-1 may smoothly enter the sound guide hole of the limiting assembly 130, thereby ensuring acoustic output of the speaker 120 with maximum efficiency. Preferably, in some embodiments, on the reference plane perpendicular to the vibration direction, the projection of the second diaphragm 121-2 falls within the projection of the second sound guide hole 130-2. Alternatively, in some embodiments, on the reference plane perpendicular to the vibration direction, a projected area of an overlapping region between the projection of the second diaphragm 121-2 and the projection of the second sound guide hole 130-2 is not less than 80% of the projected area of the projection of the second diaphragm 121-2. Such a configuration, when the second diaphragm 121-2 vibrates, allows the air pushed by the second diaphragm 121-2 to smoothly enter the sound guide hole of the limiting assembly

130, thereby ensuring the acoustic output of the speaker 120 with maximum efficiency.

[0110] In addition, referring to FIG. 20, based on the first sealing ring 131 and the second sealing ring 132, the sound generating assembly may be sealingly fixed in the interior of the first housing 110 (i.e., an accommodating cavity) by means of an interference fit, or the like. For example, the first sealing ring 131 elastically abuts against the inner side wall 110a, and the second sealing ring 132 elastically abuts against the outer side wall 110b. In this way, by utilizing the first sealing ring 131 and the second sealing ring 132, the speaker 120 is sealingly fixed in the first housing 110 from two sides in the vibration direction, thereby forming the first acoustic cavity 111-1 and the second acoustic cavity 111-2.

[0111] It should be noted that the 'boundary of the first acoustic cavity 111-1' described in the foregoing embodiments may be defined by the first sealing ring 131, i.e., it may be understood that on the reference plane perpendicular to the vibration direction, the projection of the first sealing ring 131 on the reference plane is the boundary of the first acoustic cavity 111-1.

[0112] In some embodiments, the deformation resistance of the first sealing ring 131 and the deformation resistance of the second sealing ring 132 are less than the deformation resistance of the second housing. For example, the first sealing ring 131 and the second sealing ring 132 may be made of an elastic material, such as a silicone material, or the like, and the second housing may be made of a metal material (e.g., an aluminum alloy) or other materials (e.g., plastic having a material hardness greater than the material hardness of the sealing rings).

[0113] Exemplarily, the first sealing ring 131 and the second sealing ring 132 are made of an elastic material, such as a silicone material, or the like, and the first sealing ring 131 and the second sealing ring 132 may be integrally formed with the second housing by means of injection molding, overmolding, or the like. In this way, the limiting assembly 130 may be configured as a relatively independent and complete structural member, which facilitates reduction of disassembly and assembly difficulty of the sound generating assembly and the sound generating portion 100, and enhances the structural stability of the sound generating assembly and even the sound generating portion 100.

[0114] In some embodiments, a reinforcing structure is provided at a junction of the second housing and the first sealing ring 131 (and the second sealing ring 132). The reinforcing structure may be a sawtooth structure, a hole structure, or the like, arranged on the first transverse side wall or the second transverse side wall. The reinforcing structure enhances the structural connection stability of the first sealing ring 131 (and the second sealing ring 132) and the second housing, thereby preventing detachment of the sealing rings during disassembly and assembly of the sound generating portion

100.

[0115] In some embodiments, referring to FIGS. 22 to 24, the second housing is a split structure and includes a first cover 133 and a second cover 134. One end of the speaker 120 in the vibration direction extends into the first cover 133, and the other end thereof extends into the second cover 134. It may also be understood that the first cover 133 and the second cover 134 respectively cover or shield the opposing two ends of the speaker 120 in the vibration direction. The side wall of the first cover 133 located between the speaker 120 and the inner side wall 110a is the first transverse side wall, the side wall of the second cover 134 located between the speaker 120 and the outer side wall 110b is the second transverse side wall, and the side walls of the first cover 133 and the second cover 134 that enclose around the vibration direction and are fixedly connected to the speaker 120 are their respective longitudinal side walls.

[0116] On the one hand, by utilizing the relative positional relationship between the first cover 133, the second cover 134, and the speaker 120, an accommodating gap 130-4 surrounding the speaker 120 may be formed between the first cover 133 and the second cover 134. The accommodating gap 130-4 provides structural assembly space for a circuit board 150, or the like, electrically connected to the speaker 120 and the microphone assembly. For example, wires, flat cables, flexible printed circuits (FPC), or the like, may be received and fixed in the accommodating gap 130-4, thereby allowing for full utilization of the structural space, effectively enhancing the structural compactness of the sound generating assembly, and facilitating miniaturization of the sound generating portion 100 and even the earphone.

[0117] On the other hand, by configuring the first cover 133 and the first sealing ring 131 as an independent and complete structural member, and configuring the second cover 134 and the second sealing ring 132 as an independent and complete structural member, it also facilitates disassembly and assembly of the speaker 120 and the limiting assembly 130, and reduces disassembly and assembly difficulty of the sound generating assembly.

[0118] In some embodiments, the limiting assembly 130 may also omit the second housing, and utilize the first sealing ring 131 and the second sealing ring 132 to directly establish a sealed connection relationship between the speaker 120 and the first housing 110. By way of example, the first sealing ring 131 is clamped and fixed between the speaker 120 and the inner side wall 110a, and cooperates with the speaker 120 and the inner side wall 110a to form the first acoustic cavity 111-1; the second sealing ring 132 is clamped and fixed between the speaker 120 and the outer side wall 110b, and cooperates with the speaker 120 and the outer side wall 110b to form the second acoustic cavity 111-2. In this case, the first sealing ring 131 and the

second sealing ring 132 may adopt an annular structure, and the corresponding sound guide holes may also be formed by providing openings in the first sealing ring 131 and the second sealing ring 132.

[0119] In other embodiments, the limiting assembly 130 may also omit the first sealing ring 131 and the second sealing ring 132, and utilize an interference abutment relationship between the second housing (e.g., the first cover 133 and the second cover 134) and the first housing 110 (e.g., the inner side wall 110a and the outer side wall 110b) to form the first acoustic cavity 111-1 and the second acoustic cavity 111-2.

[0120] In other embodiments, the limiting assembly 130 may also adopt other suitable structures, as long as it may allow the speaker 120 to be stably fixed in the first housing 110, or may allow the speaker 120 to divide the accommodating cavity into the first acoustic cavity 111-1 and the second acoustic cavity 111-2. Such details will not be described in detail herein.

[0121] In some embodiments, referring to FIG. 21, the first housing 110 is provided with an opening structure and a positioning structure (wherein for ease of distinction and description, the positioning structure is defined as a third positioning structure). The opening structure may be enclosed and formed by the inner side wall 110a, the outer side wall 110b, the upper side wall 110c, and the lower side wall 110d. The opening structure may also be arranged to extend through a bottom side wall or a top side wall of the first housing 110 in the short axis direction. That is, the first housing 110 may be formed by splicing and enclosing a plurality of housing side walls. For example, the inner side wall 110a, the outer side wall 110b, the upper side wall 110c, and the lower side wall 110d are an integral structure, and the bottom side wall and the top side wall cover the opening structure and jointly enclose the accommodating cavity of the first housing 110 with other side walls.

[0122] The opening structure communicates with the accommodating cavity and is mainly configured to guide the sound generating assembly into and out of the accommodating cavity, so as to realize disassembly and assembly of the sound generating assembly and the first housing 110. The third positioning structure may be arranged in the accommodating cavity. For example, the third positioning structure may include protruding structures, stepped structures, or the like, arranged on the housing side walls such as the inner side wall 110a, the outer side wall 110b, the upper side wall 110c, and the lower side wall 110d. It is mainly configured to abut against the limiting assembly 130 to limit the position of the sound generating assembly in the accommodating cavity, thereby providing support for precise and rapid assembly of the sound generating assembly.

[0123] In some embodiments, based on the first transverse side wall and the first sound guide hole 130-1, and the second transverse side wall and the

second sound guide hole 130-2, support may be provided for adjusting the resonance frequency and the specific acoustic impedance of corresponding acoustic cavities, and the sound pressure level, or the like, of the sound output from corresponding sound outlet holes, so as to enhance an active noise reduction effect.

[0124] Exemplarily, the first sound guide hole 130-1 includes an opening of the first sealing ring 131 and an opening of the first transverse side wall. On the reference plane perpendicular to the vibration direction, a first overlapping region exists between the projection of the opening of the first transverse side wall, the projection of the first sound outlet hole 112-1, and the projection of the opening of the first sealing ring 131. In the first overlapping region, the proportion of the projection of the opening of the first transverse side wall is greater than the projection proportion of the first sound outlet hole 112-1. For example, on the reference plane, within the first overlapping region, the projected area proportion of the opening of the first transverse side wall may be greater than 30% (e.g., greater than 80%), and the projected area proportion of the first sound outlet hole 112-1 may be between 20% and 30%. In this way, adverse effects on sound output due to excessively small opening areas of the first sound guide hole 130-1 and the second sound guide hole 130-2 may be minimized.

[0125] Preferably, the second sound guide hole 130-2 includes an opening of the second sealing ring 132 and an opening of the second transverse side wall. On the reference plane perpendicular to the vibration direction, a second overlapping region exists between the projection of the opening of the second transverse side wall, the projection of the second sound outlet hole 112-2, and the projection of the opening of the second sealing ring 132. In the second overlapping region, the proportion of the projection of the opening of the second transverse side wall is greater than the projection proportion of the second sound outlet hole 112-2. For example, on the reference plane, within the second overlapping region, the projected area proportion of the opening of the second transverse side wall may be greater than 30% (e.g., greater than 80%), and the projected area proportion of the second sound outlet hole 112-2 may be between 20% and 30%. In this way, adverse effects on sound output due to excessively small opening areas of the first sound guide hole 130-1 and the second sound guide hole 130-2 may be minimized.

[0126] In some embodiments, referring to FIGS. 22 and 23, the second housing has a rib structure 130-3, and the rib structure 130-3 is arranged on the first transverse side wall and the second transverse side wall; for ease of distinction and description, the rib structure 130-3 of the first transverse side wall is defined as a first rib structure, and the rib structure 130-3 of the second transverse side wall is defined as a second rib structure, the first rib structure is located in the first sound guide hole 130-1, and the second rib structure is located in the second sound guide hole 130-2.

[0127] The first rib structure may be configured to support and fix a first acoustic resistance mesh in the first acoustic cavity 111-1 described in the foregoing embodiments. For example, the first acoustic resistance mesh covers the first sound guide hole 130-1 through the first rib structure and is fixed on the side of the first transverse side wall facing the inner side wall 110a. The second rib structure may be configured to support and fix a second acoustic resistance mesh in the second acoustic cavity 111-1 described in the foregoing embodiments. For example, the second acoustic resistance mesh covers the second sound guide hole 130-2 through the second rib structure and is fixed on the side of the second transverse side wall facing the outer side wall 110b.

[0128] On the one hand, the rib structure 130-3 may be utilized to adjust the opening area, shape, and distribution, or the like, of the corresponding sound guide holes, so as to realize adjustment of the acoustic characteristics of the corresponding acoustic cavities or the sound output. On the other hand, the acoustic resistance mesh may be fixed on the corresponding rib structure 130-3 and the corresponding side wall of the limiting assembly 130 by means of adhesive bonding, welding, or the like, thereby preventing vibration of the acoustic resistance mesh due to air vibration when the speaker 120 operates, and further preventing adverse effects on the sound output (e.g., the frequency response curve, or the like), and ensuring the active noise reduction effect. If the quantity of the rib structures 130-3 is too small, it may lead to unstable fixing of the acoustic resistance mesh, and the acoustic resistance mesh may vibrate to generate noise. If the quantity of the rib structures 130-3 is too large, it may lead to an excessively small actual area of the corresponding sound guide holes, affecting the resonance frequency of the corresponding acoustic cavities, impacting the second resonance frequency of the output sound of the earphone, and further affecting the active noise reduction effect of the earphone. In some embodiments, in order to ensure the active noise reduction effect of the earphone and prevent the acoustic resistance mesh from vibrating to generate noise, the quantity of the rib structures 130-3 (e.g., the first rib structure or the second rib structure) may be 4.

[0129] In some embodiments, referring to FIG. 24, where the second housing has the first transverse side wall and the second transverse side wall, the minimum distance between the first transverse side wall and the center of the main region of the first diaphragm 121-1 is greater than the maximum amplitude of vibration of the main region toward the inner side wall 110a, and the minimum distance between the second transverse side wall and the center of the main region of the second diaphragm 121-2 is greater than the maximum amplitude of vibration of the main region toward the outer side wall 110b.

[0130] Thus, based on the limitation on the distance

between the amplitude of the diaphragms and the corresponding side walls, collision of the diaphragms with the limiting assembly 130 during the vibration may be prevented, thereby ensuring the sound output effect.

[0131] It should be noted that a diaphragm typically includes a main region and a surround region surrounding the main region. The main region can move in the vibration direction under a driving force generated by cooperation between the magnetic circuit assembly and the voice coil assembly in the speaker 120, thereby generating sound by pushing or compressing the air in the interior of the first housing 110 or the interior of the speaker 120. The surround region may generate elastic deformation with movement of the main region, and provides an elastic restoring force to the main region.

[0132] In addition, in some embodiments where the second housing is omitted or the second housing does not have the first transverse side wall or the second transverse side wall, in order to prevent collision of the diaphragms with the corresponding housing side walls in the first housing 110 during the vibration, the minimum distance in the vibration direction from the center of the main region of the first diaphragm 121-1 to the inner side wall 110a is set to be greater than the maximum amplitude of vibration of the main region toward the inner side wall 110a, and the minimum distance in the vibration direction between the center of the main region of the second diaphragm 121-2 and the outer side wall 110b is set to be greater than the maximum amplitude of vibration of the main region toward the outer side wall 110b.

[0133] In some embodiments, referring to FIG. 24, the first transverse side wall and the second transverse side wall respectively have a central portion and an arc portion annularly connected to the central portion, and one end of the arc portion away from the central portion is connected to the longitudinal side wall of the second housing. In the vibration direction, the central portion of the first transverse side wall faces the main region of the first diaphragm 121-1 (at this time, the first sound guide hole 130-1 may be arranged in the central portion of the first transverse side wall), and the arc portion of the first transverse side wall faces the surround region of the first diaphragm 121-1. The central portion of the second transverse side wall faces the main region of the second diaphragm 121-2 (at this time, the second sound guide hole 130-2 may be arranged in the central portion of the second transverse side wall), and the arc portion of the second transverse side wall faces the surround region of the second diaphragm 121-2.

[0134] On the one hand, a second clearance space 130-5 may be formed between the surround region of the first diaphragm 121-1 and the arc portion of the first transverse side wall, and the second clearance space 130-5 may be utilized to provide clearance for the surround region of the first diaphragm 121-1 when the first diaphragm 121-1 vibrates. Meanwhile, another second clearance space 130-6 may also be formed between

the surround region of the second diaphragm 121-2 and the arc portion of the second transverse side wall, and the other second clearance space 130-6 may be utilized to provide clearance for the surround region of the second diaphragm 121-2 when the second diaphragm 121-2 vibrates. In summary, the clearance spaces may prevent collision of the surround regions of the diaphragms with the limiting assembly 130 during the vibration, so as to ensure the sound output effect.

[0135] On the other hand, compared to a solution in which the transverse side wall and the longitudinal side wall adopt a right-angle connection transition, based on an arc portion forming an arc-shaped transition structure between the transverse side wall and the longitudinal side wall, the first housing may be configured into a structural form adapted to the second housing, thereby causing the corner regions between the adjacent side walls of the first housing to tend to be curved and smooth, and avoiding the appearance of sharp edges. In this way, without affecting the vibration of the diaphragms, it may not only enhance the comfort of wearing the sound generating portion 100 or the earphone, but also improve the appearance of the sound generating portion 100. Meanwhile, it also facilitates adaptation design for the longitudinal side wall and the outer contour structure of the speaker 120. For example, by means of structural adaptation and fixing of the longitudinal side wall and a bracket in the speaker 120, the speaker 120 may be stably positioned and fixed in the interior of the second housing.

[0136] In some embodiments, for the speaker 120 in which the first diaphragm 121-1 and the second diaphragm 121-2 vibrate synchronously in the same direction, in order to enable the frequency response curve of the sound output from the speaker 120 to have a flatter region in a wider frequency band range, the resonance frequency of the second resonance peak may be increased and the frequency response curve of the sound output from the earphone (specifically, the first sound outlet hole 112-1) may be optimized by designing the quantity, shape, dimension, and position of one or more acoustic structures (e.g., sound outlet holes, acoustic cavities) of the sound generating portion 100, thereby supporting active noise reduction of the earphone in a wider frequency band range and enhancing the sound output effect of the earphone.

[0137] FIG. 25 is a schematic diagram illustrating frequency response curves of a speaker corresponding to sound outlet holes of different sizes according to some embodiments of the present disclosure. It should be noted that FIG. 25 shows the data measured under conditions where the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are single holes consistent in shape (e.g., the dimension of a short side is half of the dimension of a long side). It may be understood that the area of the housing side walls of the first housing 110 remains unchanged, the width dimension of the sound outlet holes remains unchanged, and the

ratio of the length dimension of the sound outlet holes represents the change in size of the sound outlet holes.

[0138] In FIG. 25, the curve L421 represents the frequency response when a ratio of a long side dimension of the sound outlet hole to a long side dimension of the first housing 110 is 0.1; the curve L422 represents the frequency response when the ratio of the long side dimension of the sound outlet hole to the long side dimension of the first housing 110 is 0.3; the curve L423 represents the frequency response when the ratio of the long side dimension of the sound outlet hole to the long side dimension of the first housing 110 is 0.5; the curve L424 represents the frequency response when the ratio of the long side dimension of the sound outlet hole to the long side dimension of the first housing 110 is 0.7; the curve L425 represents the frequency response when the ratio of the long side dimension of the sound outlet hole to the long side dimension of the first housing 110 is 0.9; and the curve L426 represents the total sound pressure level of the speaker 120, i.e., it may be regarded as the output sound pressure level when the speaker 120 is not encompassed by the first housing 110. The width dimensions of the sound outlet holes with different long side dimensions are the same, and the sound outlet holes are arranged at central positions of the corresponding inner side wall and outer side wall.

[0139] As shown in FIG. 25, as the dimension of the sound outlet holes gradually decreases, the resonance peak of the sound generating portion 100 at high frequencies (e.g., above 4.5 kHz) gradually shifts forward, and the peak resonance frequency of the high frequency resonance peak of the curve L422 is approximately 10 kHz.

[0140] Based on this, in some embodiments, referring to FIGS. 26A to 26C and FIGS. 32A and 32B, the first sound outlet hole 112-1 and the second sound outlet hole 112-2 may adopt a single hole structure, and a ratio of the dimension of the first sound outlet hole 112-1 and/or the second sound outlet hole 112-2 to the corresponding dimension of the first housing 110 is not less than 0.3. For example, where the length of the first housing 110 and the sound outlet holes in the long axis direction is greater than their respective width in the short axis direction, a ratio of the long side dimension of the sound outlet holes to the long side dimension of the first housing 110 may be not less than 0.3. For example, a ratio of the length of the first sound outlet hole 112-1 in the long axis direction to the length of the inner side wall in the long axis direction may be not less than 0.3, and a ratio of the length of the first sound outlet hole 112-1 in the long axis direction to the length of the outer side wall in the long axis direction may be not less than 0.3. The contour shape of the sound generating portion 100 is a centrally symmetric geometric shape, such as a circular shape, or the like, a ratio of the radius of the sound outlet hole to the radius of the corresponding side wall of the first housing 110 may be

not less than 0.3. In this way, the resonance frequency of the corresponding acoustic cavities may be not less than 1 kHz, ensuring that the second resonance peak of the sound output through the sound outlet holes shifts toward the high frequency band, finally causing the earphone to have a flatter output in a wider frequency band range, and enhancing the active noise reduction effect of the earphone against larger ambient noise in open-type scenarios.

[0141] FIGS. 26A-26C are schematic diagrams illustrating different positions of sound outlet holes according to some embodiments of the present disclosure; and FIG. 27 is a schematic diagram illustrating frequency response curves of a speaker corresponding to sound outlet holes at different positions according to some embodiments of the present disclosure. The sound outlet hole (e.g., the first sound outlet hole 112-1) shown in FIG. 26A is located at a central position of the surface of the first housing 110. The sound outlet hole (e.g., the first sound outlet hole 112-1) shown in FIG. 26B is eccentrically arranged with respect to the surface of the first housing 110 in a length direction. The sound outlet hole (e.g., the first sound outlet hole 112-1) shown in FIG. 26C is eccentrically arranged with respect to the surface of the first housing 110 in a width direction. It should be noted that FIG. 27 shows the data measured under conditions where the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are both single holes, and their shapes, dimensions, and arrangement positions are the same.

[0142] In FIG. 27, the sound outlet holes corresponding to curves L441, L442, L443, and L444 are all eccentrically arranged in the long axis direction with respect to the surface of the first housing 110. The curve L441 indicates that a distance between a center of a sound outlet hole and the center of the corresponding surface in the long axis direction is 1 mm; the curve L442 indicates that the distance between the center of the sound outlet hole and the center of the corresponding surface in the long axis direction is 3 mm; the curve L443 indicates that the distance between the center of the sound outlet hole and the center of the corresponding surface in the long axis direction is 5 mm; and the curve L444 indicates that the distance between the center of the sound outlet hole and the center of the corresponding surface in the long axis direction is 0 mm, which means the sound outlet hole is not eccentrically arranged, and a sound outlet hole is arranged at the center of the corresponding surface of the first housing 110.

[0143] As shown in FIG. 27, in a range of 1 kHz to 10 kHz, the sound pressure level corresponding to the resonance peak of the curve L444 is higher than those of the other curves, indicating that when a sound outlet hole is located at the center of the corresponding side wall of the first housing 110, the sound pressure level of the sound output by the sound generating portion 100 may be slightly larger.

[0144] Based on this, in some embodiments of the present disclosure, with reference to FIG. 26A, the first sound outlet hole 112-1 and the second sound outlet hole 112-2 may employ a single opening structure, and the centroid of the first sound outlet hole 112-1 coincides with the center of the inner side wall, and the centroid of the second sound outlet hole 112-2 coincides with the center of the outer side wall, thereby allowing the sound outlet hole to be located at the central position of the corresponding side wall of the first housing 110. That is, on a reference plane perpendicular to the vibration direction, a distance between a centroid of a projection of a second sound outlet hole and a centroid of a projection of the corresponding side wall of the first housing 110 and/or a distance between a centroid of a projection of the first sound outlet hole and a centroid of a projection of the corresponding side wall of the first housing 110 is not greater than 5 mm. This may increase the sound pressure level of the sound output by the earphone, improve the sensitivity of the earphone's output, and enhance the listening effect for a user.

[0145] As shown in FIG. 27, by comparing the curves L441, L442, L443, and L444, the resonance frequencies corresponding to the high-frequency resonance peaks of the four curves are substantially the same, indicating that different arrangement positions of sound outlet holes in a large-area concentrated opening manner (i.e., a large-area single-hole manner) have no effect on the high-frequency peak position of the earphone.

[0146] Based on this, in some embodiments of the present disclosure, considering the structure of the earphone and other components, when a sound outlet hole may not be arranged at the central position of the corresponding side wall of the first housing 110, the first sound outlet hole 112-1 or the second sound outlet hole 112-2 may be eccentrically adjusted. Taking the arrangement position of the first sound outlet hole 112-1 as an example: with reference to FIG. 26B, the first sound outlet hole 112-1 may be eccentrically arranged in the long axis direction with respect to the center of the inner side wall; with reference to FIG. 26C, the first sound outlet hole 112-1 may be eccentrically arranged in the width direction with respect to the center of the inner side wall; and the first sound outlet hole 112-1 may also be eccentrically arranged in both the long axis direction and the width direction with respect to the center of the inner side wall.

[0147] In some embodiments of the present disclosure, in order to improve the sound output effect of the earphone and/or enhance the sound leakage reduction effect of the earphone, the first acoustic cavity 111-1 and the second acoustic cavity 111-2 may be arranged to be the same or similar, and by means of the arrangement of the first sound outlet hole 112-1 and the second sound outlet hole 112-2, the effect of the first sound output by the first sound outlet hole 112-1 and the sec-

ond sound output by the second sound outlet hole 112-2 canceling each other out in a far field may be improved, thereby improving the far-field sound leakage reduction effect of the earphone; or, the effect of the first sound and the second sound canceling each other out in a near field may be reduced, thereby improving the near-field listening effect. For example, when the first sound outlet hole 112-1 and the second sound outlet hole 112-2 have the same dimension, are arranged opposite each other, and have the same arrangement manner, and when the first sound output by the first sound outlet hole 112-1 and the second sound output by the second sound outlet hole 112-2 can have opposite phases and the same amplitude, the effect of the first sound and the second sound canceling each other out in a far field may be enhanced, thereby improving the sound leakage reduction effect of the earphone. As another example, when the first sound outlet hole 112-1 is designed to point towards the external auditory canal of a user, and the second sound outlet hole 112-2 is designed to be close to the external auditory canal of the user, and when the first sound output by the first sound outlet hole 112-1 and the second sound output by the second sound outlet hole 112-2 can have opposite phases and the same amplitude, the effect of the first sound and the second sound canceling each other out in a near field may be reduced, thereby improving the near-field listening effect of the earphone.

[0148] FIGS. 28A-28B are schematic diagrams illustrating different relative positions of a first sound outlet hole and a second sound outlet hole according to some embodiments of the present disclosure; and FIG. 29 is a schematic diagram illustrating frequency response curves of a speaker corresponding to a first sound outlet hole and a second sound outlet hole disposed at different positions according to some embodiments of the present disclosure. In FIG. 28A, the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are arranged opposite each other, and both are located at the central position of the corresponding surface; in FIG. 28B, the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are eccentrically arranged in the long axis direction. It should be noted that FIG. 29 shows data obtained under conditions where the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are single holes with consistent shapes (e.g., a dimension of a short side is half a dimension of a long side) and have the same dimension.

[0149] In FIG. 29, the curve L461 represents the frequency response curve at the first sound outlet hole 112-1 when the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are arranged opposite each other; the curve L462 represents the frequency response curve at the second sound outlet hole 112-2 when the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are arranged opposite each other; the curve L463 represents the frequency re-

sponse curve at the first sound outlet hole 112-1 when the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are arranged in a staggered manner; and the curve L464 represents the frequency response curve at the second sound outlet hole 112-2 when the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are arranged in a staggered manner. The areas of the first sound outlet hole 112-1 and the second sound outlet hole 112-2 corresponding to curves L461, L462, L463, and L464 are the same. As shown in FIG. 29, compared to the curve L461 and the curve L462, the high-frequency resonance peaks of the curve L463 and the curve L464 are significantly shifted forward, moving from near 10 kHz to near 8 kHz.

[0150] Based on this, in some embodiments of the present disclosure, with reference to FIG. 28A, the first sound outlet hole 112-1 and the second sound outlet hole 112-2 may employ a single hole structure, and the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are arranged opposite each other. That is, on a reference plane perpendicular to the vibration direction, a distance between a centroid of a projection of the second sound outlet hole 112-2 and a centroid of a projection of the first sound outlet hole 112-1 is not greater than 5 mm. In this way, when the first sound output by the first sound outlet hole 112-1 and the second sound output by the second sound outlet hole 112-2 can have opposite phases and the same amplitude, the first sound and the second sound may cancel each other out in a far field, thereby improving the sound leakage reduction effect of the earphone. In other embodiments of the present disclosure, with reference to FIG. 28B, the first sound outlet hole 112-1 and the second sound outlet hole 112-2 may also be arranged in a staggered manner, in order to satisfy the appearance requirement of the earphone or the sound generating portion 100 or the structural design requirements of various components (e.g., to improve the near-field listening effect of the earphone, or the like).

[0151] In a case where the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are arranged in a staggered manner, by designing the dimension, shape, specific acoustic impedance, or the like of the first sound outlet hole 112-1 and the second sound outlet hole 112-2, the first sound output by the first sound outlet hole 112-1 and the second sound output by the second sound outlet hole 112-2 canceling each other out in a near field may be reduced, thereby ensuring the near-field listening effect of the earphone.

[0152] Illustratively, the acoustic resistance mesh may be arranged at the second sound outlet hole 112-2, e.g., the acoustic resistance mesh in one or more forms of a steel mesh, a gauze mesh, or a waterproof and breathable membrane; the acoustic resistance mesh may be disposed within the second acoustic cavity 111-2 and cover the second sound outlet hole 112-2; by reducing the sound pressure level of the sound output by the second sound outlet hole 112-2

via the acoustic resistance mesh, it can both ensure a large output in a low-frequency band and avoid the sound output by the second sound outlet hole 112-2 affecting the sound output by the first sound outlet hole 112-1, thereby ensuring the near-field listening effect of the earphone.

[0153] Due to process limitations in an actual processing and production process, and component design or appearance design requirements of the earphone, the dimensions of the first sound outlet hole 112-1 and the second sound outlet hole 112-2 may be different, which may affect the output of the earphone, thereby affecting the near-field listening effect of the earphone and the active noise reduction effect for a larger ambient noise in an open-environment scenario.

[0154] FIG. 30 is a schematic diagram illustrating a first sound outlet hole and a second sound outlet hole of different sizes according to some embodiments of the present disclosure; and FIG. 31 is a schematic diagram illustrating frequency response curves of a speaker corresponding to a first sound outlet hole and a second sound outlet hole of different sizes according to some embodiments of the present disclosure. It should be noted that FIG. 31 shows data obtained under conditions where the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are single holes with the same shape (e.g., a dimension of a short side of a sound outlet hole is half a dimension of a long side) and both are arranged opposite each other.

[0155] In FIG. 31, the curve L481 represents the frequency response curve at the first sound outlet hole 112-1 when a ratio of a long side dimension of the first sound outlet hole 112-1 to a long side dimension of the corresponding surface of the first housing 110 is 0.5 and a ratio of a long side dimension of the second sound outlet hole 112-2 to the long side dimension of the corresponding surface of the first housing 110 is 0.5; the curve L482 represents the frequency response curve at the second sound outlet hole 112-2 when the ratio of the long side dimension of the first sound outlet hole 112-1 to the long side dimension of the corresponding surface of the first housing 110 is 0.5 and the ratio of the long side dimension of the second sound outlet hole 112-2 to the long side dimension of the corresponding surface of the first housing 110 is 0.5; the curve L483 represents the frequency response curve at the first sound outlet hole 112-1 when the ratio of the long side dimension of the first sound outlet hole 112-1 to the long side dimension of the corresponding surface of the first housing 110 is 0.5 and a ratio of the long side dimension of the second sound outlet hole 112-2 to the long side dimension of the corresponding surface of the first housing 110 is 0.2; and the curve L484 represents the frequency response curve at the second sound outlet hole 112-2 when the ratio of the long side dimension of the first sound outlet hole 112-1 to the long side dimension of the corresponding surface of the first housing 110 is 0.5 and a ratio of the long side

dimension of the second sound outlet hole 112-2 to the long side dimension of the corresponding surface of the first housing 110 is 0.2. Width dimensions of sound outlet holes with different long side dimensions are the same.

[0156] As shown in FIG. 31, compared to curves L481 and L482, when the dimension of the first sound outlet hole 112-1 is greater than the dimension of the second sound outlet hole 112-2, the high-frequency resonance peak of the curve L484 is significantly shifted forward, the high-frequency resonance peaks of the curve L481, the curve L482, and the curve L483 are located near 10 kHz, while the high-frequency resonance peak of the curve L484 is located near 5 kHz; the curve L483 has a peak-to-valley dip near 6 kHz, affecting the output of the sound generating portion 100; when the dimension of the first sound outlet hole 112-1 is equal to the dimension of the second sound outlet hole 112-2, the trends of the curve L481 and the curve L482 are substantially the same, with good consistency, indicating that an output effect of the sound generating portion 100 is improved.

[0157] Based on this, in some embodiments of the present disclosure, the dimensions of the first sound outlet hole 112-1 and the second sound outlet hole 112-2 are set to be the same, which is beneficial for ensuring that the sound generating portion 100 has a flat frequency response curve and a phase curve with smaller variations in a wider frequency band range, thereby enhancing the active noise reduction effect of the earphone in a wider frequency band range.

[0158] In other embodiments of the present disclosure, with reference to FIG. 30, in order to satisfy design requirements, appearance requirements, or the like of various components of the earphone, and when it is necessary to set the dimension of the first sound outlet hole 112-1 and the dimension of the second sound outlet hole 112-2 to be different, the dimension of the first sound outlet hole 112-1 may be set to be greater than the dimension of the second sound outlet hole 112-2. For example, on a reference plane perpendicular to the vibration direction, a ratio of a projected area of the second sound outlet hole 112-2 to a projected area of the first sound outlet hole 112-1 is 0.4 to 2.5. Through the dimension design of the first sound outlet hole 112-1 and the second sound outlet hole 112-2, when the first sound output by the first sound outlet hole 112-1 and the second sound output by the second sound outlet hole 112-2 can have opposite phases and the same amplitude, the effect of the first sound and the second sound canceling each other out in a far field may be improved, thereby improving the sound leakage reduction effect of the earphone.

[0159] When the dimension of the first sound outlet hole 112-1 is different from the dimension of the second sound outlet hole 112-2, an acoustic resistance mesh may also be arranged at the second sound outlet hole 112-2, and the acoustic resistance mesh may be dis-

posed within the second acoustic cavity 111-2 and cover the second sound outlet hole 112-2; by reducing the sound pressure level of the sound output by the second sound outlet hole 112-2 via the acoustic resistance mesh, it can both ensure a large output in a low-frequency band and avoid the sound output by the second sound outlet hole 112-2 affecting the sound output by the first sound outlet hole 112-1, thereby ensuring the near-field listening effect of the earphone.

[0160] FIGS. 32A-32B are schematic diagrams illustrating acoustic holes of different shapes according to some embodiments of the present disclosure; and FIG. 33 is a schematic diagram illustrating frequency response curves of a speaker corresponding to acoustic holes of different shapes according to some embodiments of the present disclosure. In FIG. 32A, the sound outlet hole is single concentrated opening, and in FIG. 32B, the sound outlet hole is single non-concentrated opening (e.g., annular opening).

[0161] In FIG. 33, the curve L501 represents the frequency response curve of the sound generating portion 100 corresponding to a sound outlet hole, which is single concentrated opening as shown in FIG. 32A, and the curve L502 represents the frequency response curve of the sound generating portion 100 corresponding to a sound outlet hole, which is single non-concentrated opening (e.g., annular opening) as shown in FIG. 32B.

[0162] It should be noted that an opening area of the sound outlet hole represented by the curve L501 and an opening area of the sound outlet hole represented by the curve L502 are the same (i.e., the opening rate is the same), and the opening positions are the same (i.e., the positions of the centers of the corresponding equivalent hole portions are the same); the calculation formula for the opening rate is a ratio of an opening area of a sound outlet hole to the area of the corresponding housing side wall of the first housing 110, e.g., an area ratio of the first sound outlet hole 112-1 to the inner side wall surface; both the single concentrated opening and the single non-concentrated opening can be understood as employing a single hole structure for a corresponding sound outlet hole.

[0163] As shown in FIG. 33, compared to the curve L501, the high-frequency resonance peak of the curve L502 is shifted to the right, indicating that the design of the single non-concentrated opening can cause the resonance frequency of the corresponding acoustic cavity to be located at a higher frequency. Therefore, in some embodiments of the present disclosure, with reference to FIG. 32B, the first sound outlet hole 112-1 or the second sound outlet hole 112-2 may employ a single hole structure in a single non-concentrated opening manner, and compared to a sound outlet hole in a single concentrated opening manner, it may cause the position of the peak resonance frequency of the resonance peak of the sound output by the sound outlet hole to be in a higher frequency band, thereby being

more beneficial for the earphone to have a relatively flat acoustic output in a wider frequency band range, and improving the active noise reduction effect of the earphone.

[0164] FIGS. 34A-34B are schematic diagrams illustrating different quantities of acoustic holes according to some embodiments of the present disclosure; and FIG. 35 is a schematic diagram illustrating frequency response curves of a speaker corresponding to acoustic holes with different opening shapes and different quantities according to some embodiments of the present disclosure. In FIG. 34A, an acoustic hole is non-single concentrated opening, and in FIG. 34B, an acoustic hole is single non-concentrated opening (e.g., annular opening). Total opening areas of sound outlet holes shown in FIGS. 34A and 34B are the same, i.e., the opening rates are the same.

[0165] In FIG. 35, the curve L521 represents the frequency response of the sound generating portion 100 corresponding to a sound outlet hole being single concentrated opening with an opening rate of 0.25; the curve L522 represents the frequency response of the sound generating portion 100 corresponding to a sound outlet hole being non-single concentrated opening and large mesh opening with an opening rate of 0.2178, as shown in FIG. 34A; and the curve L523 represents the frequency response of the sound generating portion 100 corresponding to a sound outlet hole being non-single concentrated opening and small mesh opening with an opening rate of 0.1657, as shown in FIG. 34B.

[0166] With reference to FIG. 35, by comparing curves L521, L522, and L523, as a dimension of a single sound outlet hole decreases and a quantity of sound outlet holes increases, the resonance peaks of the corresponding curves at high frequencies gradually increase. Therefore, in some embodiments of the present disclosure, a sound outlet hole (e.g., the first sound outlet hole 112-1) may employ holes with a non-single concentrated opening distribution as shown in FIGS. 34A and 34B, that is, a sound outlet hole is a porous structure composed of a plurality of micro-holes arranged in an array; this can both cause a position of a high-frequency peak of the speaker 120 to be higher, and can greatly increase an effective area of the sound output, ensuring the active noise reduction effect, and at the same time, it can satisfy the appearance design requirements of the sound generating portion 100 or the earphone.

[0167] With reference to FIG. 35, by comparing curves L521, L522, and L523, as a dimension of a single sound outlet hole decreases and a quantity of sound outlet holes increases, the output sound pressure level of the corresponding curves at high frequencies decreases; when the opening rate is fixed, if the dimension of the single sound outlet hole is too small, although the total quantity of sound outlet holes can be increased, thereby increasing high-frequency resonance peaks, it may also increase acoustic resistance

of the sound outlet hole, thereby affecting the output sound pressure level. Therefore, in order to ensure the output sound pressure level of the earphone, when a sound outlet hole (e.g., the first sound outlet hole 112-1) employs a porous structure in a non-single concentrated opening manner, that is, when the sound outlet hole is a porous structure composed of a plurality of micro-holes arranged in an array, a diameter of a single micro-hole may be not less than 0.2 mm.

[0168] FIGS. 36A-36F are schematic diagrams illustrating different distributions of non-single concentrated openings of sound outlet holes according to some embodiments of the present disclosure. FIG. 36A shows sound outlet holes of a non-single concentrated opening type distributed on one side of the corresponding side wall of the first housing 110 in the long axis direction, and a corresponding aperture ratio is 0.15; FIG. 36B shows sound outlet holes of the non-single concentrated opening type annularly distributed on one side of the corresponding side wall of the first housing 110 in the long axis direction, and the corresponding aperture ratio is 0.15; FIG. 36C shows sound outlet holes of the non-single concentrated opening type annularly distributed over an entire surface of the corresponding side wall of the first housing 110, and the corresponding aperture ratio is 0.15; FIG. 36D shows sound outlet holes of the non-single concentrated opening type annularly distributed on one side of the corresponding side wall of the first housing 110 in the long axis direction, and a pressure relief hole is provided on another side of the corresponding side wall in the long axis direction, the aperture ratio corresponding to the sound outlet holes is 0.15, and an aperture ratio corresponding to the pressure relief hole is 0.0375; FIG. 36E shows sound outlet holes of the non-single concentrated opening type distributed in a central region of the corresponding side wall of the first housing 110, and the corresponding aperture ratio is 0.15; and FIG. 36F shows sound outlet holes of the non-single concentrated opening type distributed over an entire surface of the corresponding side wall of the first housing 110, and the corresponding aperture ratio is 0.30. In this case, the first sound outlet hole 112-1 and the second sound outlet hole 112-2 may be designed to be directly aligned, or may be designed to be staggered.

[0169] FIG. 37 is a schematic diagram illustrating frequency response curves of a sound generating portion corresponding to sound outlet holes with different distributions of non-single concentrated openings according to some embodiments of the present disclosure. The curve L541 corresponds to sound outlet holes of a non-single concentrated opening type annularly distributed over an entire surface of the corresponding side wall of the first housing 110, with an aperture ratio of 0.15. The curve L542 corresponds to the sound outlet holes shown in FIG. 36B. The curve L543 corresponds to the corresponding side wall of the first housing 110 being fully opened, with an aperture ratio of 1. The

curve L544 corresponds to the sound outlet holes shown in FIG. 36D. The curve L545 corresponds to the sound outlet holes shown in FIG. 36E. The curve L546 corresponds to the sound outlet holes shown in FIG. 36F. The curve L547 corresponds to the speaker 120 without the first housing 110.

[0170] Referring to FIG. 37, by comparing the curve L546 and the curve L543, positions of the high frequency peaks are substantially the same, both being approximately 8.3 kHz. By comparing the curve L541, the curve L542, the curve L544, and the curve L545 with the curve L543, the frequencies corresponding to the high frequency peaks of the curve L541, the curve L542, the curve L544, and the curve L545 with an aperture ratio of 0.15 are all lower than the frequency corresponding to the high frequency peak of the curve L513 with an aperture ratio of 0.3. By comparing the curve L541, the curve L542, the curve L544, and the curve L545, all having the aperture ratio of 0.15, the high frequency peak of the curve L544 is located near 8.3 kHz, and has an additional resonance peak near 6.5 kHz; the high frequency peak of the curve L541 is located near 8.3 kHz, and has an additional resonance peak near 6.1 kHz; the high frequency peak of the curve L545 is located near 7.1 kHz; and the high frequency peak of the curve L542 is located near 6.5 kHz. When the aperture ratio of the sound outlet hole is 0.15, the high frequency peaks corresponding to the curve L541, the curve L542, the curve L544, and the curve L545 are all higher than 6 kHz.

[0171] Based on this, in some embodiments, when the sound outlet hole is a porous structure formed by a plurality of micro-holes arranged in an array (i.e., when the sound outlet hole adopts a non-single concentrated opening structure), in order to enable the earphone to have a relatively flat output in a relatively wide frequency band range, the aperture ratio of the sound outlet hole may be not less than 0.1; it may also be understood that, on a reference plane perpendicular to the thickness direction (vibration direction), an area proportion of a projection of the first sound outlet hole 112-1 or a projection of the second sound outlet hole 112-2 in a projection of the corresponding side wall (e.g., the inner side wall or the outer side wall) of the first housing 110 is not less than 10%.

[0172] For example, when the aperture ratio of the sound outlet hole is 0.15, the high frequency peaks corresponding to the curve L541, the curve L542, the curve L544, and the curve L545 are all higher than 6 kHz, in this case, the earphone has a relatively flat output in a relatively wide frequency band range, thereby allowing the earphone to have a better active noise reduction effect. As another example, the aperture ratio of the sound outlet hole may be not less than 0.3, thereby further enabling the earphone to have a relatively flat output in an even wider frequency band range, and causing the high frequency peak of the frequency response output by the sound outlet hole to be

higher than 8 kHz.

[0173] Due to the first sound outlet hole 112-1 being located on a side closer to the external auditory canal 11 in the wearing state, and being limited by factors such as an opening dimension of the first sound outlet hole 112-1 and a covering area relative to the first acoustic cavity 111-1, a portion of the sound generated by the speaker 120 (specifically, the first diaphragm 121-1) within the first acoustic cavity 111-1 may be blocked by a side wall of the first housing 110 (e.g., a portion of the inner side wall where the first sound outlet hole 112-1 is not formed) and cannot be directly output through the first sound outlet hole 112-1, thereby forming a standing wave within the first acoustic cavity 111-1, which may cause the peak resonance frequency of the second resonance peak to shift forward (i.e., move towards a low frequency band), affecting the active noise reduction effect of the earphone in a relatively wide frequency band range.

[0174] Therefore, in some embodiments, referring to FIG. 36D and FIG. 38, the inner side wall is further provided with a sound tuning hole 113-3 extending therethrough, the sound tuning hole 113-3 communicates with the first acoustic cavity 111-1; based on a communication relationship between the first sound outlet hole 112-1, the sound tuning hole 113-3, and the first acoustic cavity 111-1, a peak resonance frequency of the second resonance peak of the sound output through the first sound outlet hole 112-1 to outside the first housing 110 may be adjusted with the aid of the sound tuning hole 113-3, for example, the peak resonance frequency of the second resonance peak is not less than 1 kHz. In this case, the first sound outlet hole 112-1 may be a single-hole structure (e.g., a single concentrated opening structure), or may be a multi-hole structure (i.e., a non-single concentrated opening structure).

[0175] Specifically, a majority of the sound generated by the speaker 120 within the first acoustic cavity 111-1 is output through the first sound outlet hole 112-1, while a small portion of the sound may be output through the sound tuning hole 113-3, thereby minimizing the formation of a standing wave within the first acoustic cavity 111-1, allowing the peak resonance frequency of the second resonance peak of the frequency response curve of the sound output from the first sound outlet hole 112-1 to move as much as possible towards a high frequency band, achieving an adjustment of the peak resonance frequency of the resonance peak, and ultimately allowing the earphone to have a relatively flat output in an even wider frequency band range; meanwhile, it also facilitates enhancing the sound pressure level of the sound output from the first sound outlet hole 112-1, thereby ensuring the user's listening experience.

[0176] FIG. 38 is a schematic diagram illustrating a relative position between a first sound outlet hole and a sound tuning hole according to some embodiments of the present disclosure; FIG. 39 is a schematic diagram

illustrating frequency response curves of a sound generating portion corresponding to different distances between any two holes or between any hole and a boundary of an acoustic cavity in FIG. 38 according to some embodiments of the present disclosure; and FIG. 40 is a schematic diagram illustrating frequency response curves of a sound generating portion corresponding to different area ratios of a first sound outlet hole and a sound tuning hole in FIG. 38.

[0177] Considering that a difference in a relative position between the sound tuning hole 113-3 and the first sound outlet hole 112-1 may affect an output of the speaker 120 or a position of the peak resonance frequency of the resonance peak. Referring to FIG. 38, taking the first sound outlet hole 112-1 and the sound tuning hole 113-3 both adopting a multi-hole structure as an example, L1-X is defined as the minimum distance between any two holes, and L2-X is defined as the minimum distance from the boundary of the first acoustic cavity 111-1 to any hole. The minimum distance herein refers to a distance between contour edges of any hole, or a distance from a contour edge of any hole to a boundary of an acoustic cavity.

[0178] Referring to FIG. 39, a horizontal coordinate LM is L1-X or L2-X (i.e., the LM is the minimum distance between any two holes or the minimum distance from the boundary of the first acoustic cavity 111-1 to any hole).

[0179] As shown in FIG. 39, when LM=1.3 mm, the corresponding high frequency peak is 9.5 kHz; when LM=2.1 mm, the corresponding high frequency peak is 9.25 kHz; when LM=2.7 mm, the corresponding high frequency peak is 9 kHz; when LM=3.4 mm, the corresponding high frequency peak is 8.75 kHz; when LM=4 mm, the corresponding high frequency peak is 7.75 kHz; when LM=6 mm, the corresponding high frequency peak is 7.5 kHz; when LM=8 mm, the corresponding high frequency peak is 6.7 kHz; when LM=10 mm, the corresponding high frequency peak is 5.8 kHz; when LM=12 mm, the corresponding high frequency peak is 4.5 kHz; and when LM=14 mm, the corresponding high frequency peak is 3.65 kHz. As the LM increases, the corresponding high frequency peak successively shifts forward, which means that a corresponding aperture area decreases, thereby causing the sound pressure level of the sound output from one side of the inner side wall to decrease. When LM=14 mm, compared with other smaller LMs, the sound pressure level at 1 kHz decreases by 3 dB, which is an acceptable state.

[0180] Therefore, in some embodiments, the minimum distance between any two holes or the minimum distance from the boundary of the first acoustic cavity 111-1 to any hole may be set to be not greater than 14 mm; it may also be understood that, the minimum distance between the first sound outlet hole 112-1 and the sound tuning hole 113-3 is not greater than 14 mm, the minimum distance from the boundary of the first acous-

tic cavity 111-1 to the first sound outlet hole 112-1 is not greater than 14 mm, and the minimum distance from the boundary of the first acoustic cavity 111-1 to the sound tuning hole 113-3 is not greater than 14 mm. It may also be understood that, when the first sound outlet hole 112-1 and/or the sound tuning hole 113-3 is a porous structure formed by a plurality of micro-holes arranged in an array, a minimum distance between any two adjacent micro-holes is not greater than 14 mm.

[0181] Thus, it may cause sound output from the first sound outlet hole 112-1 to have a relatively flat phase curve at least in a frequency band range before 1 kHz, thereby ensuring that the earphone has a relatively flat output in a relatively wide frequency band range, to facilitate the earphone to perform active noise reduction in a relatively wide frequency band range. In addition, as described in the foregoing embodiments, an aperture of each micro-hole may be set to be not less than 0.2 mm.

[0182] Further, in some embodiments, any one of the above-mentioned minimum distances may be set to be not greater than 10 mm, not greater than 8 mm, not greater than 6 mm, or not greater than 3.4 mm. For example, when the minimum distance is 10 mm, the peak resonance frequency of the second resonance peak may be adjusted to 5.8 kHz; when the minimum distance is 8 mm, the peak resonance frequency of the second resonance peak may be adjusted to 6.7 kHz; when the minimum distance is 6 mm, the peak resonance frequency of the second resonance peak may be adjusted to 7.5 kHz; and when the minimum distance is 3.4 mm, the peak resonance frequency of the second resonance peak may be adjusted to 8.75 kHz. Thus, by selectively setting the minimum distance, it may cause the peak resonance frequency of the second resonance peak to move as much as possible towards a high frequency band, further widening a width of the flat region of the frequency response curve, thereby enabling the earphone to perform active noise reduction in an even wider frequency band range.

[0183] In some embodiments, a ratio of a total area of the sound tuning hole 113-3 to a total area of the first sound outlet hole 112-1 may be set to be less than 23%. Specifically, on a reference plane perpendicular to the thickness direction, a total projected area of the first sound outlet hole 112-1 on the reference plane is defined as S1, a total projected area of the sound tuning hole 113-3 on the reference plane is defined as S2, and a ratio of the total projected area S2 of the sound tuning hole 113-3 to the total projected area S1 of the first sound outlet hole 112-1 is defined as SS.

[0184] As shown in FIG. 40, as the SS gradually increases, the high frequency peak gradually shifts backward, and the sound pressure level of output sound gradually decreases; an increase of the SS means that an aperture area of the sound tuning hole 113-3 increases, which may effectively achieve a pressure relief effect, thereby causing the high frequency peak to

shift backward, however, due to the increase of the aperture area of the sound tuning hole 113-3, sound leaked through the sound tuning hole 113-3 also increases, thereby causing the sound pressure level of the sound output through the first sound outlet hole 112-1 to decrease. It can be seen from FIG. 40 that, when the SS is from 0% (i.e., the sound tuning hole 113-3 is not provided) to 22.7%, the high frequency peak shifts backward from 8.5 kHz to 9.75 kHz, and meanwhile the sound pressure level of output sound decreases by 1 dB, which is an acceptable range.

[0185] Therefore, by setting the ratio of the total area of the sound tuning hole 113-3 to the total area of the first sound outlet hole 112-1 to be less than 23%, it may effectively avoid a problem that an excessively large opening of the sound tuning hole 113-3 or an excessively large area proportion thereof causes excessive sound to leak from the sound tuning hole 113-3, thereby causing the problem of a decreased sound pressure level or a reduced volume of the first sound outlet hole 112-1.

[0186] Illustratively, in some embodiments, the ratio of the total area of the sound tuning hole 113-3 to the total area of the first sound outlet hole 112-1 is set to be 22.7%, thereby allowing the peak resonance frequency of the second resonance peak to be adjusted to approximately 9.75 kHz, further widening a width of the flat region of the frequency response curve of the sound output through the first sound outlet hole 112-1, so as to enable the earphone to perform active noise reduction in an even wider frequency band range.

[0187] In some embodiments, referring to FIG. 38, in the wearing state, the sound tuning hole 113-3 is located at a position away from the external auditory canal 11 compared to the first sound outlet hole 112-1. In an open application scenario, due to a relatively large ambient noise received by the user's external auditory canal 11, improving an output performance of the earphone is beneficial for the earphone to perform active noise reduction for the relatively large ambient noise; therefore, by arranging the sound tuning hole 113-3 at a position away from the external auditory canal 11 compared to the first sound outlet hole 112-1, sound output through the sound tuning hole 113-3 and sound output through the first sound outlet hole 112-1 may interfere destructively in a far field, to reduce sound leakage of the earphone, thereby ensuring the user's listening experience.

[0188] For example, on a reference plane perpendicular to the thickness direction, a length of a projection of the first acoustic cavity 111-1 in the long axis direction is not less than a width thereof in the short axis direction. For example, the projection shape of the first acoustic cavity 111-1 may be a rectangle with a length greater than a width. As another example, the projection shape of the first acoustic cavity 111-1 may be a square or a circle with a length equal to a width. A projection of the first acoustic cavity 111-1 on the refer-

ence plane (e.g., a region shown by a dashed box in FIG. 38) is divided into a first region and a second region along a length direction (e.g., the two regions separated by a dashed arrow in FIG. 38), and a ratio of a length of the first region in the long axis direction to the length of the projection of the first acoustic cavity in the long axis direction may be set to be less than 40%, e.g., 38.3%. A projection of the sound tuning hole 113-3 on the reference plane is located in the first region, and a projection of the first sound outlet hole 112-1 on the reference plane is located in the second region.

[0189] Thus, by arranging the sound tuning hole 113-3 and the first sound outlet hole 112-1 in different regions of the inner side wall corresponding to the first acoustic cavity 111-1, it may both ensure that the sound tuning hole 113-3 is located at a position away from the external auditory canal compared to the first sound outlet hole 112-1 in a wearing state, and distinguish the sound tuning hole 113-3 from the first sound outlet hole 112-1 when the sound tuning hole 113-3 adopts an array of micro-holes or a large-area concentrated opening and is relatively close to the first sound outlet hole 112-1; for example, in a length direction or a diameter direction of the first acoustic cavity 111-1, a hole in a region accounting for 38.3% from the boundary of the first acoustic cavity 111-1 may be regarded as the sound tuning hole 113-3.

[0190] It should be noted that, the dashed box in FIG. 38 represents a projection boundary of the first acoustic cavity 111-1 on the reference plane; and the dashed arrow in FIG. 38 represents an approximate boundary between the first region and the second region in the projection shape of the first acoustic cavity 111-1, wherein a region on a left side of the dashed arrow represents the first region, and a region on a right side of the dashed arrow represents the second region.

[0191] In some embodiments, referring to FIG. 38, when the first sound outlet hole 112-1 is a porous structure formed by a plurality of micro-holes arranged in an array, an aperture of a micro-hole located in a region where the inner side wall faces the external auditory canal 11 in the wearing state is set to be larger than an aperture of a micro-hole located in other regions of the inner side wall; by way of example, among the plurality of micro-holes of the sound outlet hole 112-1, an aperture of a micro-hole closer to the boundary of the first acoustic cavity 111-1 and the sound tuning hole 113-3 is smaller than an aperture of a micro-hole located at other positions. Thus, by differentially setting the apertures of the plurality of micro-holes in the first sound outlet hole 112-1, it may improve a sound pressure level of the sound output from a part of the earphone facing the external auditory canal 11, thereby ensuring the user's listening experience.

[0192] As described in some embodiments provided above, by arranging the acoustic resistance mesh at the second sound outlet hole 112-2, it may reduce the sound pressure level of the sound output from the sec-

ond sound outlet hole 112-2, forming a peak-valley suppression for the high frequency resonance peak, while ensuring that the earphone has a relatively large output in a low frequency band, it can also prevent sound output from the second sound outlet hole 112-2 from affecting sound output from the first sound outlet hole 112-1, thereby ensuring a near-field listening experience of the earphone. In some embodiments, an acoustic resistance mesh may also be arranged at the first sound outlet hole 112-1, for example, the acoustic resistance mesh may be disposed within the first acoustic cavity 111-2 and cover the first sound outlet hole 112-1 and the sound tuning hole 113-3. For ease of distinction and description, the acoustic resistance mesh at the second sound outlet hole 112-2 is defined as a second acoustic resistance mesh, and the acoustic resistance mesh at the first sound outlet hole 112-1 is defined as a first acoustic resistance mesh; wherein, a specific acoustic impedance of the first acoustic resistance mesh is set to be less than a specific acoustic impedance of the second acoustic resistance mesh, for example, a ratio of the specific acoustic impedance of the second acoustic resistance mesh to the specific acoustic impedance of the first acoustic resistance mesh is not less than 10 (e.g., the specific acoustic impedance of the first acoustic resistance mesh is less than 10 Rayl, and the specific acoustic impedance of the second acoustic resistance mesh is greater than 700 Rayl).

[0193] Thus, based on the characteristic of the first acoustic resistance mesh having a relatively small specific acoustic impedance, it may minimize an influence on sound output from the first sound outlet hole 112-1, ensuring a sound output effect of the sound-producing part 100 closer to the external auditory canal 11, and based on the first acoustic resistance mesh and the second acoustic resistance mesh, they can play good roles such as dust prevention and water resistance in the sound-producing part 100.

[0194] In some embodiments, as described above, in order to reduce the resonance frequency of the first resonance peak, the K value of the first diaphragm 121-1 and the second diaphragm 121-2 may be set to be relatively low. In this case, in order to ensure an output stability of the speaker 120, reduce vibration modes, and improve a vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, the first diaphragm 121-1 and the second diaphragm 121-2 may be directly connected via a connecting member (e.g., a first connecting member), or indirectly connected via the voice coil assembly 123 and the connecting members (e.g., the first voice coil, a second connecting member, and the second voice coil).

[0195] FIG. 41 is a schematic diagram illustrating an internal structure of a speaker according to some embodiments of the present disclosure; FIG. 42 is schematic diagram illustrating another internal structure of a speaker according to some embodiments of the pre-

sent disclosure; FIG. 43A is a schematic diagram illustrating an exploded view of a speaker according to some embodiments of the present disclosure; and FIG. 43B is schematic diagram illustrating another exploded view of a speaker according to some embodiments of the present disclosure.

[0196] Referring to FIG. 41 and FIG. 42, in some embodiments, the voice coil assembly 123 only includes the first voice coil 123-1. The first voice coil 123-1 is configured to simultaneously drive the first diaphragm 121-1 and the second diaphragm 121-2 to vibrate synchronously in the same direction. In some embodiments, the magnetic circuit assembly 122 may include a magnetic shield 1221 and an inner magnet 1222. The inner magnet 1222 may be arranged within the first voice coil 123-1. The magnetic shield 1221 and the inner magnet 1222 are spaced apart in a direction perpendicular to the vibration direction. A magnetic gap is formed between a side wall of the magnetic shield 1221 and an outer side of the inner magnet 1222, and at least a portion of the first voice coil 123-1 extends into the magnetic gap. In some embodiments, the first voice coil 123-1 includes a first end located outside the magnetic gap (e.g., an upper end of the first voice coil 123-1 in FIG. 41) and a second end located within the magnetic gap (e.g., a lower end of the first voice coil 123-1 in FIG. 41). The first end of the first voice coil 123-1 is connected to the first diaphragm 121-1, and the second end of the first voice coil 123-1 is connected to the second diaphragm 121-2.

[0197] Considering that when a dimension of the first voice coil 123-1 is too large, a driving force of the first voice coil 123-1 may be decreased, which may affect an output of the speaker 120. In some embodiments, in order to decrease the dimension of the first voice coil 123-1 and ensure the driving force of the first voice coil 123-1, the second end of the first voice coil 123-1 may be connected to the second diaphragm 121-2 via a first connecting member 124.

[0198] In some embodiments, as shown in FIG. 41, the first connecting member 124 includes an annular structure adapted to the first voice coil 123-1. Through the arrangement of the annular structure, the connection area between the first connecting member 124 and the second diaphragm 121-2 is increased, thereby ensuring the connection strength between the first connecting member 124 and the second diaphragm 121-2, simultaneously making the force of the first connecting member 124 on the second diaphragm 121-2 more uniform, and making the vibration of the second diaphragm 121-2 more stable. One end of the first connecting member 124 is connected to the first voice coil 123-1, and the other end of the first connecting member 124 is connected to the second diaphragm 121-2. In some embodiments, the bottom wall of the magnetic shield 1221 may be provided with an annular notch. The first connecting member 124 may pass through the annular notch, allowing the first voice coil 123-1 to

simultaneously drive the first diaphragm 121-1 and the second diaphragm 121-2 located on two sides of the magnetic shield 1221. In some embodiments, in order to maintain the installation stability of the magnetic shield 1221, the first connecting member 124 may include a plurality of sub-connecting portions arranged in an annular shape, where the annular shape is adapted to the first voice coil 123-1. The bottom wall of the magnetic shield 1221 is accordingly provided with a plurality of notches forming annular portions.

[0199] Referring to FIG. 42, FIG. 43A and FIG. 43B, in some embodiments, the first connecting member 124 includes a sub-connecting portion and a connecting surface. One end of the sub-connecting portion is connected to the second end of the first voice coil 123-1, the other end of the sub-connecting portion is connected to the connecting surface, and the connecting surface is connected to the second diaphragm 121-2. By connecting the connecting surface to the second diaphragm 121-2, the driving force and the vibration of the first voice coil 123-1 can be better transmitted to the second diaphragm 121-2, thereby making the vibration of the second diaphragm 121-2 more stable, facilitating an improvement in the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, reducing the distortion of an earphone output, improving the active noise reduction effect of the earphone, and improving an output effect of the earphone.

[0200] Referring to FIG. 43A, in some embodiments, the sub-connecting portion may include a plurality of (e.g., four) symmetrically arranged strip-shaped structures, to decrease the mass of the first connecting member 124, reduce the load of the first voice coil 123-1, and improve the driving force of the first voice coil 123-1, thereby improving the output of the speaker 120. When applied to an open-type earphone, since the external auditory canal of the user receives a relatively large amount of ambient noise, improving the output performance of the earphone helps the earphone perform active noise reduction on the relatively large ambient noise.

[0201] Referring to FIG. 43B, in some embodiments, the sub-connecting portion may include two plate-shaped structures, in order to improve the structural strength of the first connecting member 124, improve the connection strength between the connecting surface and the first voice coil 123-1, improve the vibration stability of the second diaphragm 121-2, facilitate an improvement in the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, reduce the distortion of the earphone output, improve the active noise reduction effect of the earphone, and improve the output effect of the earphone.

[0202] In some embodiments, the speaker 120 has a long side along the long axis direction of the sound generating portion 100 and a short side along the short axis direction of the sound generating portion 100. In

some embodiments, the plate-shaped structures may be arranged between the short side of the connecting surface and the short side of the first voice coil 123-1.

[0203] In some embodiments, by decreasing the mass of the first connecting member 124, the load of the first voice coil 123-1 can be reduced, the driving force of the first voice coil 123-1 can be improved, and the output of the speaker 120 can be improved, thereby further improving the output performance of the earphone and improving the active noise reduction performance of the earphone against relatively large ambient noise. In some embodiments, in order to decrease the mass of the first connecting member 124 while ensuring the connection stability between the first connecting member 124 and the second diaphragm 121-2, thereby improving the active noise reduction effect of the earphone, the connecting surface of the first connecting member 124 may be hollowed out.

[0204] Since two ends of the first voice coil 123-1 simultaneously drive the first diaphragm 121-1 and the second diaphragm 121-2, this causes the load of the first voice coil 123-1 to increase, leading to a decrease in the output of the speaker 120, which may affect the active noise reduction effect of the earphone against relatively large ambient noise. In some embodiments, in order to ensure the output of the speaker 120 and improve the active noise reduction effect of the earphone against relatively large ambient noise, the magnetic circuit assembly 122 may be designed to improve the magnetic field strength of the magnetic circuit assembly 122, in order to increase the driving force of the first voice coil 123-1, thereby improving the output of the speaker 120 and improving the active noise reduction effect of the earphone against relatively large ambient noise.

[0205] FIGS. 44A-46B are schematic diagrams illustrating different structures of a speaker according to some embodiments of the present disclosure.

[0206] Referring to FIG. 44A and FIG. 44B, in some embodiments, under the condition that the thickness of the magnetic shield 1221 remains unchanged, the dimension of the inner magnet 1222 may be increased, in order to increase the magnetic field strength, thereby increasing the driving force of the first voice coil 123-1. The thickness of the magnetic shield 1221 refers to the thickness of the bottom wall or the side wall of the magnetic shield 1221. The thickness of the bottom wall of the magnetic shield 1221 refers to the dimension of the bottom wall in the vibration direction. The thickness of the side wall of the magnetic shield 1221 refers to the thickness of the side wall in the corresponding short axis direction or the long axis direction. For example, in FIG. 44A and FIG. 44B, the thicknesses of the magnetic shield 1221 are both 0.7 mm. Compared to FIG. 44A, the dimension of the inner magnet 1222 in FIG. 44B is increased, in order to increase the driving force of the first voice coil 123-1, improve the output of the speaker 120, and improve the active noise reduction

effect of the earphone against relatively large ambient noise.

[0207] In order to enable the inner magnet 1222 to have a larger dimension, increase the driving force of the first voice coil 123-1, improve the output of the speaker 120, and improve the active noise reduction effect of the earphone against relatively large ambient noise, in some embodiments, a ratio of the dimension of the inner magnet 1222 to the thickness of the side wall of the magnetic shield 1221 may be 5 to 72.5.

[0208] In order to avoid an excessively large dimension of the earphone, when the thickness of the magnetic shield 1221 remains unchanged (e.g., the thickness of the magnetic shield 1221 is 0.7 mm), the dimension of the inner magnet 1222 should not be excessively large. In some embodiments, in the short axis direction or the long axis direction, the ratio of the dimension of the inner magnet 1222 to the thickness of the side wall of the magnetic shield 1221 may be 11.4 to 120. In some embodiments, in order to further increase the driving force of the first voice coil 123-1, improve the output of the speaker 120, and improve the active noise reduction effect of the earphone against relatively large ambient noise, in the short axis direction or the long axis direction, the ratio of the dimension of the inner magnet 1222 to the thickness of the side wall of the magnetic shield 1221 may be 12.8 to 60.

[0209] It should be noted that the foregoing ratio of the dimension of the inner magnet 1222 to the thickness of the side wall of the magnetic shield 1221 refers to the ratio of the dimension of the inner magnet 1222 in the long axis direction to the thickness of the side wall of the magnetic shield 1221 in the long axis direction, or the ratio of the dimension of the inner magnet 1222 in the short axis direction to the thickness of the side wall of the magnetic shield 1221 in the short axis direction. When the magnetic shield 1221 is a 'II'-shaped structure and only includes side walls in the long axis direction or the short axis direction, the foregoing ratio of the dimension of the inner magnet 1222 to the thickness of the side wall of the magnetic shield 1221 refers to the ratio of the dimension of the inner magnet 1222 in the corresponding direction to the thickness of the side wall of the magnetic shield 1221 in the corresponding direction.

[0210] Referring to FIG. 45A and FIG. 45B, in some embodiments, in order to avoid an excessively large dimension of the magnetic circuit assembly 122 and decrease a design space of the speaker 120, under the condition that the dimension of the magnetic circuit assembly 122 is fixed, the dimension of the magnetic shield 1221 is fixed. At this time, the thickness of the magnetic shield 1221 may be decreased, and the dimension of the inner magnet 1222 may be increased, in order to increase the magnetic field strength, thereby increasing the driving force of the first voice coil 123-1, improving the output of the speaker 120, and improving

the active noise reduction effect of the earphone against relatively large ambient noise. For example, in FIG. 45A and FIG. 45B, the dimension of the magnetic shield 1221 remains unchanged. Compared to FIG. 45A, the side wall thickness of the magnetic shield 1221 in FIG. 45B is decreased (e.g., decreased from 0.7 mm to 0.1 mm), and the dimension of the inner magnet 1222 in FIG. 45B is increased.

[0211] In some embodiments, in the short axis direction or the long axis direction, the ratio of the dimension of the inner magnet 1222 to the dimension of the magnetic shield 1221 may be 0.9 to 72.5, in order to increase the driving force of the first voice coil 123-1, improve the output of the speaker 120, and improve the active noise reduction effect of the earphone against relatively large ambient noise. The dimension of the magnetic shield 1221 refers to a distance between outer surfaces of opposite side walls of the magnetic shield 1221 (e.g., a distance between two opposite side walls of the magnetic shield 1221 along the long axis direction, or a distance between two opposite side walls of the magnetic shield 1221 along the short axis direction). When the magnetic shield 1221 is a 'II'-shaped structure and only includes side walls in the long axis direction or the short axis direction, the dimension of the magnetic shield 1221 in a direction where no side wall is arranged may be a distance between two outer surfaces of the bottom wall in the direction where no side wall is arranged. When the magnetic shield 1221 is a circular structure, the dimension of the magnetic shield 1221 may refer to a diameter of the circular structure. The ratio of the dimension of the inner magnet 1222 to the dimension of the magnetic shield 1221 refers to the ratio of the dimension of the inner magnet 1222 in the long axis direction to the dimension of the magnetic shield 1221 in the long axis direction, or the ratio of the dimension of the inner magnet 1222 in the short axis direction to the dimension of the magnetic shield 1221 in the short axis direction.

[0212] In some embodiments, in order to further increase the driving force of the first voice coil 123-1, in the short axis direction or the long axis direction, a ratio of the dimension of the inner magnet 1222 to the width of the magnetic shield 1221 may be 1.2 to 60. In some embodiments, in order to ensure the structural strength of the magnetic shield 1221, the thickness of the magnetic shield 1221 should not be excessively thin (e.g., the thickness of the magnetic shield 1221 may be greater than 0.1 mm). In the short axis direction or the long axis direction, the ratio of the dimension of the inner magnet 1222 to the width of the magnetic shield 1221 may be 1.4 to 30.

[0213] Referring to FIG. 45A and FIG. 46A, in order to further improve the magnetic field strength, increase the driving force of the first voice coil 123-1, improve the output of the speaker 120, and improve the active noise reduction effect of the earphone against relatively large ambient noise, an outer magnet 1223 may be ar-

ranged on the side wall of the magnetic shield 1221, that is, the side wall of the magnetic shield 1221 may include the outer magnet 1223.

[0214] Referring to FIG. 46A and FIG. 46B, in some embodiments, in order to avoid an excessively large dimension of the magnetic circuit assembly 122 and decrease the design space of the speaker 120, while arranging the outer magnet 1223 on the side wall of the magnetic shield 1221, the dimension of the inner magnet 1222 may be increased, and the dimension of the outer magnet 1223 may be decreased. For example, compared to FIG. 46A, the thickness of the outer magnet 1223 in FIG. 46B is decreased (e.g., decreased from 0.7 mm to 0.1 mm), and the dimension of the inner magnet 1222 in FIG. 46B is increased.

[0215] In some embodiments, in the short axis direction or the long axis direction, a ratio of the thickness of the outer magnet 1223 to the dimension of the inner magnet 1222 may be 0.6 to 13.7, in order to increase the driving force of the first voice coil 123-1, improve the output of the speaker 120, and improve the active noise reduction effect of the earphone against relatively large ambient noise. When the outer magnet 1223 is an annular structure, the thickness of the outer magnet 1223 refers to a difference between an annular outer diameter and an annular inner diameter of the outer magnet 1223. When the outer magnet 1223 is a split structure shown in FIG. 51, the thickness of the outer magnet 1223 refers to a distance between an inner side surface of each portion of the split structure facing the inner magnet 1222 and an outer side surface of each portion of the split structure away from the inner magnet 1222.

[0216] In some embodiments, for reasons of processing difficulty, the thickness of the outer magnet 1223 should not be excessively thin (e.g., the thickness of the outer magnet 1223 may not be less than 0.5 mm). In the short axis direction or the long axis direction, the ratio of the thickness of the outer magnet 1223 to the dimension of the inner magnet 1222 may be 0.8 to 10. In some embodiments, if the thickness of the outer magnet 1223 is excessively large, it may cause the side wall of the magnetic shield 1221 that accommodates the outer magnet 1223 to be excessively thick, thereby causing the earphone to be excessively heavy and affecting the wearing comfort of the user. To improve the wearing comfort of the earphone, a ratio of the thickness of the outer magnet 1223 to the dimension of the inner magnet 1222 may be 0.9 to 8 in the short axis direction or the long axis direction.

[0217] FIG. 47 is a schematic diagram illustrating driving force coefficients of a speaker including inner magnets of different dimensions according to some embodiments of the present disclosure. The driving force coefficient of the speaker 120 is a sum of a driving force coefficient of the first voice coil 123-1 and a driving force coefficient of the second voice coil 123-2. As shown in FIG. 47, the curve L61 represents a driving

force coefficient of the speaker 120 corresponding to inner magnets 1222 of different dimensions when the thickness of the magnetic shield 1221 remains unchanged (e.g., the thickness of the magnetic shield 1221 is 0.7 mm); the curve L62 represents a driving force coefficient of the speaker 120 corresponding to inner magnets 1222 of different dimensions when a dimension of the magnetic circuit assembly 122 is fixed (e.g., the dimension of the speaker 120 is 16 mm); and the curve L63 represents a driving force coefficient of the speaker 120 corresponding to inner magnets 1222 of different dimensions when the outer magnet 1223 is arranged on the side wall of the magnetic shield 1221 and the dimension of the magnetic circuit assembly 122 is fixed.

[0218] As shown in FIG. 47, the curve L63 is above the curve L61 and the curve L62, that is, when the dimension of the inner magnet 1222 is the same, the driving force coefficient of the speaker 120 corresponding to L63 is the largest, indicating that arranging the outer magnet 1223 on the side wall of the magnetic shield 1221 can effectively improve the driving force coefficient of the speaker 120. When the dimension of the inner magnet 1222 is relatively small (e.g., less than 8 mm), the curve L61 and the curve L62 approximately overlap. In this case, a dimension variation of the magnetic circuit assembly 122 corresponding to the curve L61 is relatively small, and the dimension thereof does not differ significantly from the fixed dimension of the magnetic circuit assembly 122 corresponding to the curve L62, and the driving force coefficient also differs relatively little. When the dimension of the inner magnet 1222 is relatively large (e.g., 8 mm to 13 mm), the curve L62 is above the curve L61 and is close to it. In this case, a dimension variation of the magnetic circuit assembly 122 corresponding to the curve L61 is relatively large, and the dimension thereof does not differ significantly from the fixed dimension of the magnetic circuit assembly 122 corresponding to the curve L62. When the dimension of the inner magnet 1222 is the same, the driving force coefficient of the speaker 120 corresponding to the curve L61 is relatively small.

[0219] In summary, by arranging the outer magnet 1223 and increasing the dimension of the inner magnet 1222, the driving force coefficient of the speaker 120 may be improved, the output of the speaker 120 may be improved, and the active noise reduction effect of the earphone against relatively large ambient noise may be improved.

[0220] FIG. 48 is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure.

[0221] Referring to FIG. 48, in some embodiments, the first diaphragm 121-1 may be connected to the first voice coil 123-1, and the first diaphragm 121-1 and the second diaphragm 121-2 are connected by a second connecting member 126. In the vibration direction of

the first diaphragm 121-1 and the second diaphragm 121-2, the magnetic circuit assembly 122 is provided with the through hole, and the second diaphragm 121-2 is arranged at an end of the through hole. When the first voice coil 123-1 drives the first diaphragm 121-1 to vibrate, the first diaphragm 121-1 drives the second diaphragm 121-2 to vibrate synchronously via the second connecting member 126. By arranging the second diaphragm 121-2 in the structure of the through hole, the thickness dimension of the speaker 120 can be effectively reduced, the design flexibility of the speaker 120 can be improved, and the wearing comfort of the earphone can be improved.

[0222] In some embodiments, the second diaphragm 121-2 may be arranged at an end of the through hole close to the first diaphragm 121-1, to reduce the dimension of the second connecting member 126, reduce a load on the first voice coil 123-1, improve the driving force of the first voice coil 123-1, improve the output of the speaker 120, thereby further improving the output performance of the earphone and improving the active noise reduction effect of the earphone against relatively large ambient noise.

[0223] FIG. 49 is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure; FIG. 50 is a schematic diagram illustrating another perspective of the internal structure of the speaker shown in FIG. 49; and FIG. 51 is schematic diagram illustrating an exploded view of the speaker shown in FIG. 49.

[0224] Referring to FIG. 49, in some embodiments, the voice coil assembly 123 includes the first voice coil 123-1 and the second voice coil 123-2 arranged along the vibration direction. The first diaphragm 121-1 is connected to the first voice coil 123-1, the second diaphragm 121-2 is connected to the second voice coil 123-2, and the first voice coil 123-1 and the second voice coil 123-2 respectively drive the first diaphragm 121-1 and the second diaphragm 121-2 to vibrate synchronously in the same direction.

[0225] In some embodiments, compared to a case where the voice coil assembly 123 only includes the first voice coil 123-1, when the voice coil assembly 123 includes both the first voice coil 123-1 and the second voice coil 123-2, the voice coil assembly 123 can utilize the magnetic gap more fully, thereby improving a driving force of the voice coil assembly 123, improving the output of the speaker 120, improving a sound output effect of the earphone, and improving the active noise reduction effect of the earphone against relatively large ambient noise.

[0226] Referring to FIG. 49, FIG. 50, and FIG. 51, in some embodiments, the first diaphragm 121-1 and the second diaphragm 121-2 may be connected by the second connecting member 126, to improve the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, reduce distortion of the ear-

phone output, improve the active noise reduction effect of the earphone, and improve the output effect of the earphone.

[0227] In some embodiments, the magnetic circuit assembly 122 is provided with the through hole. The through hole penetrates the inner magnet 1222, a first magnetic plate 1224 at an upper end of the inner magnet 1222, and the bottom wall of the magnetic shield 1221 at a lower end of the inner magnet 1222. The second connecting member 126 is arranged in the through hole, thereby connecting the first diaphragm 121-1 and the second diaphragm 121-2.

[0228] In some embodiments, the arrangement of the through hole may further ensure that when the first diaphragm 121-1 and the second diaphragm 121-2 vibrate, gas within the common cavity 111-3 between the first diaphragm 121-1 and the second diaphragm 121-2 may move back and forth as an accompanying mass with the vibration of the two diaphragms, thereby attempting to avoid compression of the common cavity 111-3 by the two diaphragms and resulting in frequency response peaks and valleys, improving an output quality of the earphone, and thereby further improving the active noise reduction effect of the earphone.

[0229] In some embodiments, the second connecting member 126 needs to have a relatively high deformation resistance capability, so as to reduce its own deformation as much as possible while ensuring the connection of the first diaphragm 121-1 and the second diaphragm 121-2, thereby improving the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, reducing distortion of the earphone output, improving the active noise reduction effect of the earphone, and improving the output effect of the earphone. In some embodiments, a Young's modulus of a material of the second connecting member 126 may be 100 MPa to 150 MPa. In some embodiments, to further improve the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, the Young's modulus of the material of the second connecting member 126 may be 110 MPa to 140 MPa.

[0230] To improve the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, reduce the distortion of the earphone output, improve the active noise reduction effect of the earphone, and improve the output effect of the earphone, a contact region between two ends of the second connecting member 126 and the first diaphragm 121-1 and the second diaphragm 121-2 should not be excessively small, so as to better transmit deformation and force between the first diaphragm 121-1 and the second diaphragm 121-2. However, when the dimension of the second connecting member 126 is excessively large, it may cause the dimension of the through hole of the magnetic circuit assembly 122 to be excessively large, affecting the driving force coefficient of the speaker 120, the output of the speaker 120, and the active noise reduction effect of the earphone. In some embodi-

ments, in order to improve the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2 while ensuring that the speaker 120 has a relatively large driving force coefficient, the dimension of the second connecting member 126 may be designed based on the dimension of the magnetic circuit assembly. For example, the dimension of the second connecting member 126 may be 3.4 mm * 1.4 mm * 4.7 mm.

[0231] To avoid adding an excessively large load to the first diaphragm 121-1 and the second diaphragm 121-2 by the second connecting member 126, ensure the driving force coefficient of the speaker 120, and improve the active noise reduction effect of the earphone, the mass of the second connecting member 126 should be relatively small. That is, when the dimension of the second connecting member 126 is fixed, the density of the second connecting member 126 should not be excessively large. In some embodiments, to reduce the load on the first diaphragm 121-1 and the second diaphragm 121-2, the density of the second connecting member 126 may be 100 kg/m³ to 140 kg/m³.

[0232] FIG. 52 is a schematic diagram illustrating force factors of a speaker corresponding to through holes of different sizes according to some embodiments of the present disclosure. In some embodiments, when the dimension of the second connecting member 126 remains unchanged, the schematic diagram illustrating the driving force coefficient of the speaker 120 shown in FIG. 52 is obtained, with the dimensions of the through hole being 0 mm * 0 mm, 2 mm * 1 mm, 4 mm * 2 mm, 5 mm * 2.5 mm, 6 mm * 3 mm, and 10 mm * 5 mm, respectively. The through hole dimension of 0 mm * 0 mm refers to that no through hole is provided. In this case, it may be considered that the first diaphragm 121-1 and the second diaphragm 121-2 are not connected by the second connecting member 126, and no direct connection exists between the first diaphragm 121-1 and the second diaphragm 121-2 (e.g., as shown in FIG. 61A).

[0233] Referring to FIG. 52, the larger the dimension of the through hole, the smaller the driving force coefficient of the speaker 120 corresponding thereto. Taking the driving force coefficient of the speaker 120 when the through hole dimension is 0 mm * 0 mm as a reference, when the through hole dimension is 2 mm * 1 mm, the effect on the driving force coefficient of the speaker 120 can be substantially ignored; when the through hole dimension is 4 mm * 2 mm, the driving force coefficient of the speaker 120 decreases by 0.1, and the decrease is relatively small; and when the through hole dimension is 6 mm * 3 mm, the driving force coefficient of the speaker 120 decreases by 0.15.

[0234] On the other hand, since the second connecting member 126 penetrates the through hole, the dimension of the through hole also affects the dimension of the second connecting member 126. If the dimension of the through hole is excessively small, it may cause

the dimension of the second connecting member 126 to be excessively small, the connection strength of the second connecting member 126 may be insufficient, and the second connecting member 126 may be prone to fracture and damage. Taking all factors into consideration, in order for the speaker 120 to have a relatively large driving force coefficient while the second connecting member 126 has an appropriate dimension, the length of the through hole may be 2 mm to 10 mm, and the width thereof may be 1 mm to 5 mm.

[0235] FIG. 53 is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure. Referring to FIG. 53, in some embodiments, the voice coil assembly 123 includes the first voice coil 123-1 and the second voice coil 123-2 arranged along the vibration direction. The first diaphragm 121-1 is connected to the first voice coil 123-1, the second diaphragm 121-2 is connected to the second voice coil 123-2, and the first voice coil 123-1 and the second voice coil 123-2 respectively drive the first diaphragm 121-1 and the second diaphragm 121-2 to vibrate synchronously in the same direction. The first voice coil 123-1 and the second voice coil 123-2 are connected by a third connecting member 127, to indirectly connect the first diaphragm 121-1 and the second diaphragm 121-2.

[0236] Optionally, the magnetic circuit assembly 122 may be further provided with the through hole. The through hole may further ensure that when the first diaphragm 121-1 and the second diaphragm 121-2 vibrate, gas within the common cavity 111-3 between the first diaphragm 121-1 and the second diaphragm 121-2 may move back and forth as an accompanying mass with the vibration of the two diaphragms, thereby attempting to avoid compression of the common cavity 111-3 by the two diaphragms and resulting in frequency response peaks and valleys, improving an output quality of the earphone, and thereby further improving the active noise reduction effect of the earphone.

[0237] In some embodiments, while the first diaphragm 121-1 and the second diaphragm 121-2 are directly connected by the second connecting member 126, the first voice coil 123-1 and the second voice coil 123-2 may also be connected by the third connecting member 127. The third connecting member 127 can prevent the first voice coil 123-1 and the second voice coil 123-2 from generating relative displacement, thereby further improving the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, reducing distortion of the earphone output, improving the active noise reduction effect of the earphone, and improving the output effect of the earphone.

[0238] FIG. 54A is a schematic diagram illustrating another exemplary structure of a speaker according to some embodiments of the present disclosure; FIG. 54B is a schematic diagram illustrating another perspective of the structure of the speaker shown in FIG. 54A; FIG. 55 is a schematic diagram illustrating another connec-

tion structure of a first voice coil and a second voice coil according to some embodiments of the present disclosure; and FIG. 56 is a schematic diagram illustrating another exemplary structure of a speaker according to some embodiments of the present disclosure. Referring to FIG. 54A; FIG. 54B; FIG. 55; and FIG. 56, in some embodiments, the first voice coil 123-1 and the second voice coil 123-2 may be connected by the third connecting member 127, thereby achieving an indirect connection of the first diaphragm 121-1 and the second diaphragm 121-2, ensuring the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, reducing the distortion of the earphone output, improving the active noise reduction effect of the earphone, and improving the output effect of the earphone. Optionally, similar to the magnetic circuit assembly 122 shown in FIG. 53, the magnetic circuit assembly 122 may be further provided with the through hole.

[0239] In some embodiments, the third connecting member 127 may be a sheet-like structure. The sheet-like structure extends along the vibration direction. The first voice coil 123-1 and the second voice coil 123-2 are respectively connected to an inner side or an outer side of the sheet-like structure. The arrangement of the sheet-like structure can reduce space occupied by a connecting portion of the first voice coil 123-1 and the second voice coil 123-2, thereby preventing the dimension of the speaker 120 from being excessively large. In some embodiments, the first voice coil 123-1 may be connected to an inner side of the sheet-like structure, and the second voice coil 123-2 may be connected to the inner side of the sheet-like structure; or, the first voice coil 123-1 may be connected to the inner side of the sheet-like structure, and the second voice coil 123-2 may be connected to an outer side of the sheet-like structure; or, the first voice coil 123-1 may be connected to the outer side of the sheet-like structure, and the second voice coil 123-2 may be connected to the inner side of the sheet-like structure; or the first voice coil 123-1 may be connected to the outer side of the sheet-like structure, and the second voice coil 123-2 may be connected to the outer side of the sheet-like structure.

[0240] In some embodiments, the third connecting member 127 may be a folded structure. As shown in FIG. 56A and FIG. 55, the folded structure may be a 'Z'-shaped structure, including a first portion connected to the first voice coil 123-1, a second portion connected to the second voice coil 123-2, and a third portion connecting the first portion and the second portion. The extension direction of the first portion and the second portion may be parallel or approximately parallel, and the third portion may be perpendicular or approximately perpendicular to the first portion and the second portion. Through the design of the first portion, the second portion, and the third portion, the folded structure has a certain dimension in the vibration direction and also has a certain dimension in a direction perpendicular to the

vibration direction, thereby allowing the third connecting member 127 of the folded structure to be applicable to the first voice coil 123-1 and the second voice coil 123-2 of different dimensions. The third connecting member 127 of the folded structure may be connected between the first voice coil 123-1 and the second voice coil 123-2 in the long axis direction, or may be connected between the first voice coil 123-1 and the second voice coil 123-2 in the short axis direction. The mass of the folded structure may be relatively small, which may reduce the load on the first voice coil 123-1 and the second voice coil 123-2, improve the output of the speaker 120, and further improve the active noise reduction effect of the earphone on relatively large ambient noise in an open wearing manner.

[0241] In some embodiments, the third connecting member 127 may also be a spacer structure, and the spacer structure extends in a direction perpendicular to the vibration direction, as shown in FIG. 56. The first voice coil 123-1 and the second voice coil 123-2 are respectively connected to the two ends of the spacer structure in the vibration direction. At this time, the first voice coil 123-1 and the second voice coil 123-2 may be connected and fixed to the spacer structure in a manner of clamping the spacer structure. The spacer structure can be applicable to the first voice coil 123-1 and the second voice coil 123-2 of different dimensions. The spacer structure has a relatively high strength and strong connection stability, which may further ensure the vibration consistency between the first diaphragm 121-1 and the second diaphragm 121-2, reduce distortion of the earphone output, improve the active noise reduction effect of the earphone, and improve the output performance of the earphone. On the other hand, a thickness of the spacer structure in the vibration direction is limited, which may avoid an excessively large dimension of the speaker 120.

[0242] In some embodiments, the third connecting member 127 may include two sub-connecting portions, the two sub-connecting portions are respectively connected to the first diaphragm 121-1 and the second diaphragm 121-2, and the two sub-connecting portions are interconnected. The arrangement of the sub-connecting portions may improve the design flexibility of the third connecting member 127 and improve the scope of applicability of the third connecting member 127.

[0243] FIG. 57 is a schematic diagram illustrating a frame according to some embodiments of the present disclosure; and FIG. 58 is a schematic diagram illustrating another frame according to some embodiments of the present disclosure.

[0244] Referring to FIG. 57 and FIG. 58, in some embodiments, the first voice coil 123-1 and the second voice coil 123-2 may be connected through an annular frame 123-4. The frame 123-4 has a relatively high strength and strong connection stability, which may further ensure the vibration consistency between the

first diaphragm 121-1 and the second diaphragm 121-2, reduce distortion of the earphone output, improve the active noise reduction effect of the earphone, and improve the output performance of the earphone.

[0245] Referring to FIG. 58, in some embodiments, the quantity of the frame 123-4 may be one, the frame 123-4 may include the integrally formed first portion and second portion, the first voice coil 123-1 may be arranged on an outer peripheral side or an inner peripheral side of the first portion, and the second voice coil 123-2 may be arranged on an outer peripheral side or an inner peripheral side of the second portion. For example, the first voice coil 123-1 is arranged on the outer peripheral side of the first portion, and the second voice coil 123-2 may be arranged on the outer peripheral side of the second portion. For example, the first voice coil 123-1 is arranged on the outer peripheral side of the first portion, and the second voice coil 123-2 may be arranged on the inner peripheral side of the second portion. For example, the first voice coil 123-1 is arranged on the inner peripheral side of the first portion, and the second voice coil 123-2 may be arranged on the outer peripheral side of the second portion. For example, the first voice coil 123-1 is arranged on the inner peripheral side of the first portion, and the second voice coil 123-2 may be arranged on the inner peripheral side of the second portion. The arrangement of the integrally formed frame 123-4 may effectively prevent the voice coil assembly 123 from detaching from the frame 123-4 during a vibration process, thereby enhancing the structural stability and integrity of the voice coil assembly 123.

[0246] Referring to FIG. 57, in some embodiments, the quantity of the frames 123-4 may be two, the two frames 123-4 may be connected via a connecting member (e.g., the third connecting member 127) or directly connected (e.g., by bonding), the first voice coil 123-1 may be arranged on an outer peripheral side or an inner peripheral side of one of the frames 123-4, and the second voice coil 123-2 may be arranged on an outer peripheral side or an inner peripheral side of the other one of the frames 123-4. For example, the first voice coil 123-1 is arranged on the outer peripheral side of one of the frames 123-4, and the second voice coil 123-2 may be arranged on the outer peripheral side of the other one of the frames 123-4. For example, the first voice coil 123-1 is arranged on the outer peripheral side of one of the frames 123-4, and the second voice coil 123-2 may be arranged on the inner peripheral side of the other one of the frames 123-4. For example, the first voice coil 123-1 is arranged on the inner peripheral side of one of the frames 123-4, and the second voice coil 123-2 may be arranged on the outer peripheral side of the other one of the frames 123-4. For example, the first voice coil 123-1 is arranged on the inner peripheral side of one of the frames 123-4, and the second voice coil 123-2 may be arranged on the inner peripheral side of the other one of the frames 123-4. The separate

arrangement of the two frames 123-4 may improve the flexibility of arranging the frames 123-4.

[0247] In some embodiments, the frame 123-4 may serve as a portion of the third connecting member 127, and the first voice coil 123-1 and the second voice coil 123-2 are connected through the frame 123-4 of the third connecting member 127. For example, the third connecting member 127 may include a frame 123-4, and the frame 123-4 includes integrally formed first portion and second portions. For example, the third connecting member 127 may include two frames 123-4, and the two frames 123-4 may be connected via a sub-connecting portion of the third connecting member 127.

[0248] In some embodiments, the material of the frame 123-4 and/or the third connecting member 127 may include an aluminum alloy, or may include a lower density PMI material or PC material, or the like, and may also adopt a hybrid material (e.g., a PC material with added glass fiber or carbon fiber, or the like). Through the above material arrangement, the load on the first voice coil 123-1 and the second voice coil 123-2 may be reduced, which is beneficial for improving a driving force factor of the speaker 120 and improving the active noise reduction effect of the earphone on relatively large ambient noise in an open wearing manner.

[0249] In some embodiments, the first voice coil 123-1 and the second voice coil 123-2 may also be directly bonded using an adhesive.

[0250] Through the arrangement of direct connection between the first diaphragm 121-1 and the second diaphragm 121-2 and/or direct connection between the first voice coil 123-1 and the second voice coil 123-2, the probability of separation between the first diaphragm 121-1 and the second diaphragm 121-2 may be further reduced, thereby improving the vibration consistency between the first diaphragm 121-1 and the second diaphragm 121-2, reducing distortion of the earphone output, improving the active noise reduction effect of the earphone, and improving the output performance of the earphone. On the other hand, the arrangement of direct connection between the first diaphragm 121-1 and the second diaphragm 121-2 through the second connecting member 126 may also reduce the difficulty of alignment precision requirements when the first voice coil 123-1 and the second voice coil 123-2 are connected, thereby reducing the operation difficulty.

[0251] In some embodiments, the first voice coil 123-1 and the second voice coil 123-2 may adopt an unequal diameter structure. For example, on the reference plane perpendicular to the vibration direction, a gap exists between an orthographic projection of the first voice coil 123-1 and an orthographic projection of the second voice coil 123-2 in the long axis direction or in the short axis direction, thereby causing a portion connected to each other and another portion separated

from each other to exist between the first voice coil 123-1 and the second voice coil 123-2. This allows for forming a clearance channel 123-3 between the first voice coil 123-1 and the second voice coil 123-2, based on the existence of the gap, to allow the magnetic circuit assembly 122 (e.g., the side wall of the magnetic shield 1221) to pass through the voice coil assembly 123. It may also be understood that, based on the reference plane perpendicular to the vibration direction, the orthographic projection of the first voice coil 123-1 in the reference plane and the orthographic projection of the second voice coil 123-2 in the reference plane may be partially adjoined or partially overlapped, thereby forming the clearance channel 123-3 at the separated portions of the first voice coil 123-1 and the second voice coil 123-2.

[0252] In some embodiments, referring to FIG. 57, the contour shape of the speaker 120 is non-circular (e.g., rectangular, elliptical, or the like). At this time, the side walls of the first voice coil 123-1 and the second voice coil 123-2 parallel to the long axis direction may be defined as long side walls, and the side walls parallel to the short axis direction may be defined as short side walls. The orthographic projection of the long side wall of the first voice coil 123-1 on the reference plane is connected to or at least partially overlaps the orthographic projection of the long side wall of the second voice coil 123-2 on the reference plane, while the orthographic projection of the short side wall of the first voice coil 123-1 on the reference plane is separated from the orthographic projection of the short side wall of the second voice coil 123-2 on the reference plane. That is, a dimension of the short side wall of the first voice coil 123-1 is the same as a dimension of the short side wall of the second voice coil 123-2, and a dimension of the long side wall of the first voice coil 123-1 is different from a dimension of the long side wall of the second voice coil 123-2. Thus, the clearance channel 123-3 may be formed between the short side wall of the first voice coil 123-1 and the short side wall of the second voice coil 123-2. In other embodiments, a dimension of the short side wall of the first voice coil 123-1 may be different from a dimension of the short side wall of the second voice coil 123-2, and a dimension of the long side wall of the first voice coil 123-1 may be the same as a dimension of the long side wall of the second voice coil 123-2. In still other embodiments, a dimension of the short side wall of the first voice coil 123-1 may be different from a dimension of the short side wall of the second voice coil 123-2, and a dimension of the long side wall of the first voice coil 123-1 may also be different from a dimension of the long side wall of the second voice coil 123-2.

[0253] In some embodiments, the contour shape of the sound generating portion 100 or the speaker 120 is generally circular. At this time, the first voice coil 123-1 and the second voice coil 123-2 may be connected via the third connecting member 127, so that the ortho-

graphic projection of the first voice coil 123-1 on the reference plane is a first annular ring, the orthographic projection of the second voice coil 123-2 on the reference plane is a second annular ring, and the first annular ring and the second annular ring have different diameters. With the aid of the third connecting member 127, local connection and local separation between the first voice coil 123-1 and the second voice coil 123-2 may be achieved, thereby forming the clearance channel 123-3.

[0254] By setting the first voice coil 123-1 and the second voice coil 123-2 as the unequal diameter structure with partially unequal dimensions, the clearance channel 123-3 formed between the first voice coil 123-1 and the second voice coil 123-2 may provide a clearance space for the magnetic circuit assembly 122 (e.g., the side wall of the magnetic shield 1221). This is equivalent to placing the voice coil assembly 123 within the same magnetic gap of the magnetic circuit assembly 122. This not only may enhance the robustness of the structure itself of the magnetic circuit assembly 122 and provide support for quick combined assembly of the speaker 120, but also may be beneficial for reducing assembly difficulty and cost, and may prevent the voice coil assembly 123 from touching the magnetic circuit assembly 122 during a movement process, which would affect the sound output. Meanwhile, the outer magnet 1223 adopts an annular structure surrounding the magnetic shield 1221 or the inner magnet 1222, which may cause the magnetic circuit assembly 122 to have a larger design dimension, thereby increasing the driving force of the voice coil assembly 123 by increasing the volume of the magnet, improving the sound output performance of the speaker 120, and improving the active noise reduction effect of the earphone on relatively large ambient noise in an open wearing manner.

[0255] In other embodiments, the first voice coil 123-1 and the second voice coil 123-2 may also adopt equal diameter dimensions. Specifically, on the reference plane perpendicular to the vibration direction, the orthographic projection of the first voice coil 123-1 overlaps the orthographic projection of the second voice coil 123-2. At this time, on a reference plane parallel to the vibration direction, a gap exists between the orthographic projection of the first voice coil 123-1 and the orthographic projection of the second voice coil 123-2 in the vibration direction, thereby also forming the clearance channel 123-3 between them based on the existence of the gap. At this time, the magnetic circuit assembly 122 (e.g., the extension portion at the top end of the side wall of the magnetic shield 1221 shown in FIG. 51 and FIG. 54B) may pass through the clearance channel 123-3 along the direction perpendicular to the vibration direction. For example, for the extension portion at the top end of the side wall of the magnetic shield 1221 shown in FIG. 51 and FIG. 54B, the extension portion may pass through the clearance channel

123-3 along the direction perpendicular to the vibration direction, and the two ends of the extension portion are respectively connected to the side wall of the magnetic shield 1221 and the outer magnet 1223.

[0256] In some embodiments, the frame 123-4 may also form the clearance channel 123-3, the principle of formation thereof being the same as the principle of forming the clearance channel 123-3 by the first voice coil 123-1 and the second voice coil 123-2.

[0257] FIG. 59 is a schematic diagram illustrating frequency response curves of a speaker shown in FIG. 58. For example, where a dimension of the first voice coil 123-1 is smaller than a dimension of the second voice coil 123-2: the curve L321 represents the output sound pressure level of the first diaphragm 121-1 corresponding to the first voice coil 123-1 (a small voice coil) when the first voice coil 123-1 and the second voice coil 123-2 are simultaneously driven; the curve L322 represents the output sound pressure level of the second diaphragm 121-2 corresponding to the second voice coil 123-2 (a large voice coil) when the first voice coil 123-1 and the second voice coil 123-2 are simultaneously driven; the curve L323 represents the output phase of the first diaphragm 121-1 corresponding to the first voice coil 123-1 (a small voice coil) when the first voice coil 123-1 and the second voice coil 123-2 are simultaneously driven; and the curve L324 represents the output phase of the second diaphragm 121-2 corresponding to the second voice coil 123-2 (a large voice coil) when the first voice coil 123-1 and the second voice coil 123-2 are simultaneously driven.

[0258] In some embodiments, the data acquisition environment of the data shown in FIG. 59 is as follows: by fixing the speaker 120 (e.g., handheld, directly fixed via a fixing platform, fixed by a handheld fixing device, or the like), applying a voltage excitation of 0.5 Vrms, the frequency response and the phase of a corresponding diaphragm are measured by a test microphone located at a distance of 5 mm from the corresponding diaphragm. When fixing the speaker 120, it is necessary to prevent the speaker 120 from being blocked, thereby avoiding affecting the acquisition effect.

[0259] As shown in FIG. 59, the curve L321 and the curve L322 are relatively flat in a range of 200 Hz to 10 kHz, without peaks or valleys, indicating that the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2 is good, and the output consistency is good. The phase differences of the curve L323 and the curve L324 are both about 180° in a range of 200 Hz to 10 kHz, indicating that the vibration phases of the first diaphragm 121-1 and the second diaphragm 121-2 are opposite, and the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2 is good. In a frequency range of 200 Hz to 10 kHz, the phase change of the curve L323 or the curve L324 is not greater than 20°, indicating that the vibration phase consistency of the first diaphragm 121-1 and the second diaphragm 121-2 is good.

[0260] In summary, by adopting an unequal-diameter structure for the first voice coil 123-1 and the second voice coil 123-2, it may also be ensured that the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2 is good, thereby reducing output distortion of the earphone, improving the active noise reduction effect of the earphone, and improving the output effect of the earphone.

[0261] FIG. 60 is a schematic diagram illustrating a structure of a magnetic shield according to some embodiments of the present disclosure.

[0262] Referring to FIG. 60, in some embodiments, the magnetic shield 1221 may be a 'II'-shaped structure. Specifically, the magnetic shield 1221 includes a bottom wall 12211, an inner side wall 12212, and an extension portion 12213 provided at a top end of the inner side wall 12212. The magnetic shield 1221 includes the inner side wall 12212 parallel to the short axis direction, and does not include inner side wall 12212 parallel to the long axis direction. The inner magnet 1222 is arranged on the bottom wall 12211, and the bottom wall 12211 and the inner side wall 12212 may support and fix the inner magnet 1222. The extension portion 12213 may be connected to the outer magnet 1223. Through the structural form of the magnetic circuit assembly 122 having unconnected long sides and connected short sides, a strong and uniform magnetic field may be formed between long sides of the inner magnet 1222 and long sides of the outer magnet 1223, thereby allowing the magnetic field to pass through the magnetic gap as much as possible, achieving full utilization of the magnetic field, effectively enhancing the driving force of the voice coil assembly 123, improving the sound output performance of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise in an open wearing manner.

[0263] In some embodiments, the inner side wall 12212 or the extension portion 12213 of the magnetic shield 1221 may pass through the clearance channel 123-3, allowing the magnetic circuit assembly 122 to extend out of the voice coil assembly 123, thereby facilitating the fixing of the magnetic circuit assembly 122.

[0264] In some embodiments, in order to improve the structural strength of the magnetic shield 1221, a connecting position between the inner side wall 12212 and the bottom wall 12211, and a connecting position between the inner side wall 12212 and the extension portion 12213 may be provided with a rounded transition, and the bottom wall 12211 may be provided with a reinforcing member.

[0265] In some embodiments, the inner side wall 12212 may be hollowed out, or the material of the inner side wall 12212 may include a non-magnetic material, in order to reduce the conduction of magnetic field lines of the inner side wall 12212 in an up-down direction, weaken the influence of magnetic short circuit of the inner side wall 12212, and reduce the influence on the

voice coil assembly 123, thereby allowing the voice coil assembly 123 to have a larger driving force, improving the sound output performance of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise in an open wearing manner.

[0266] In some embodiments, the four peripheral corners of the bottom wall 12211 are provided with a stepped structure, and the provision of the stepped structure may further prevent the bottom wall 12211 of the magnetic shield 1221 from interfering with the third connecting member 127, allowing the third connecting member 127 to have a larger movement space, thereby causing the voice coil assembly 123 to have a larger vibration space, improving the output performance of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise in an open wearing manner.

[0267] FIGS. 61A-61G are schematic diagrams illustrating different exemplary structures of a speaker according to some embodiments of the present disclosure.

[0268] Referring to FIG. 61A, in some embodiments, the voice coil assembly 123 includes the first voice coil 123-1 and the second voice coil 123-2 arranged along the vibration direction, the first diaphragm 121-1 is connected to the first voice coil 123-1, the second diaphragm 121-2 is connected to the second voice coil 123-2, and the first voice coil 123-1 and the second voice coil 123-2 respectively drive the first diaphragm 121-1 and the second diaphragm 121-2 to vibrate synchronously in the same direction. The first diaphragm 121-1 and the second diaphragm 121-2 are not directly connected to each other, and the first voice coil 123-1 and the second voice coil 123-2 are not directly connected to each other. The first voice coil 123-1 independently drives the first diaphragm 121-1 to vibrate, the second voice coil 123-2 independently drives the second diaphragm 121-2 to vibrate, and the first diaphragm 121-1 and the second diaphragm 121-2 vibrate synchronously in the same direction. Through the above-described settings, the internal structure of the speaker 120 may be simplified, and production difficulty may be reduced.

[0269] In some embodiments, in order to improve the output sound of the earphone, improve the listening effect of the earphone, and improve the active noise reduction effect of the earphone against zero article larger ambient noise, the magnetic circuit assembly 122 may be designed to enhance the magnetic field strength of the magnetic circuit assembly 122 and improve the driving force of the voice coil assembly 123.

[0270] Referring to FIG. 61A, in some embodiments, the magnetic shield 1221 may include the bottom wall 12211 and a side wall, the side wall may be a folded structure, the folded structure has an opening facing a bottom of the magnetic shield 1221, the folded structure includes the inner side wall 12212 and an outer

side wall 12214 of the magnetic shield 1221, the bottom wall 12211 is arranged at an end of the inner side wall 12212 close to the opening, and the inner magnet 1222 is arranged on the bottom wall 12211. An end of the inner side wall 12212 away from the opening and an end of the outer side wall 12214 away from the opening are connected via the extension portion 12213. A first magnetic gap is formed between the inner side wall 12212 of the magnetic shield 1221 and the inner magnet 1222, and at least a portion of the first voice coil 123-1 is located within the first magnetic gap; a second magnetic gap is formed between the inner side wall 12212 of the magnetic shield 1221 and the outer side wall 12214, and at least a portion of the second voice coil 123-2 is located within the second magnetic gap.

[0271] Since the second voice coil 123-2 is relatively far from the inner magnet 1222, the magnetic field strength near the second voice coil 123-2 is relatively small, and the second voice coil 123-2 may have a problem of insufficient driving force. In order to improve the driving force of the second voice coil 123-2, thereby improving the driving force of the speaker 120, improving the output of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise, the magnetic circuit assembly 122 may be designed.

[0272] Referring to FIG. 61B, in some embodiments, the outer magnet 1223 may be provided at the outer side wall 12214 of the magnetic shield 1221 (that is, the outer side wall 12214 may include the outer magnet 1223), to increase the magnetic field strength near the second voice coil 123-2, thereby improving the driving force of the second voice coil 123-2, improving the driving force of the speaker 120, improving the output of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise. In this case, the first magnetic gap is formed between the inner magnet 1222 and the inner side wall 12212, and the second magnetic gap is formed between the outer magnet 1223 and the inner side wall 12212. In some embodiments, a magnetization direction of the outer magnet 1223 may be the same as or opposite to a magnetization direction of the inner magnet 1222. For example, an N pole of the inner magnet 1222 may be located at an upper end, and an N pole of the outer magnet 1223 may be located at an upper end (as shown in FIG. 61A). As another example, the N pole of the inner magnet 1222 may be located at the upper end, and the N pole of the outer magnet 1223 may be located at the lower end (as shown in FIG. 61G).

[0273] In some embodiments, when magnetization directions of the inner magnet 1222 and the outer magnet 1223 are the same (e.g., both N poles are located at the upper end shown in FIG. 61A), the inner side wall 12212 of the magnetic shield 1221 is subjected to a combined action of the inner magnet 1222 and the out-

er magnet 1223, a magnetic field saturation phenomenon occurs in the inner side wall 12212, limiting the improvement of the magnetic field strength at positions of the first voice coil 123-1 and the second voice coil 123-2, affecting the driving force of the first voice coil 123-1 and the second voice coil 123-2, and affecting the active noise reduction effect of the earphone. In some embodiments, as shown in FIG. 61C, the magnetic circuit assembly 122 may be designed by increasing the dimension of the inner side wall 12212, so as to minimize the occurrence of magnetic field saturation in the inner side wall 12212, thereby improving the magnetic field strength at positions of the first voice coil 123-1 and the second voice coil 123-2, further improving the driving force of the speaker 120, improving the output of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise.

[0274] Referring to FIGS. 61B and 61C, in some embodiments, in order to prevent the dimension of the magnetic circuit assembly 122 from being excessively large, the dimension of the inner magnet 1222 may be reduced to increase the dimension of the inner side wall 12212, while maintaining the dimension of the magnetic shield 1221 unchanged (that is, maintaining the dimension of the magnetic shield 1221 unchanged). In some embodiments, in the short axis direction or in the long axis direction, a ratio of the thickness of the inner side wall 12212 to the dimension of the magnetic shield 1221 may be 0.05 to 0.16. In some embodiments, in order to further improve the driving force of the speaker 120, in the short axis direction or in the long axis direction, a ratio of the thickness of the inner side wall 12212 to the dimension of the magnetic shield 1221 may be 0.06 to 0.15. In some embodiments, while maintaining the dimension of the magnetic circuit assembly 122 unchanged (that is, maintaining a width of the magnetic shield 1221 unchanged), the thickness of the inner side wall 12212 is negatively correlated with the dimension of the inner magnet 1222. By way of example, in the short axis direction or in the long axis direction, when the dimension of the magnetic shield 1221 is 16 mm, the thickness of the inner side wall 12212 may be 0.8 mm to 2.5 mm; when the dimension of the inner magnet 1222 is greater than 4.7 mm, the thickness of the inner side wall 12212 may be 2 mm to 2.5 mm; when the dimension of the inner magnet 1222 is greater than 5.7 mm, the thickness of the inner side wall 12212 may be 1.5 mm to 2.5 mm; when the dimension of the inner magnet 1222 is greater than 6.7 mm, the thickness of the inner side wall 12212 may be 1.25 mm to 2.5 mm; when the radius of the inner magnet 1222 is greater than 7.7 mm, the thickness of the inner side wall 12212 may be 1.1 mm to 2.5 mm; when the dimension of the inner magnet 1222 is greater than 8.7 mm, the thickness of the inner side wall 12212 may be 1 mm to 2 mm; when the radius of the inner magnet 1222 is greater than 9.7 mm, the thickness of the inner

side wall 12212 may be 0.8 mm to 1.6 mm; and when the radius of the inner magnet 1222 is greater than 10.7 mm, the thickness of the inner side wall 12212 may be 0.8 mm to 1.3 mm.

[0275] In some embodiments, as shown in FIG. 61D, the outer magnet 1223 may also be provided on the inner side wall 12212 (that is, the inner side wall 12212 may include the outer magnet 1223), to prevent magnetic field saturation from occurring in the inner side wall 12212, ensuring the magnetic field strength at positions of the first voice coil 123-1 and the second voice coil 123-2, thereby further improving the driving force of the speaker 120, improving the output of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise. In this case, the first magnetic gap is formed between the inner magnet 1222 and the outer magnet 1223, and the second magnetic gap is formed between the outer magnet 1223 and the outer side wall 12214. In some embodiments, a magnetization direction of the outer magnet 1223 may be the same as or opposite to a magnetization direction of the inner magnet 1222.

[0276] In some embodiments, as shown in FIG. 61E, in order to further improve the magnetic field strength at positions of the first voice coil 123-1 and the second voice coil 123-2, thereby improving the driving force of the speaker 120, improving the output of the speaker 120, and improving the active noise reduction effect of the earphone against larger ambient noise, the inner side wall 12212 of the magnetic shield 1221 may be provided with a first outer magnet 1223-1, and the outer side wall 12214 of the magnetic shield 1221 may be provided with a second outer magnet 1223-2. That is, the inner side wall 12212 may include the first outer magnet 1223-1, and the outer side wall 12214 may include the second outer magnet 1223-2. In this case, the first magnetic gap is formed between the inner magnet 1222 and the first outer magnet 1223-1, and the second magnetic gap is formed between the first outer magnet 1223-1 and the second outer magnet 1223-2. In some embodiments, magnetization directions of the inner magnet 1222, the first outer magnet 1223-1, and the second outer magnet 1223-2 may be the same as or opposite to each other. For example, the magnetization direction of the inner magnet 1222 may be the same as the magnetization direction of the first outer magnet 1223-1, and the magnetization direction of the inner magnet 1222 may be the same as the magnetization direction of the second outer magnet 1223-2; or the magnetization direction of the inner magnet 1222 may be the same as the magnetization direction of the first outer magnet 1223-1, and the magnetization direction of the inner magnet 1222 may be opposite to the magnetization direction of the second outer magnet 1223-2; or the magnetization direction of the inner magnet 1222 may be opposite to the magnetization direction of the first outer magnet 1223-1, and the magnetization direction of the inner magnet 1222 may

be the same as the magnetization direction of the second outer magnet 1223-2; or the magnetization direction of the inner magnet 1222 may be opposite to the magnetization direction of the first outer magnet 1223-1, and the magnetization direction of the inner magnet 1222 may be opposite to the magnetization direction of the second outer magnet 1223-2.

[0277] Referring to FIG. 61F, when the outer side wall 12214 of the magnetic shield 1221 includes the outer magnet 1223 (that is, the outer side wall 12214 includes the outer magnet 1223), and the magnetization direction of the inner magnet 1222 is opposite to the magnetization direction of the outer magnet 1223 (e.g., the N-pole of the inner magnet 1222 may be located at the upper end, and the N-pole of the outer magnet 1223 may be located at the lower end), a magnetic field zero pole appears on the inner side wall 12212 of the magnetic shield 1221, and the inner side wall 12212 is not configured to conduct magnetism. In this case, the inner side wall 12212 of the magnetic shield 1221 mainly provides connection and support. To reduce the mass and dimension of the speaker 120, the thickness of the inner side wall 12212 of the magnetic shield 1221 may be designed to be relatively thin (e.g., less than or equal to 0.4 mm). In some embodiments, as shown in FIG. 61G, to further reduce the mass and dimension of the speaker 120, the thickness of the inner side wall 12212 of the magnetic shield 1221 may also be designed to be 0, that is, the structure of the inner side wall 12212 is omitted.

[0278] In some embodiments, to reduce the mass and dimension of the speaker 120, the inner side wall 12212 may be hollowed out.

[0279] Since the outer magnet 1223 and the inner magnet 1222 need to be mounted and connected, the side wall of the magnetic shield 1221 needs to retain at least a portion of the inner side wall 12212, to connect the outer side wall 12214 to the bottom wall 12211 of the magnetic shield 1221. By way of example, the outer side wall 12214 on the long side of the magnetic shield 1221 may be connected to the bottom wall 12211 of the magnetic shield 1221 via the inner side wall 12212, and the short side of the magnetic shield 1221 may not be provided with the inner side wall 12212.

[0280] To improve the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, to improve the output effect of the speaker 120, and to improve the active noise reduction effect of the earphone against large ambient noise in an open wearing state, the driving forces of the first voice coil 123-1 and the second voice coil 123-2 may be close or the same. In some embodiments, by designing the dimensions of the inner magnet 1222 and the outer magnet 1223, the magnetic field strengths near the first voice coil 123-1 and the second voice coil 123-2 may be made similar, thereby improving the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2, and improving the active noise reduc-

tion effect of the earphone.

[0281] FIG. 62 is a schematic diagram illustrating frequency response curves of a speaker corresponding to inner and outer magnets of different sizes according to some embodiments of the present disclosure; and FIG. 63 is a schematic diagram illustrating another structure of a speaker according to some embodiments of the present disclosure.

[0282] In some embodiments, the data in FIG. 62 is data measured under conditions where a width of the magnetic gap is 1.1 mm and the thickness of the inner side wall 12212 of the magnetic shield 1221 is 0.7 mm.

[0283] Referring to FIG. 63, the ratio of the dimension Wim of the inner magnet 1222 to the dimension Wom of the outer magnet 1223 refers to Wim/Wom. In FIG. 62, L701 represents the BL value of the speaker 120 when Wim/Wom is 0.32, L702 represents the BL value of the speaker 120 when Wim/Wom is 0.56, L703 represents the BL value of the speaker 120 when Wim/Wom is 0.85, L704 represents the BL value of the speaker 120 when Wim/Wom is 1.22, L705 represents the BL value of the speaker 120 when Wim/Wom is 1.70, L706 represents the BL value of the speaker 120 when Wim/Wom is 2.35, L707 represents the BL value of the speaker 120 when Wim/Wom is 3.28, L708 represents the BL value of the speaker 120 when Wim/Wom is 4.70, L709 represents the BL value of the speaker 120 when Wim/Wom is 7.19, L710 represents the BL value of the speaker 120 when Wim/Wom is 15.59, and L711 represents the BL value of the speaker 120 when Wim/Wom is 33.43.

[0284] Referring to FIG. 63, the dimension refers to a dimension parameter of related components in a direction perpendicular to the vibration direction; for example, the thickness of the outer magnet 1223 refers to a distance between an outer surface and an inner surface of the outer magnet 1223, and the dimension of the inner magnet 1222 refers to a dimension of a cross section of the inner magnet 1222.

[0285] As shown in FIG. 62, the BL value of the speaker 120 is optimal when the ratio of the dimension of the inner magnet 1222 to the thickness of the outer magnet 1223 is 7.19; further increasing the ratio of the dimension of the inner magnet 1222 to the thickness of the outer magnet 1223 may cause the BL value of the speaker 120 to decrease.

[0286] In view of this, by designing the dimension ratio of the outer magnet 1223 and the inner magnet 1222, the electromagnetic conversion efficiency of the speaker 120 may be ensured, the driving force of the voice coil assembly 123 may be improved, the output of the speaker 120 may be improved, and the active noise reduction effect of the earphone against large ambient noise may be improved.

[0287] By way of example, a dimension of the speaker 120 in the long axis direction is greater than a dimension thereof in the short axis direction; in this case, a ratio of a dimension of the inner magnet 1222 in the

long axis direction to a thickness of the outer magnet 1223 in the long axis direction is between 1.7 and 33; a ratio of a dimension of the inner magnet 1222 in the short axis direction to a thickness of the outer magnet 1223 in the short axis direction is between 1.7 and 33.

[0288] Further, in some embodiments, the ratio of the dimension of the inner magnet 1222 in the long axis direction to the thickness of the outer magnet 1223 in the long axis direction is less than or equal to 6.7, and the ratio of the dimension of the inner magnet 1222 in the short axis direction to the thickness of the outer magnet 1223 in the short axis direction is less than or equal to 2.7. Through the design of the above ranges, the BL value of the speaker 120 may be significantly improved, further enhancing the sound output performance of the speaker 120, and improving the active noise reduction effect of the earphone against large ambient noise.

[0289] By way of example, the contour shape of the speaker 120 is circular; a ratio of a dimension of the inner magnet 1222 in the radial direction (that is, equivalent to the long axis direction or the short axis direction) to a thickness of the outer magnet 1223 in the radial direction is between 1.7 and 33.

[0290] It should be noted that the thickness of the outer magnet 1223 refers to the distance between the outer surface and the inner surface of the outer magnet 1223.

[0291] When a volume of the outer magnet 1223 is too small relative to a volume of the inner magnet 1222, the second voice coil 123-2 closer to the outer magnet 1223 and away from the inner magnet 1222 has a smaller driving force, and the first voice coil 123-1 away from the outer magnet 1223 and closer to the inner magnet 1222 has a larger driving force, thereby causing a large driving force difference between the first voice coil 123-1 and the second voice coil 123-2; similarly, when a volume of the outer magnet 1223 is too large relative to a volume of the inner magnet 1222, the second voice coil 123-2 closer to the outer magnet 1223 and away from the inner magnet 1222 has a larger driving force, and the first voice coil 123-1 away from the outer magnet 1223 and closer to the inner magnet 1222 has a smaller driving force, thereby causing a large driving force difference between the first voice coil 123-1 and the second voice coil 123-2. That is, when a volume of the outer magnet 1223 and a volume of the inner magnet 1222 differ too greatly, both may lead to a large driving force difference between the first voice coil 123-1 and the second voice coil 123-2, affecting the active noise reduction effect of the earphone. In some embodiments, to further improve the vibration consistency of the first diaphragm 121-1 and the second diaphragm 121-2 and to improve the active noise reduction effect of the earphone, the ratio of the volume of the outer magnet 1223 to the volume of the inner magnet 1222 may be 0.3 to 3. In some embodiments, to further improve the vibration consistency of

the first diaphragm 121-1 and the second diaphragm 121-2 and to improve the active noise reduction effect of the earphone, the ratio of the volume of the outer magnet 1223 to the volume of the inner magnet 1222 may be 0.5 to 1.5.

[0292] FIGS. 64A-64B are schematic diagrams illustrating frequency response curves of a speaker corresponding to a magnet and a magnetic shield of different sizes in FIG. 63.

[0293] In some embodiments, FIG. 64A shows a changing trend of the electromagnetic conversion efficiency of the speaker 120 when a dimension of the magnet (e.g., the inner magnet 1222) is fixed (e.g., 2 mm) and a thickness of the magnetic shield 1221 (e.g., the bottom wall 12211) or the first magnetic plate 1224 is changed; FIG. 64B shows a changing trend of the electromagnetic conversion efficiency of the speaker 120 when the thickness of the magnetic shield 1221 (e.g., the bottom wall 12211) or the first magnetic plate 1224 is fixed (e.g., 0.7 mm) and a dimension of the magnet (e.g., the inner magnet 1222) is changed.

[0294] As shown in FIG. 64A, as the thickness of the magnetic shield 1221 or the first magnetic plate 1224 increases (that is, the ratio of the dimension of the magnet to the thickness of the magnetic shield 1221, $h_{\text{magnet}}/h_{\text{lead}}$, decreases), the BL value of the speaker 120 shows an increasing trend. However, when the thickness of the magnetic shield 1221 or the first magnetic plate 1224 increases to a certain value, the BL value reaches a maximum value. Excessively increasing the thickness of the magnetic shield 1221 or the first magnetic plate 1224 may cause the magnetic field lines to disperse and cannot be effectively concentrated near the voice coil assembly 123, causing the magnetic field near the voice coil assembly 123 to be reduced; when the thickness of the magnetic shield 1221 or the first magnetic plate 1224 decreases (that is, the ratio of the dimension of the magnet to the thickness of the magnetic shield 1221 or the first magnetic plate 1224 increases), it may cause a decrease in the magnetic saturation of the magnetic shield 1221 or the first magnetic plate 1224, reducing the magnetic conduction capability, and further reducing the magnetic field strength passing through the voice coil assembly 123. The BL value obtains the maximum value when the ratio of the dimension of the magnet to the thickness of the magnetic shield 1221 or the first magnetic plate 1224 is 1.4, however, a larger BL value is maintained when the ratio of the dimension of the magnet to the thickness of the magnetic shield 1221 or the first magnetic plate 1224 is between 1 and 4.

[0295] As shown in FIG. 64B, as the dimension of the magnet increases (that is, the ratio of the dimension of the magnet to the thickness of the magnetic shield 1221 or the first magnetic plate 1224, $h_{\text{magnet}}/h_{\text{lead}}$, decreases), the BL value of the speaker 120 shows an increasing trend; however, a rate of increase of the BL value may decrease, and the reason

may be that as the dimension of the magnet increases, the magnetic shield 1221 or the first magnetic plate 1224 experiences magnetic saturation. Further increasing the dimension of the magnet, an increase in the magnetic field passing through the voice coil assembly 123 that can be converged by the magnetic shield 1221 or the first magnetic plate 1224 is not apparent; when the ratio of the dimension of the magnet to the thickness of the magnetic shield 1221 or the first magnetic plate 1224 is between 1 and 4, the rate of increase of the BL value is high; when the ratio of the dimension of the magnet to the thickness of the magnetic shield 1221 or the first magnetic plate 1224 is greater than 4, the rate of increase significantly slows down, and the magnetic shield 1221 or the first magnetic plate 1224 starts to experience magnetic saturation, thereby reducing the overall electromagnetic conversion efficiency of the speaker 120.

[0296] Therefore, to improve the electromagnetic conversion efficiency of the speaker 120, in some embodiments, the ratio of the dimension of the inner magnet 1222 to the thickness of the magnetic shield 1221 (e.g., the bottom wall 12211) or the first magnetic plate 1224 may be between 1 and 4, and the ratio of the thickness of the outer magnet 1223 to the thickness of the magnetic shield 1221 (e.g., the inner side wall 12212) may be between 1 and 4.

[0297] In some embodiments, in order to enhance the driving force of the speaker 120, a structure of the magnetic circuit assembly 122 may be designed. In some embodiments, referring to FIG. 51, when a long side portion and a short side portion of the outer magnet 1223 are separated structures, in order to fix the outer magnet 1223 and to prevent the outer magnet 1223 from falling off, the magnetic circuit assembly 122 may include a frame 125. The frame 125 is arranged around a periphery of the outer magnet 1223, and the frame 125 cooperates with the magnetic shield 1221 to fix the outer magnet 1223.

[0298] FIG. 65 is a schematic diagram illustrating another cross-sectional structure of a sound generating assembly according to some embodiments of the present disclosure; and FIG. 66 is a schematic structural diagram illustrating a structure decomposition of a speaker according to some embodiments of the present disclosure.

[0299] In some embodiments, referring to FIG. 24, FIG. 65, and FIG. 66, an end of the outer magnet 1223 away from the extension portion 12213 may be provided with a second magnetic plate 1225. The magnetic circuit assembly 122 further includes a bracket assembly. The bracket assembly may include the first bracket 122-4 and the second bracket 122-5; the first bracket 122-4 is connected around an outer periphery of the second magnetic plate 1225, and the second bracket 122-5 is connected around an outer periphery of the extension portion 12213. Connection between the first bracket 122-4 and the second magnetic plate

1225 and between the second bracket 122-5 and the extension portion 12213 may be implemented in forms such as injection molding, adhesive bonding, bolts, or buckles; an outer peripheral edge of the first diaphragm 121-1 is fixed to the first bracket 122-4 (e.g., adhesive bonding), and an outer peripheral edge of the second diaphragm 121-2 is fixed to the second bracket 122-5 (e.g., adhesive bonding).

[0300] On one hand, by the cooperation of the first bracket 122-4, the second bracket 122-5, and the second magnetic plate 1225, it may replace a basket in some existing speakers or the aforementioned frame 125, allowing the outer magnet 1223 to have a larger volume and dimension, enhancing magnetic flux, thereby enhancing the driving force of the voice coil assembly 123; at the same time, it may also make the structure of the speaker 120 more compact, reduce assembly difficulty, and improve assembly effect.

[0301] On the other hand, by the cooperation of the first bracket 122-4 and the second bracket 122-5, as well as the magnetic shield 1221 and the diaphragms, an internal space of the speaker 120 may be enclosed to form a relatively closed cavity (that is, the common cavity 111-3); and by using the first bracket 122-4 and the second bracket 122-5, they may serve as a structural connection carrier between the speaker 120 and the first housing 110 or between the speaker 120 and the limiting assembly 130, so as to stably limit the speaker 120 inside the first housing 110, and form the first acoustic cavity 111-1 and the second acoustic cavity 111-2 that are relatively independent of the common cavity 111-3.

[0302] In some embodiments, referring to FIG. 66, the first bracket 122-4 has a first receiving groove enclosed around the second magnetic plate 1225, and the second bracket 122-5 has a second receiving groove enclosed around the extension portion 12213; an outer peripheral edge of the second magnetic plate 1225 is inserted into the first receiving groove, and an outer peripheral edge of the extension portion 12213 is inserted into the second receiving groove. By way of example, the first bracket 122-4 may be integrally formed with the second magnetic plate 1225 by means such as injection molding, overmolding, or the like, and the first bracket 122-4 is wrapped around an outer peripheral edge of the second magnetic plate 1225. In this case, the first receiving groove is equivalent to being naturally formed on the first bracket 122-4.

[0303] Based on the arranged receiving grooves, the structural connection area between the bracket and the corresponding magnetic plate is effectively increased, thereby allowing the bracket and the corresponding magnetic plate to be stably combined into one unit (e.g., the bracket and the corresponding magnetic plate are integrally injection molded), which is beneficial for reducing a quantity of components of the speaker 120 and reducing assembly difficulty of the speaker 120.

[0304] In some embodiments, referring to FIG. 65,

and FIG. 66, the first bracket 122-4, the second magnetic plate 1225, and the first diaphragm 121-1 collectively form a first chamber 120a inside the speaker 120, and the second bracket 122-5, the extension portion 12213, and the second diaphragm 121-2 collectively form a second chamber 120b inside the speaker 120; it may be understood that the first chamber 120a and the second chamber 120b are equivalent to a portion of the common cavity 111-3, and both are located on two sides of the magnetic circuit assembly in the vibration direction.

[0305] In this case, referring to FIG. 66, the first bracket 122-4 and the second bracket 122-5 are respectively provided with a positioning structure 120c and a through-hole structure 120d; for ease of distinction and description, the positioning structure 120c and the through-hole structure 120d arranged on the first bracket 122-4 respectively refer to the first positioning structure and the first through-hole structure, and the positioning structure 120c and the through-hole structure 120d arranged on the second bracket 122-5 respectively refer to the second positioning structure and the second through-hole structure.

[0306] The first positioning structure is located inside the first chamber 120a, and is mainly configured to position and limit a wire of the first voice coil 123-1 on the first bracket 122-4 inside the first chamber 120a; and the first through-hole structure is arranged through a side wall of the first bracket 122-4 (e.g., a side wall in the short axis direction), allowing the wire of the first voice coil 123-1 to be drawn out from inside the speaker 120, thereby connected to the circuit board 150 arranged around a periphery of the speaker 120 (the circuit board 150 may achieve electrical connection between the speaker 120 and a microphone assembly and a circuit board assembly of the earphone). Following the same principle, the second positioning structure is located inside the second chamber 120b, and is mainly configured to position and limit a wire of the second voice coil 123-2 on the second bracket 122-5 inside the second chamber 120b; and the second through-hole structure is arranged through a side wall of the second bracket 122-5, allowing the wire of the second voice coil 123-2 to be drawn out from inside the speaker 120 and connected to the circuit board 150.

[0307] Thus, by the cooperation between the corresponding chambers, the brackets, the positioning structure 120c, and the through-hole structure 120d, the compactness of the overall structure of the speaker 120 may not only be effectively enhanced but also a limitation on the voice coil wires may be formed, to prevent the wires from interfering with the vibration of the diaphragms. In a specific implementation, the positioning structure 120c may be a mechanical structure such as a buckle arranged on the corresponding bracket, or the like, or may be a structure formed by adhesive fixing the voice coil wires.

[0308] In some embodiments, referring to FIG. 66, the first bracket 122-4 and the second bracket 122-5 are spaced apart in the vibration direction; in this way, a receiving gap distributed around the outer magnet 1223 may be formed between the two. The circuit board 150 may be received and fixed within the receiving gap, e.g., adhesively fixed on an outer peripheral surface of the first outer magnet 1223-1. Thus, an overall volume and dimension of the speaker 120 may be effectively reduced, further enhancing the structural compactness of the speaker 120.

[0309] In some embodiments as described above, the limiting assembly 130 is arranged between the first housing 110 and the speaker 120. In this case, referring to FIG. 66, a junction of the limiting assembly 130 and the speaker 120 may form a sealant receiving space configured to receive sealant. For example, a longitudinal side wall of a first cover 133 surrounds an outer periphery of the first bracket 122-4, thereby forming a potting space between the two. A longitudinal side wall of a second cover 134 surrounds an outer periphery of the second bracket 122-5, thereby forming a potting space between the two. By filling a sealant into the potting space, a sealed fixed connection between the limiting assembly 130 and the speaker 120 is achieved.

[0310] In this manner, the sealant in the potting space may be utilized to enhance the stability and sealing performance of the structural connection between the limiting assembly 130 and the speaker 120, and a structural gap between the limiting assembly 130 and the speaker 120 may be eliminated, thereby enhancing the sealing performance of the first acoustic cavity 111-1 and the second acoustic cavity 111-2, and avoiding affecting sound output of the earphone due to sound leakage from a connection position between the limiting assembly 130 and the speaker 120.

[0311] In some embodiments, referring to FIG. 66, one or both of the first bracket 122-4 and the second bracket 122-5 are provided with the pressure balancing channel 120e. The pressure balancing channel 120e may be configured to extend through a corresponding one of the brackets along a direction perpendicular to the vibration direction (e.g., a long axis direction, a short axis direction, or the like), allowing the pressure balancing channel 120e to communicate the external space of the speaker 120 with the common cavity 111-3 formed between the first bracket 122-4, the second bracket 122-5, the first diaphragm 121-1, the second diaphragm 121-2, and the outer magnetic circuit component 122-1.

[0312] When the first diaphragm 121-1 and the second diaphragm 121-2 vibrate synchronously in the same direction, the pressure balancing channel 120e may ensure that gas within the common cavity 111-3 moves back and forth with the vibration of the two diaphragms, thereby avoiding the first diaphragm 121-1 and the second diaphragm 121-2 from affecting peaks and valleys of a frequency response curve due to com-

pressing the gas within the common cavity 111-3, improving sound output quality of the earphone, and further enhancing active noise reduction effect of the earphone.

[0313] Meanwhile, when the first diaphragm 121-1 and the second diaphragm 121-2 experience inconsistent vibration (e.g., opposite vibration directions, differences in vibration amplitudes, or the like), the pressure balancing channel 120e may be utilized to balance internal and external air pressure of the common cavity 111-3, thereby avoiding interference with the vibration of the first diaphragm 121-1 and the second diaphragm 121-2 by the gas within the common cavity 111-3, and ensuring sound output.

[0314] In some embodiments, the pressure balancing channel 120e may be covered by a mesh screen, a waterproof and breathable membrane, or the like, to enhance waterproof performance of the speaker 120.

[0315] As in some aforementioned embodiments, a magnetic circuit assembly may include the magnetic shield 1221, the inner magnet 1222, the outer magnet 1223, or the like. By improving a design of the magnetic circuit structure, a driving force of the speaker 120 may be further enhanced.

[0316] FIG. 67A is a schematic diagram illustrating another exploded view of a speaker according to some embodiments of the present disclosure; FIG. 67B is a schematic diagram illustrating a cross-section of the speaker shown in FIG. 67A along a width direction; and FIG. 67C is a schematic diagram illustrating a cross-section of the speaker shown in FIG. 67A along a length direction. As shown in FIGS. 67A-67C, in some embodiments, the outer magnet 1223 may be a ring structure. The outer magnet 1223 is arranged to surround the magnetic shield 1221. The ring structure of the outer magnet 1223 can allow the outer magnet 1223 to have a larger volume, to enhance magnetic flux, thereby enhancing the driving force of the speaker 120. In addition, the ring structure of the outer magnet 1223 can also reduce assembly difficulty and improve assembly efficiency.

[0317] In some embodiments, when the outer magnet 1223 is a ring structure, correspondingly, the magnetic circuit assembly 122 may not be provided with the frame 125, but the outer magnet 1223 is installed and fixed by the upper fixing bracket 128-1 and the lower fixing bracket 128-2. Specifically, the first diaphragm 121-1 may be fixed to the upper fixing bracket 128-1. An upper side surface of the outer magnet 1223 is connected to the upper fixing bracket 128-1 through a third magnetic conductive plate 1226. The second diaphragm 121-2 may be fixed to the lower fixing bracket 128-2. A lower side surface of the outer magnet 1223 is connected to the lower fixing bracket 128-2 through a second magnetic conductive plate 1225. In this case, a lower side surface of the inner magnet 1222 is connected to a bottom of the magnetic shield 1221, and an upper side surface of the inner magnet 1222 is con-

nected to a first magnetic conductive plate 1224. Through the design of the upper fixing bracket 128-1 and the lower fixing bracket 128-2, the frame 125 may be omitted, allowing the magnetic circuit assembly 122 to have a larger design dimension, thereby further increasing a volume of the magnets (e.g., the inner magnet 1222, the outer magnet 1223, or the like), to further increase the driving force of the speaker 120.

[0318] In some embodiments, a material of the upper fixing bracket 128-1 and the lower fixing bracket 128-2 may be a plastic material; correspondingly, the fixing brackets may be connected to corresponding magnetic conductive plates through injection molding, adhesive bonding, bolts, buckles, or the like. In some embodiments, a material of the upper fixing bracket 128-1 and the lower fixing bracket 128-2 may also be a metal material; correspondingly, the fixing brackets may be connected to the corresponding magnetic conductive plates through adhesive bonding, welding, bolts, buckles, or the like.

[0319] In some embodiments, an outer magnetic conductive plate corresponding to the outer magnet 1223 (e.g., the second magnetic conductive plate 1225, the third magnetic conductive plate 1226, the extension portion 12213, or the like) may include two interconnected members, wherein one of the members is configured to be connected to a corresponding fixing bracket, and the other one of the members is configured to be connected to the outer magnet 1223. In some embodiments, the two aforementioned members may be separately connected, or may be integrally formed.

[0320] FIG. 68A is schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure. Referring to FIG. 68A, in some embodiments, the magnetic circuit assembly 122 may further include a magnetic circuit fixing ring 129. The magnetic circuit fixing ring 129 is sleeved on an outer side of the upper fixing bracket 128-1 and the lower fixing bracket 128-2, as shown in FIG. 68A. By connecting the fixing brackets, the corresponding outer magnetic conductive plates (e.g., the second magnetic conductive plate 1225, the third magnetic conductive plate 1226, the extension portion 12213, or the like), and the outer magnet 1223 into an integral unit through the magnetic circuit fixing ring 129, installation stability of the magnetic circuit assembly 122 is further enhanced, thereby enhancing vibration stability of the speaker 120. In some embodiments, the magnetic circuit fixing ring 129 and the corresponding fixing brackets may be separately connected, or may be integrally formed.

[0321] FIG. 68B is a schematic diagram illustrating another internal structure of a speaker according to some embodiments of the present disclosure. Referring to FIG. 68B, in some embodiments, the magnetic circuit assembly 122 may not be provided with the upper fixing bracket 128-1 and the lower fixing bracket 128-2,

but instead, the magnetic circuit fixing ring 129 replaces the upper fixing bracket 128-1 and the lower fixing bracket 128-2, and directly assembles and fixes the magnetic circuit assembly 122 through the magnetic circuit fixing ring 129, thereby reducing the assembly difficulty.

[0322] In some embodiments, a material of the magnetic circuit fixing ring 129 may be the same as the material of the upper fixing bracket 128-1 and the lower fixing bracket 128-2. A connection manner between the magnetic circuit fixing ring and the corresponding fixing brackets or the corresponding outer magnetic conductive plates may be the same as a connection manner between the corresponding fixing brackets and the corresponding outer magnetic conductive plates.

[0323] FIG. 69A is a schematic diagram illustrating a structure of a speaker including a magnetic circuit fixing ring according to some embodiments of the present disclosure; FIG. 69B is a schematic diagram illustrating a structure of the speaker shown in FIG. 69A from another perspective; FIG. 70A is a schematic diagram illustrating another structure of a speaker including a magnetic circuit fixing ring according to some embodiments of the present disclosure; and FIG. 70B is a schematic diagram illustrating a structure of the speaker shown in FIG. 70A from another perspective.

[0324] Referring to FIGS. 69A and 69B, in some embodiments, the magnetic circuit fixing ring 129 may include two ring-shaped sub-rings. The two sub-rings are respectively arranged on upper and lower sides of the outer magnet 1223, to respectively install and fix the upper and lower sides of the outer magnet 1223 and the corresponding outer magnetic conductive plates, fixing brackets, or the like.

[0325] Referring to FIGS. 70A and 70B, in some embodiments, the magnetic circuit fixing ring 129 may include two semi-ring-shaped sub-rings. A spaced position of the two sub-rings may be arranged in a short side direction of the speaker 120. In this case, the sub-rings may install and fix a long side portion of the outer magnetic conductive plate, a corresponding long side portion of the outer magnet 1223, and a corresponding long side portion of the fixing brackets. In other embodiments, a spaced position of the two sub-rings may also be arranged in a long side direction of the speaker 120. In this case, the sub-rings may install and fix a short side portion and a partial long side portion of the outer magnetic conductive plate, a corresponding short side portion and a partial corresponding long side portion of the outer magnet 1223, and a corresponding short side portion and a partial corresponding long side portion of the fixing brackets.

[0326] Basic concepts have been described above. Clearly, to a person skilled in the art, the detailed disclosure above is merely by way of example and does not constitute a limitation on the present disclosure. Although not explicitly stated herein, a person skilled in the art may make various modifications, improvements,

and amendments to the present disclosure. Such modifications, improvements, and amendments are suggested in the present disclosure, thus, such modifications, improvements, and amendments still fall within the spirit and scope of exemplary embodiments of the present disclosure.

[0327] Meanwhile, the present disclosure uses specific terms to describe embodiments of the present disclosure. For example, 'an embodiment,' 'one embodiment,' and/or 'some embodiments' refer to a certain feature, structure, or characteristic related to at least one embodiment of the present disclosure. Therefore, it should be emphasized and noted that 'one embodiment,' 'an embodiment,' or 'an alternative embodiment' mentioned twice or more in different locations in the present disclosure do not necessarily refer to the same embodiment. Furthermore, certain features, structures, or characteristics in one or more embodiments of the present disclosure may be combined appropriately.

[0328] Similarly, it should be noted that to simplify the description of the present disclosure, thereby facilitating understanding of one or more inventive embodiments, in the preceding description of embodiments of the present disclosure, various features are sometimes grouped into a single embodiment, figure, or description thereof. However, this method of disclosure does not mean that the present disclosure requires more features than those recited in the claims. Indeed, features of an embodiment may be fewer than all the features of the single embodiment disclosed above.

[0329] In some embodiments, numbers are used to describe quantities of components and attributes, and it should be understood that such numbers used for the description of the embodiments are modified by the term 'approximately' in some examples. Unless otherwise specified, 'approximately' or 'about' indicates that the stated number allows a variation of $\pm 20\%$. Accordingly, in some embodiments, numerical parameters used in the present disclosure and the claims are all approximate values, and these approximate values may vary depending on characteristics required by individual embodiments. In some embodiments, numerical parameters should consider specified significant digits and adopt a general method of digit retention. Although numerical ranges and parameters used in some embodiments of the present disclosure to define the breadth of their scope are approximate values, in specific embodiments, the setting of these numerical values is as precise as possible within a feasible range.

[0330] Finally, it should be understood that the embodiments described in the present disclosure are merely for illustrating principles of embodiments of the present disclosure. Other variations may also fall within the scope of the present disclosure. Therefore, by way of example and not limitation, alternative configurations of embodiments of the present disclosure may be regarded as being consistent with the teachings of the present disclosure. Accordingly, embodiments of the

present disclosure are not limited to the embodiments expressly introduced and described herein.

Claims

1. A speaker, comprising:

a magnetic circuit assembly;
 a voice coil assembly, at least a portion of a voice coil being located within a magnetic gap of the magnetic circuit assembly;
 a first diaphragm and a second diaphragm, the first diaphragm and the second diaphragm being spaced apart in a vibration direction;
 at least one of the first diaphragm and the second diaphragm being connected to the voice coil assembly,
 the voice coil assembly being configured to drive the first diaphragm and the second diaphragm to vibrate synchronously in the same direction;
 wherein the voice coil assembly includes a first voice coil and a second voice coil arranged along the vibration direction, the first diaphragm is connected to the first voice coil, the second diaphragm is connected to the second voice coil, the first voice coil and the second voice coil are connected via a third connecting member, and the first voice coil and the second voice coil respectively drive the first diaphragm and the second diaphragm to vibrate synchronously in the same direction.

2. The speaker of claim 1, wherein the third connecting member includes a frame, the frame includes a first portion and a second portion that are integrally formed, the first voice coil is arranged on an outer peripheral side or an inner peripheral side of the first portion, and the second voice coil is arranged on an outer peripheral side or an inner peripheral side of the second portion.

3. The speaker of claim 1, wherein the third connecting member includes two frames interconnected with each other, the first voice coil is arranged on an outer peripheral side or an inner peripheral side of one of the frames, and the second voice coil is arranged on an outer peripheral side or an inner peripheral side of the other one of the frames.

4. The speaker of claim 3, wherein the two frames are directly connected.

5. The speaker of claim 3, wherein the third connecting member further includes a sub-connecting portion, and the two frames are connected via the sub-connecting portion.

6. The speaker of claim 1, wherein on a reference plane perpendicular to the vibration direction, a gap exists between an orthographic projection of the first voice coil and an orthographic projection of the second voice coil to form a clearance channel allowing the magnetic circuit assembly to pass through the voice coil assembly;
 or, on another reference plane parallel to the vibration direction, a gap exists between an orthographic projection of the first voice coil and an orthographic projection of the second voice coil to form the clearance channel.

7. The speaker of claim 6, wherein the speaker comprises a long axis direction and a short axis direction, each of the first voice coil and the second voice coil includes a long side wall parallel to the long axis direction and a short side wall parallel to the short axis direction; wherein:

a dimension of the short side wall of the first voice coil is the same as a dimension of the short side wall of the second voice coil, and a dimension of the long side wall of the first voice coil is different from a dimension of the long side wall of the second voice coil;
 or, the dimension of the short side wall of the first voice coil is different from the dimension of the short side wall of the second voice coil, and the dimension of the long side wall of the first voice coil is the same as the dimension of the long side wall of the second voice coil;
 or, the dimension of the short side wall of the first voice coil is different from the dimension of the short side wall of the second voice coil, and the dimension of the long side wall of the first voice coil is different from the dimension of the long side wall of the second voice coil.

8. The speaker of claim 6, wherein the magnetic circuit assembly includes an inner magnet and a magnetic shield, the magnetic shield includes a bottom wall and side walls located at two ends of the bottom wall, a top end of each of the side walls is provided with an extension portion, the inner magnet is arranged on the bottom wall, and the side walls pass through the clearance channel so that extension portions extend outside the voice coil assembly.

9. The speaker of claim 8, wherein the side walls are hollowed out; or a material of the side walls includes a non-magnetic material.

10. The speaker of claim 8, wherein four peripheral corners of the bottom wall are respectively provided with a stepped structure.

11. The speaker of claim 8, wherein a connecting position between each of the side walls and the bottom wall and a connecting position between each of the side walls and the extension portion are provided with a rounded transition.
12. The speaker of claim 8, wherein the bottom wall is provided with a reinforcing member.
13. The speaker of claim 1, wherein the magnetic circuit assembly includes a magnetic shield and an inner magnet, the magnetic shield includes a side wall and a bottom wall, the side wall includes a folded structure, the folded structure includes an inner side wall and an outer side wall, the bottom wall is connected to the inner side wall, a first magnetic gap is formed between the inner side wall and the inner magnet, a second magnetic gap is formed between the inner side wall and the outer side wall, at least a portion of the first voice coil is located within the first magnetic gap, and at least a portion of the second voice coil is located within the second magnetic gap.
14. The speaker of claim 13, wherein the outer side wall includes an outer magnet, the first magnetic gap is formed between the inner magnet and the inner side wall, and the second magnetic gap is formed between the outer magnet and the inner side wall.
15. The speaker of claim 14, wherein a magnetization direction of the inner magnet is the same as a magnetization direction of the outer magnet, the speaker comprises a long axis direction and a short axis direction, and in the short axis direction or in the long axis direction, a ratio of a thickness of the inner side wall to a dimension of the magnetic shield is 0.05-0.16.
16. The speaker of claim 14, wherein a magnetization direction of the inner magnet is opposite to a magnetization direction of the outer magnet, and a thickness of the inner side wall is less than or equal to 0.4 mm.
17. The speaker of claim 16, wherein the inner side wall is hollowed out.
18. The speaker of claim 13, wherein the inner side wall includes a first outer magnet, the outer side wall includes a second outer magnet, the first magnetic gap is formed between the inner magnet and the first outer magnet, and the second magnetic gap is formed between the first outer magnet and the second outer magnet.
19. The speaker of any one of claims 14-18, wherein in a short axis direction or in a long axis direction, a ratio of a dimension of the inner magnet to a thickness of the outer magnet is between 1.7 and 33.
20. The speaker of claim 19, wherein in the long axis direction, the ratio of the dimension of the inner magnet to the thickness of the outer magnet is less than or equal to 6.7; and in the short axis direction, the ratio of the dimension of the inner magnet to the thickness of the outer magnet is less than or equal to 2.7.
21. The speaker of claim 1, wherein the speaker further comprises a bracket assembly, the bracket assembly surrounds a periphery of the voice coil assembly, and the bracket assembly and the voice coil assembly are spaced apart in a radial direction perpendicular to the vibration direction; each of the first diaphragm and the second diaphragm includes a surround, a center patch, and a fixing ring, the surround is connected around an outer periphery of the center patch, and the center patch is connected to the voice coil assembly; a portion of the surround away from the center patch in the radial direction is connected to the fixing ring, and the fixing ring is connected to the bracket assembly; wherein the surround includes a first connecting portion, a surround portion connected around an outer periphery of the first connecting portion, and a second connecting portion connected around an outer periphery of the surround portion; wherein in the vibration direction, an inner surface of the first connecting portion facing the voice coil assembly is connected to an outer surface of the center patch facing away from the voice coil assembly, and an inner surface of the second connecting portion facing the voice coil assembly is connected to the bracket assembly.
22. The speaker of claim 21, wherein the diaphragm further includes a third connecting portion and a fourth connecting portion, one end of the third connecting portion in the vibration direction is connected to a junction of the surround portion and the first connecting portion, and one end of the fourth connecting portion in the vibration direction is connected to a junction of the surround portion and the second connecting portion; wherein in the radial direction, an inner circumferential surface of the third connecting portion facing the voice coil assembly is connected to a circumferential surface of the center patch, and an outer circumferential surface of the fourth connecting portion away from the voice coil assembly is connected to an inner circumferential surface of the fixing ring facing the voice coil assembly.
23. The speaker of claim 22, wherein in the radial di-

- rection, a distance between an outer circumferential surface of the third connecting portion away from the voice coil assembly and the inner circumferential surface of the third connecting portion facing the voice coil assembly is a first width, a distance between the outer circumferential surface of the third connecting portion and the outer circumferential surface of the fourth connecting portion is a second width, and a ratio of the first width to the second width is between 0.04 and 0.32.
24. The speaker of claim 22, wherein in the radial direction, a distance between the inner circumferential surface of the third connecting portion and the outer circumferential surface of the fourth connecting portion is a third width, and a ratio of an average wall thickness of the surround portion to the third width is not greater than 0.12.
25. The speaker of claim 22, wherein in the vibration direction, a distance from the inner surface of the first connecting portion to a plane where the inner surface of the second connecting portion is located is a first height; in the radial direction, a distance between the inner circumferential surface of the third connecting portion and the outer circumferential surface of the fourth connecting portion is a third width, and a ratio of the first height to the third width is not greater than 0.232.
26. The speaker of claim 22, wherein the surround further includes a fifth connecting portion spaced apart from the first connecting portion in the vibration direction, and the third connecting portion is connected between the fifth connecting portion and the surround portion in the vibration direction; wherein in the vibration direction, an outer surface of the fifth connecting portion is attached and connected to an inner surface of the center patch, a portion of the inner surface of the center patch not attached to the fifth connecting portion is connected to the voice coil assembly, and a minimum distance between the fifth connecting portion and the voice coil assembly in the radial direction is not less than 0.5 mm.
27. The speaker of claim 21, wherein the surround portion is equally divided into a first arc region, a second arc region, and a third arc region in sequence by arc length in the radial direction, a ratio of an average wall thickness of the first arc region to an average wall thickness of the second arc region is not greater than 1.2, and a ratio of an average wall thickness of the third arc region to the average wall thickness of the second arc region is not greater than 1.2.
28. The speaker of claim 21, wherein the surround portion is curved and arched relative to the first connecting portion in the vibration direction toward a side away from the voice coil assembly; in the vibration direction, a distance from the inner surface of the first connecting portion to a plane where the inner surface of the second connecting portion is located is a first height, a distance from an apex of the surround portion to the plane where the inner surface of the second connecting portion is located is a second height, and a ratio of the first height to the second height is not greater than 0.36.
29. The speaker of claim 21, wherein a material of the surround includes a silicone material, and a material of the center patch includes at least one of magnesium-aluminum alloy, carbon fiber, aluminum-coated polymethacrylimide (PMI), and aluminum-coated polyethylene naphthalate (PEN).
30. The speaker of claim 29, wherein the center patch includes a central region and an edge region connected around an outer periphery of the central region; in the vibration direction, a height difference exists between a geometric center of the central region and a plane where the edge region is located; wherein the surround and the voice coil assembly are connected to the edge region.
31. The speaker of claim 30, wherein the center patch further includes a connection region, the connection region surrounds the central region and is connected between the central region and the edge region, and the connection region is inclined in the vibration direction.
32. An earphone, comprising a speaker of any one of claims 1-31, the earphone further comprising: a first housing, the speaker being arranged within the first housing; wherein:
in a wearing state, the first housing includes an inner side wall on a side facing an external auditory canal, and an outer side wall opposite to the inner side wall and on a side away from the external auditory canal, the inner side wall is provided with a first sound outlet hole, and the outer side wall is provided with a second sound outlet hole;
the first diaphragm of the speaker and the inner side wall form a first acoustic cavity communicating with the first sound outlet hole, and the second diaphragm of the speaker and the outer side wall form a second acoustic cavity communicating with the second sound outlet hole.
33. The earphone of claim 32, wherein the earphone

further comprises a limiting assembly, the limiting assembly is arranged between the speaker and the first housing;

the limiting assembly is provided with a sound guide hole, and on a reference plane perpendicular to the vibration direction, a projection of the sound guide hole, a projection of the first sound outlet hole, a projection of the second sound outlet hole, a projection of the first diaphragm, and a projection of the second diaphragm at least partially overlap.

34. The earphone of claim 33, wherein on the reference plane, the projection of the first sound outlet hole falls within the projection of the sound guide hole;

or on the reference plane, a projected area of an overlapping region between the projection of the first sound outlet hole and the projection of the sound guide hole is not less than 80% of a projected area of the projection of the sound guide hole.

35. The earphone of claim 32, wherein the limiting assembly is in elastic abutment with the first housing.

36. The earphone of claim 32, wherein the limiting assembly includes a second housing and a sealing ring, the second housing is disposed inside the first housing; the speaker is disposed inside the second housing and is fixedly connected to the second housing; the sealing ring is connected between the second housing and the first housing; and the sound guide hole is disposed on the second housing.

37. The earphone of claim 36, wherein the second housing includes a first cover and a second cover, one end of the speaker in the vibration direction extends into the first cover, and the other end of the speaker in the vibration direction extends into the second cover; wherein:

each of the first cover and the second cover includes a transverse side wall and a longitudinal side wall, the transverse side wall is spaced opposite to the first diaphragm or the second diaphragm in the vibration direction, and the longitudinal side wall surrounds and is fixedly connected to the speaker around the vibration direction;

the transverse side wall includes a central portion and an arc portion annularly connected to the central portion, at least a portion of the sound guide hole penetrates the central portion, and one end of the arc portion away from the central portion is connected to the longitudinal side wall.

38. The earphone of claim 32, wherein each of the first sound outlet hole and the second sound outlet hole is provided with an acoustic resistance mesh; and a ratio of a specific acoustic impedance of the acoustic resistance mesh of the second sound outlet hole to a specific acoustic impedance of the acoustic resistance mesh of the first sound outlet hole is not less than 10.

39. The earphone of claim 32, wherein on a reference plane perpendicular to the vibration direction, an area proportion of a projection of the second sound outlet hole and/or a projection of the first sound outlet hole in a projection of a corresponding side wall of the first housing is not less than 10%.

40. The earphone of claim 32, wherein the speaker includes a long axis direction, and in the long axis direction, a ratio of a dimension of the second sound outlet hole and/or a dimension of the first sound outlet hole to a dimension of the first housing is not less than 0.3.

41. The earphone of claim 32, wherein on a reference plane perpendicular to the vibration direction, a distance between a centroid of a projection of the second sound outlet hole and a centroid of a projection of a corresponding side wall of the first housing is not greater than 5 mm; and/or a distance between a centroid of a projection of the first sound outlet hole and a centroid of a projection of a corresponding side wall of the first housing is not greater than 5 mm.

42. The earphone of claim 32, wherein on a reference plane perpendicular to the vibration direction, a distance between a centroid of a projection of the second sound outlet hole and a centroid of a projection of the first sound outlet hole is not greater than 5 mm.

43. The earphone of claim 32, wherein on a reference plane perpendicular to the vibration direction, a ratio of a projected area of the second sound outlet hole to a projected area of the first sound outlet hole is 0.4-2.5.

44. The earphone of claim 32, wherein the first sound outlet hole and/or the second sound outlet hole is single non-concentrated opening.

45. The earphone of claim 32, wherein the first sound outlet hole and/or the second sound outlet hole is formed by a plurality of micro-holes arranged in an array.

46. The earphone of claim 45, wherein in the wearing state, an aperture of a micro-hole located in a re-

gion of the inner side wall directly facing the external auditory canal is larger than an aperture of micro-holes located in other regions of the inner side wall.

47. The earphone of claim 32, wherein the inner side wall is further provided with a sound tuning hole communicating with the first acoustic cavity. 5
48. The earphone of claim 47, wherein a minimum distance between the first sound outlet hole and the sound tuning hole is not greater than 14 mm, a minimum distance from a boundary of the first acoustic cavity to the first sound outlet hole is not greater than 14 mm, and a minimum distance from the boundary of the first acoustic cavity to the sound tuning hole is not greater than 14 mm. 10 15
49. The earphone of claim 47, wherein the first sound outlet hole and/or the sound tuning hole is formed by a plurality of micro-holes arranged in an array, and a minimum distance between any two adjacent micro-holes is not greater than 14 mm. 20
50. The earphone of claim 47, wherein a ratio of a total area of the sound tuning hole to a total area of the first sound outlet hole is less than 23%. 25
51. The earphone of claim 47, wherein the speaker includes a long axis direction, and on a reference plane perpendicular to the vibration direction, a projection of the first acoustic cavity includes a first region and a second region arranged along the long axis direction, a projection of the sound tuning hole on the reference plane is located in the first region, and a projection of the first sound outlet hole on the reference plane is located in the second region. 30 35
52. The earphone of claim 51, wherein a ratio of a length of the first region in the long axis direction to a length of the projection of the first acoustic cavity in the long axis direction is less than 40%. 40
53. The earphone of any one of claims 32-52, wherein a frequency response curve of a sound output to outside of the first housing through the first sound outlet hole has a first resonance peak and a second resonance peak adjacent to each other; wherein a peak resonance frequency of the first resonance peak is less than a peak resonance frequency of the second resonance peak, and a ratio of the peak resonance frequency of the second resonance peak to the peak resonance frequency of the first resonance peak is not less than 3. 45 50 55
54. The earphone of claim 53, wherein the peak resonance frequency of the first resonance peak is not

greater than 300 Hz.

55. The earphone of claim 54, wherein the peak resonance frequency of the second resonance peak is not less than 3.65 kHz.
56. The earphone of claim 53, wherein in a frequency band range from the peak resonance frequency of the first resonance peak to the peak resonance frequency of the second resonance peak, a sound pressure level of a sound output from the first sound outlet hole is greater than a sound pressure level of a sound output from the second sound outlet hole.

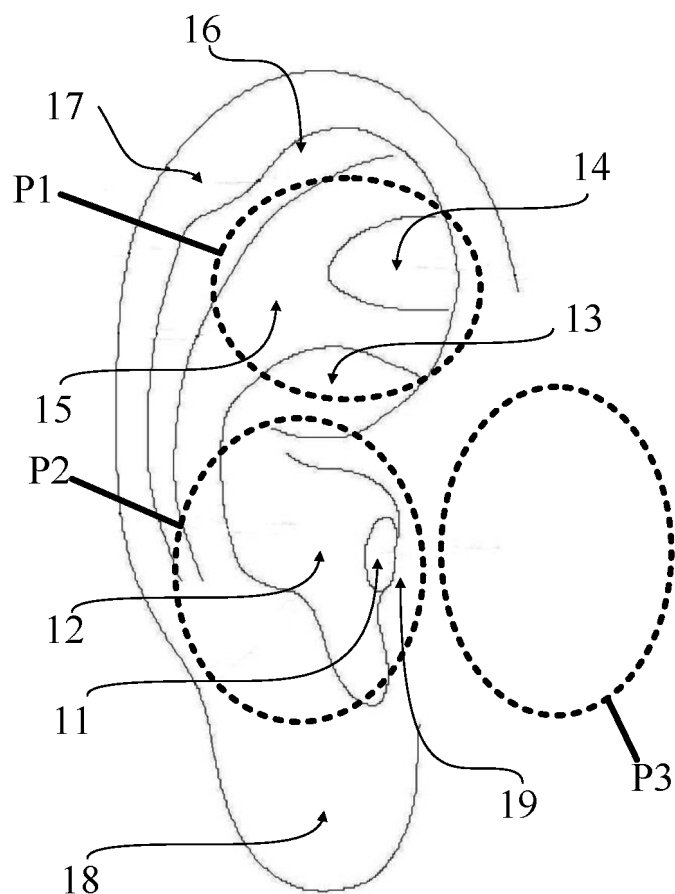


FIG. 1

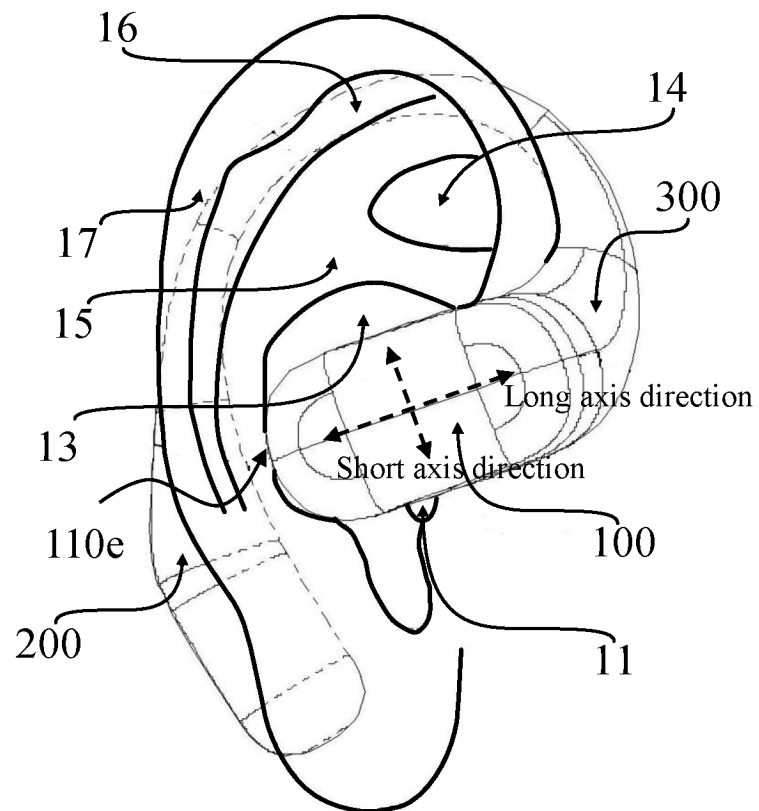


FIG. 2

100

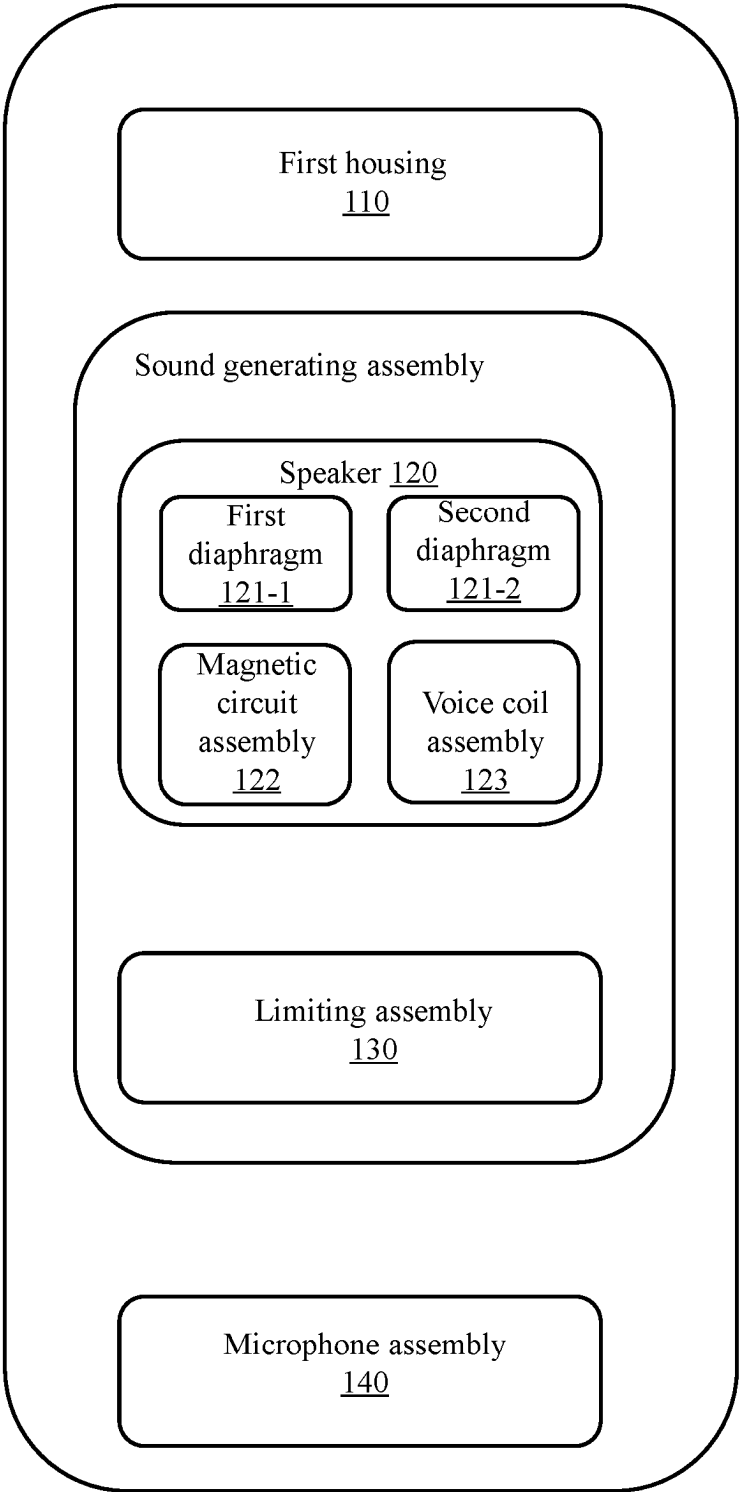


FIG. 3

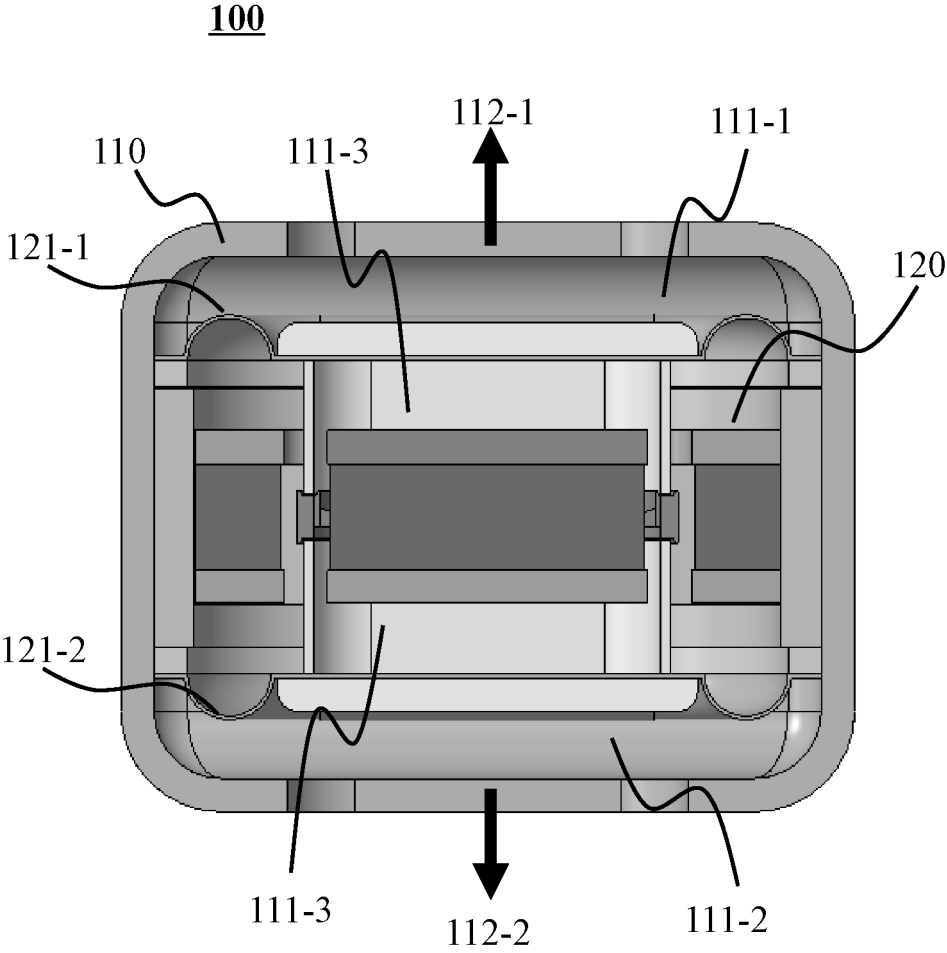


FIG. 4

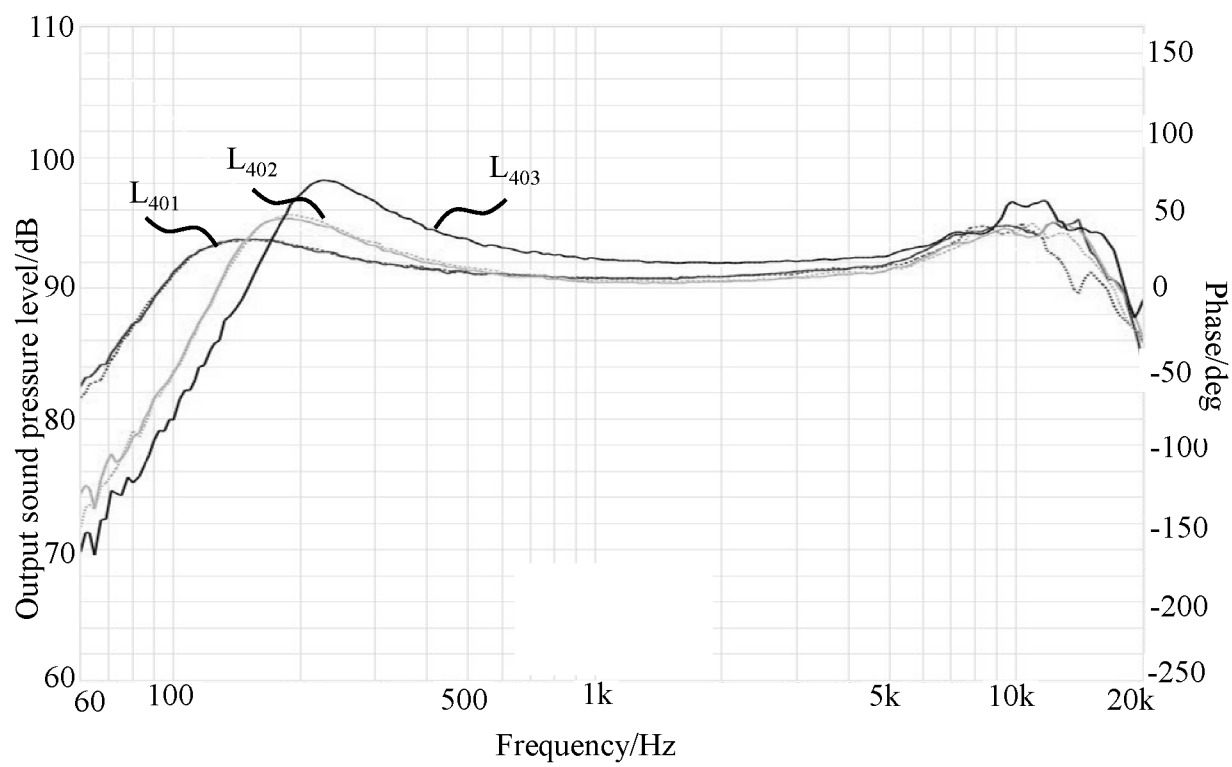


FIG. 5

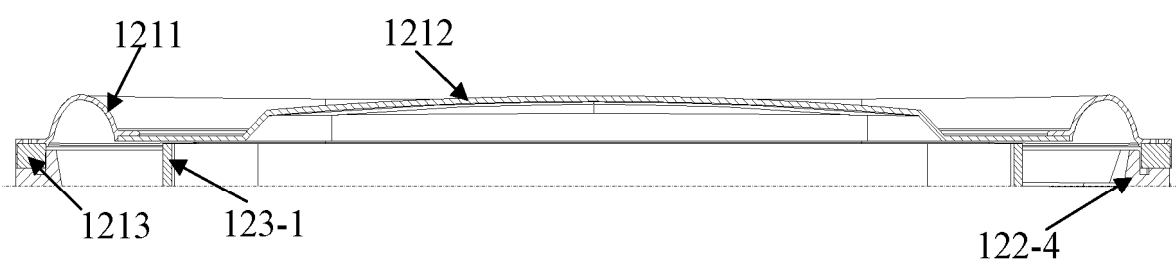


FIG. 6

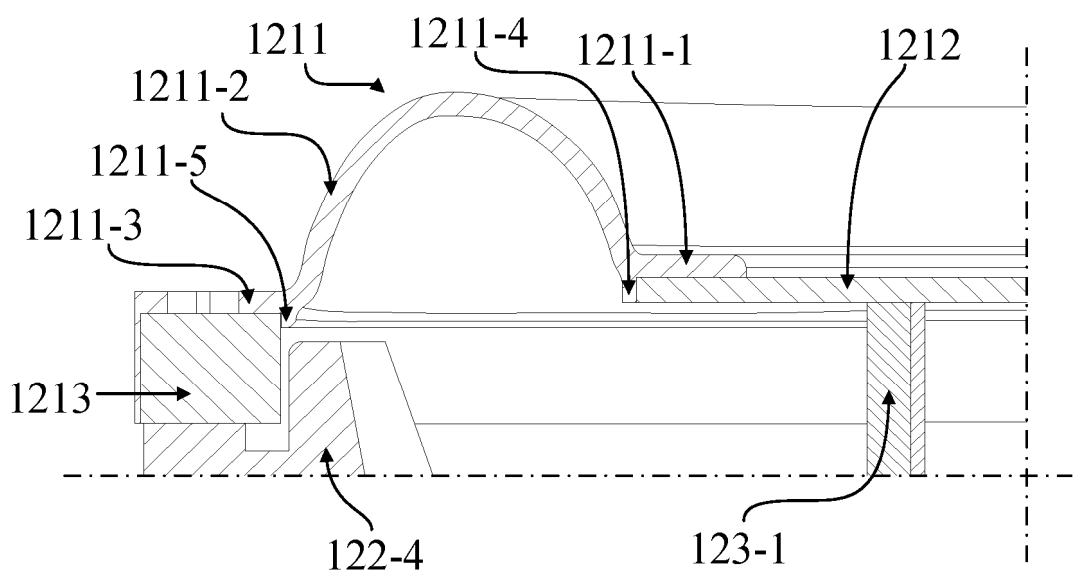


FIG. 7

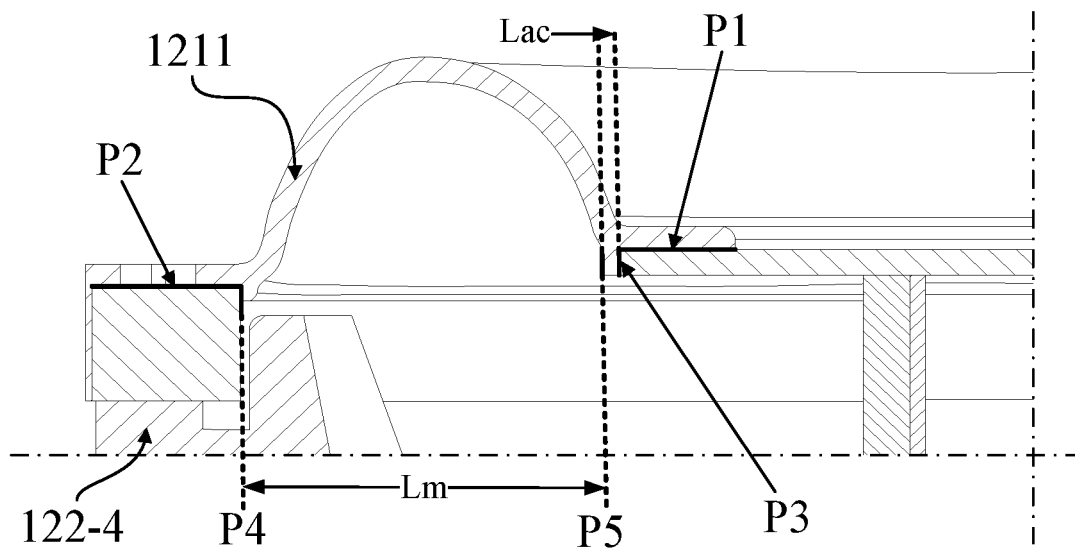


FIG. 8

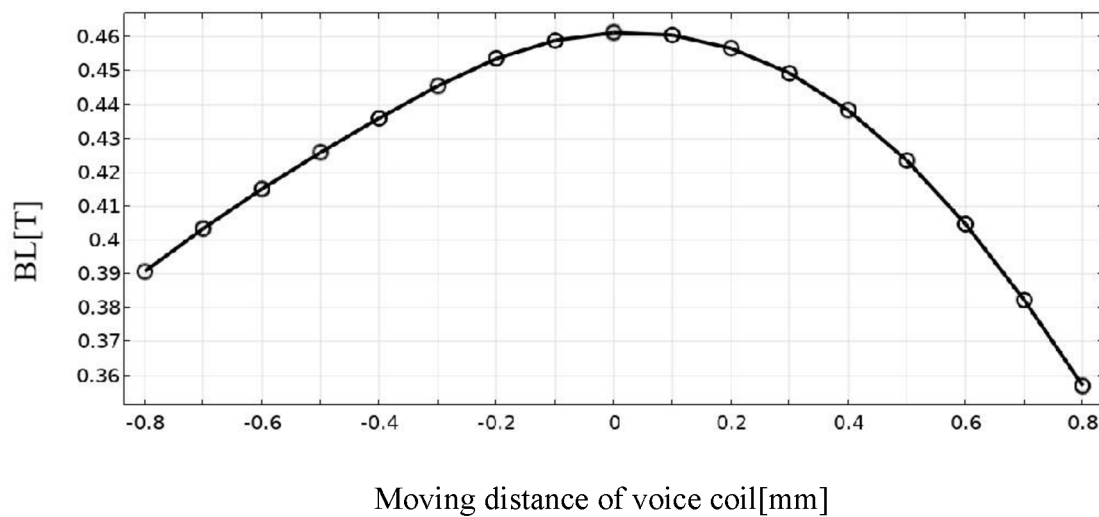


FIG. 9

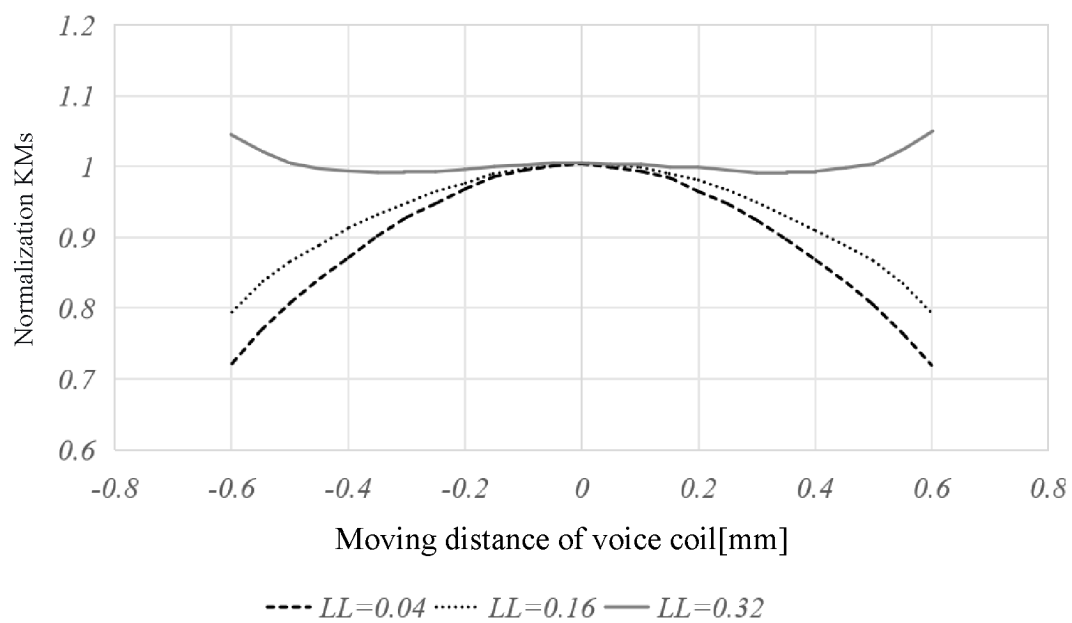


FIG. 10

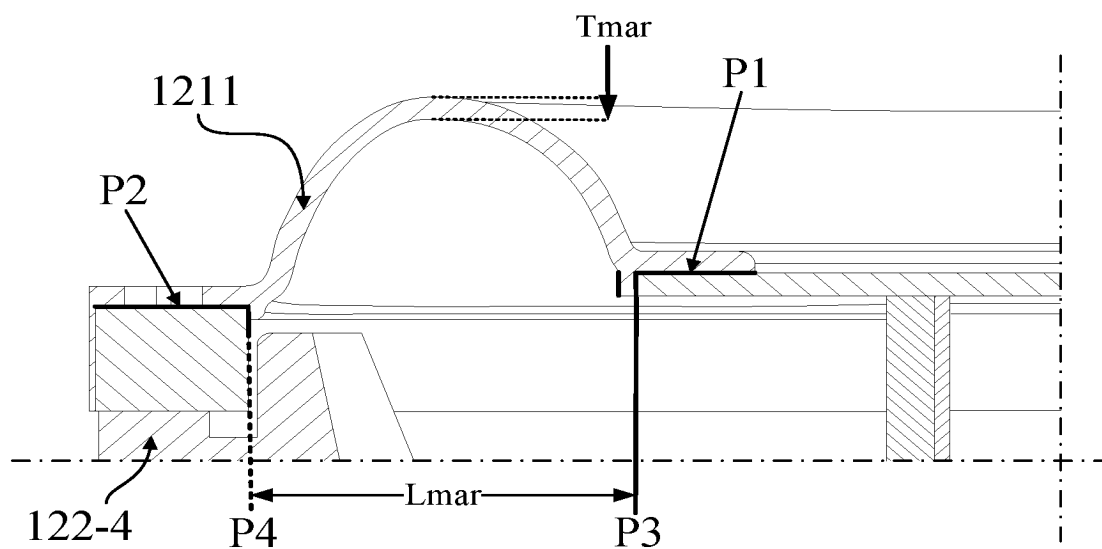


FIG. 11

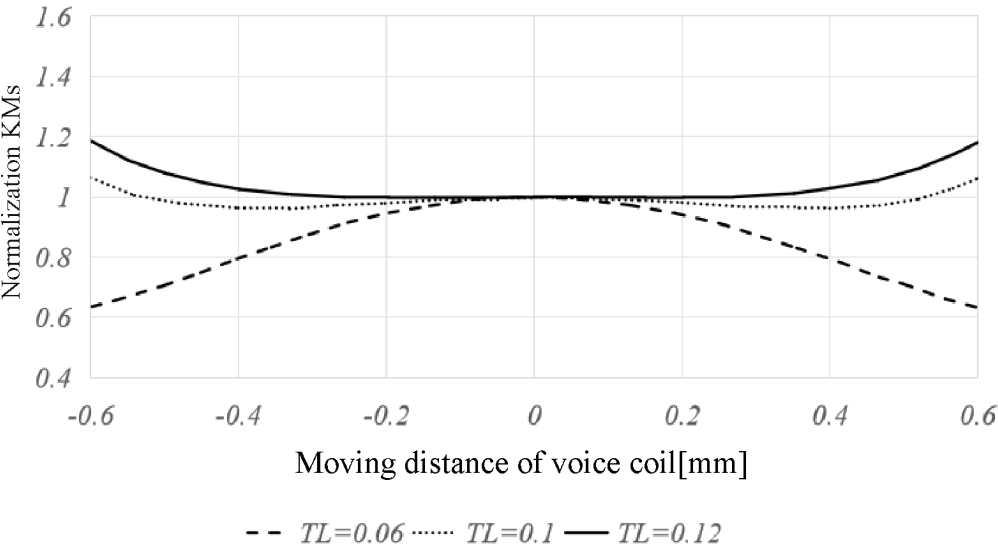


FIG. 12

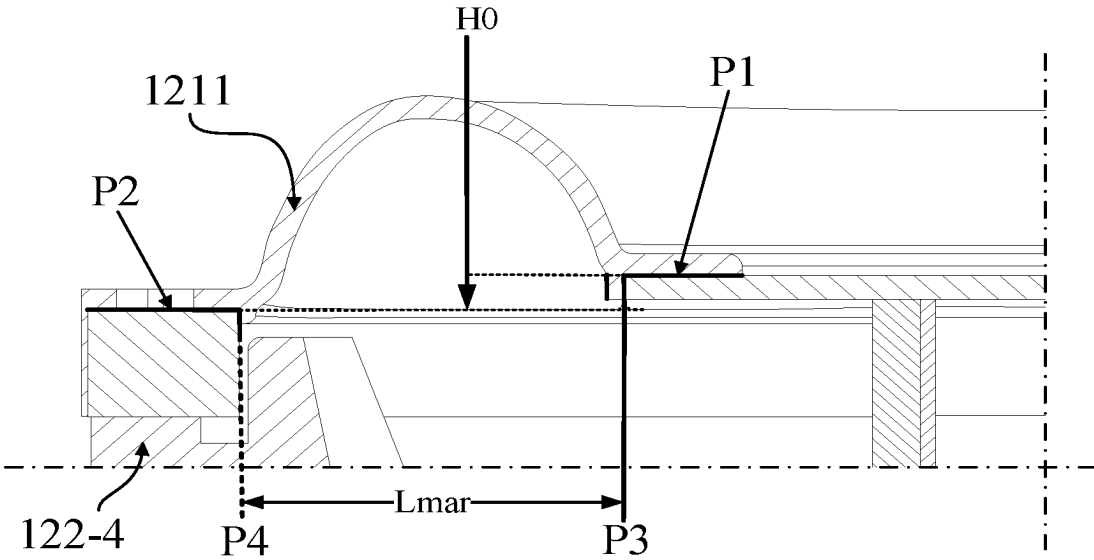


FIG. 13

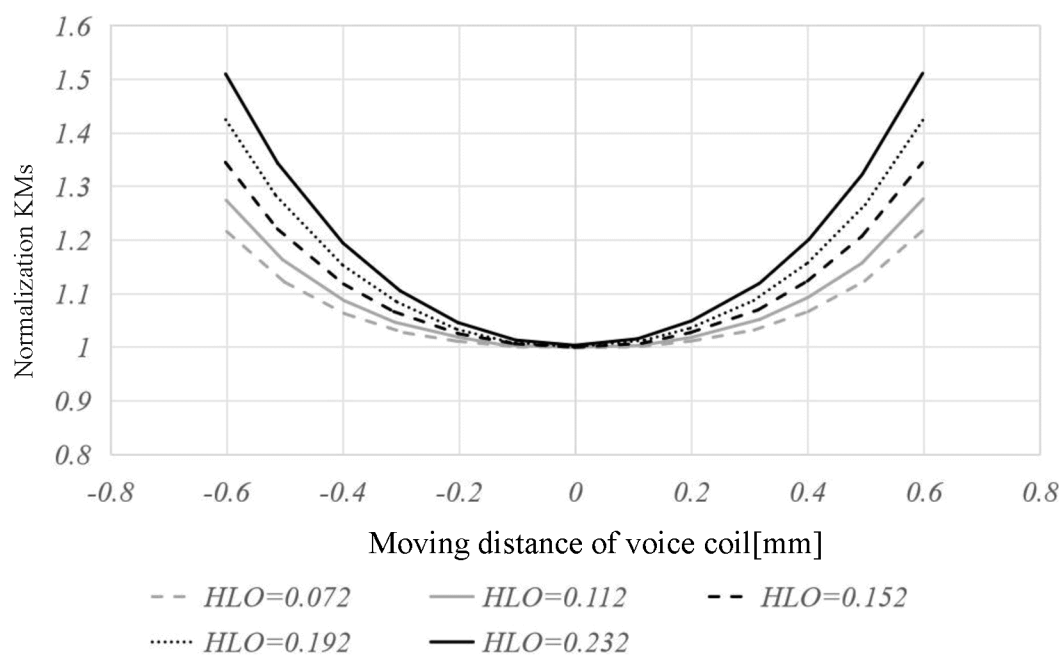


FIG. 14

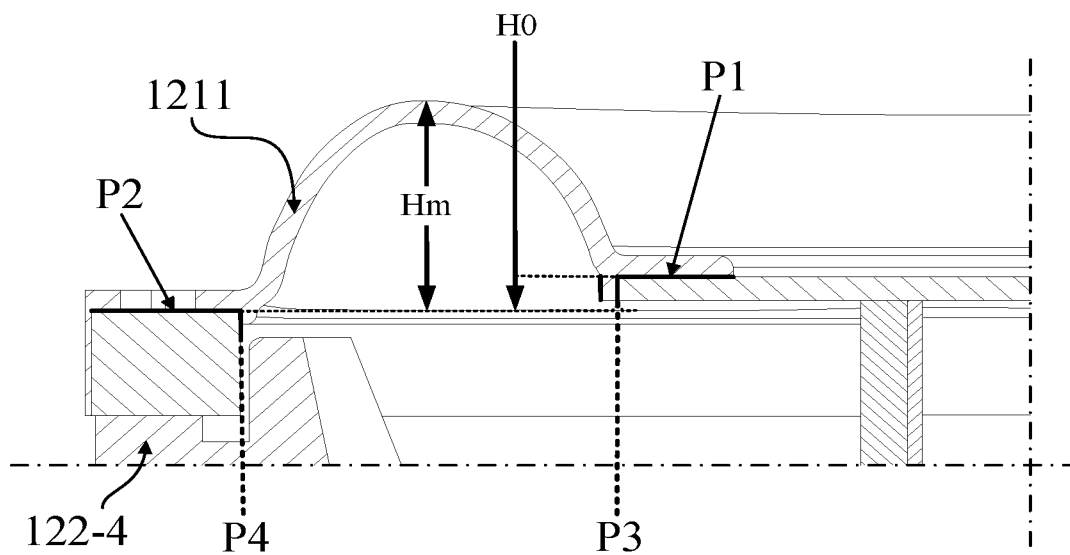


FIG. 15

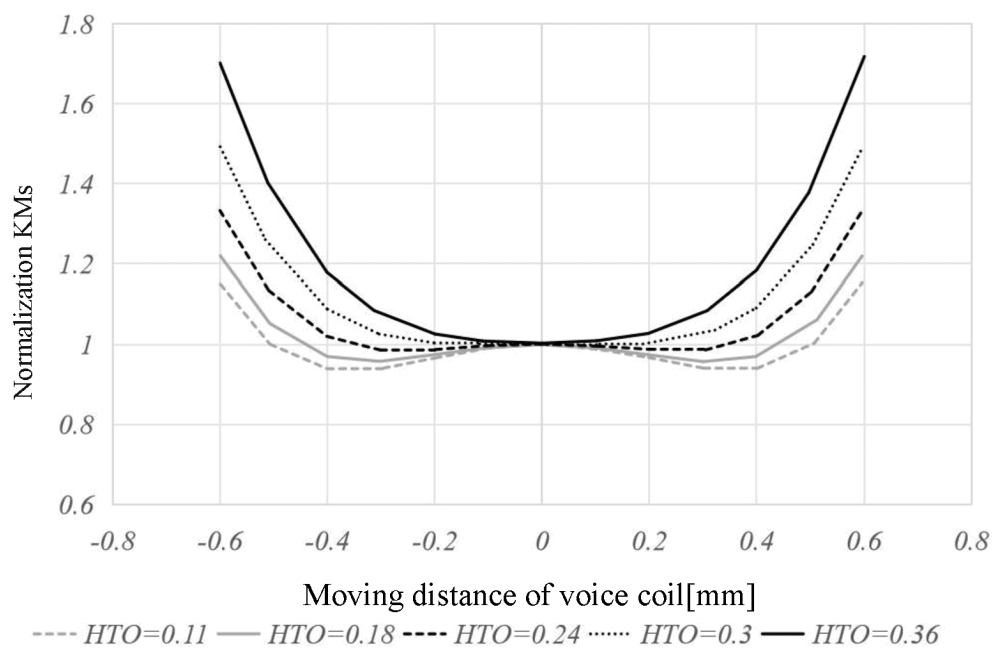


FIG. 16

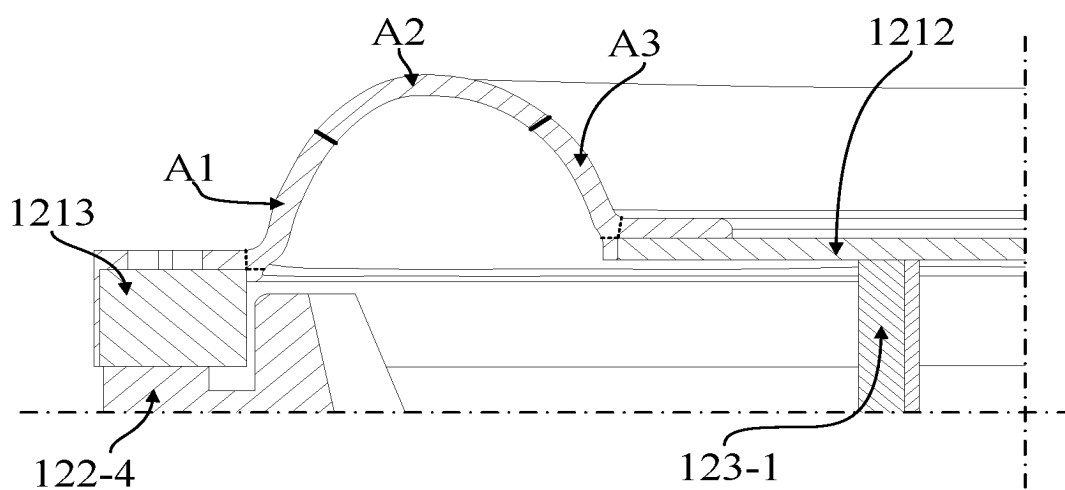


FIG. 17

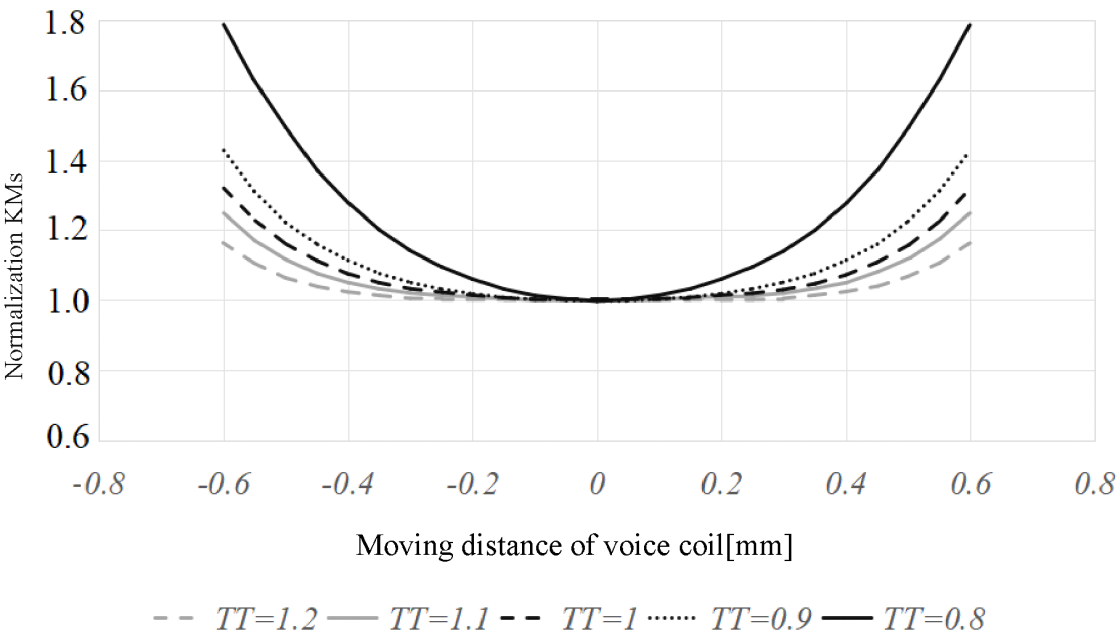


FIG. 18

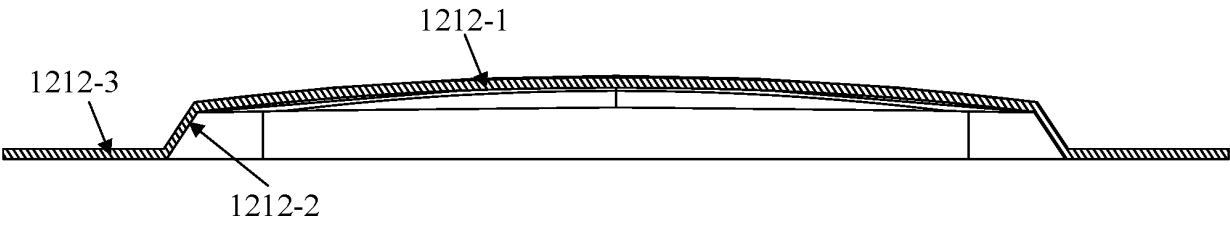


FIG. 19

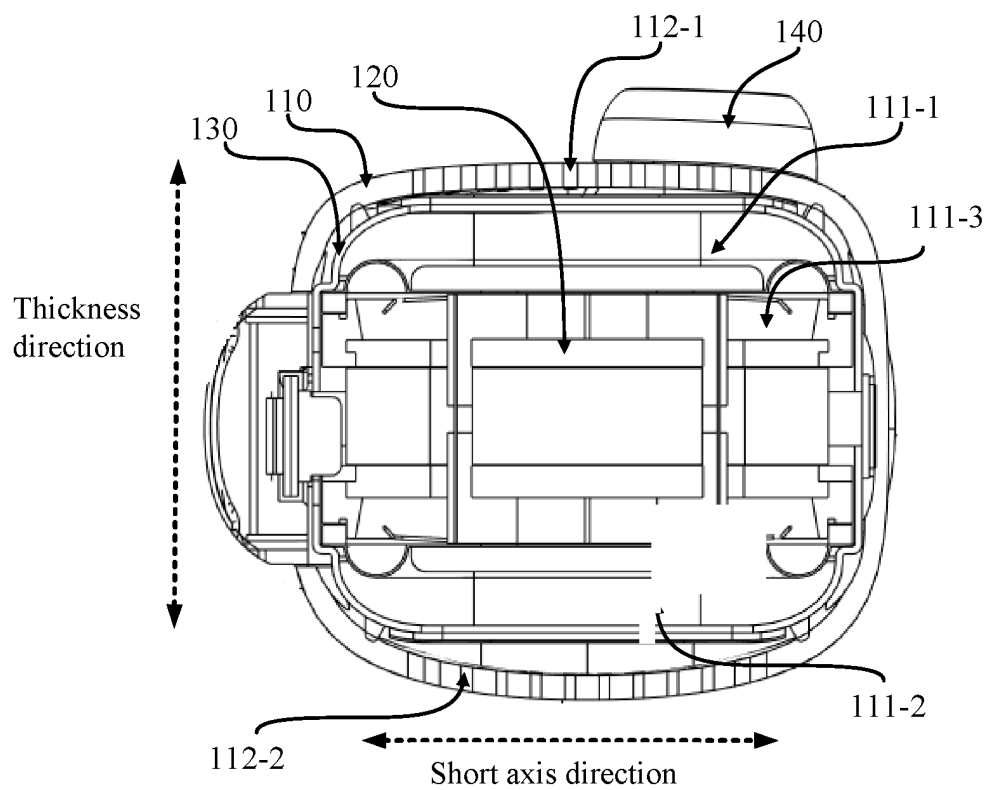


FIG. 20

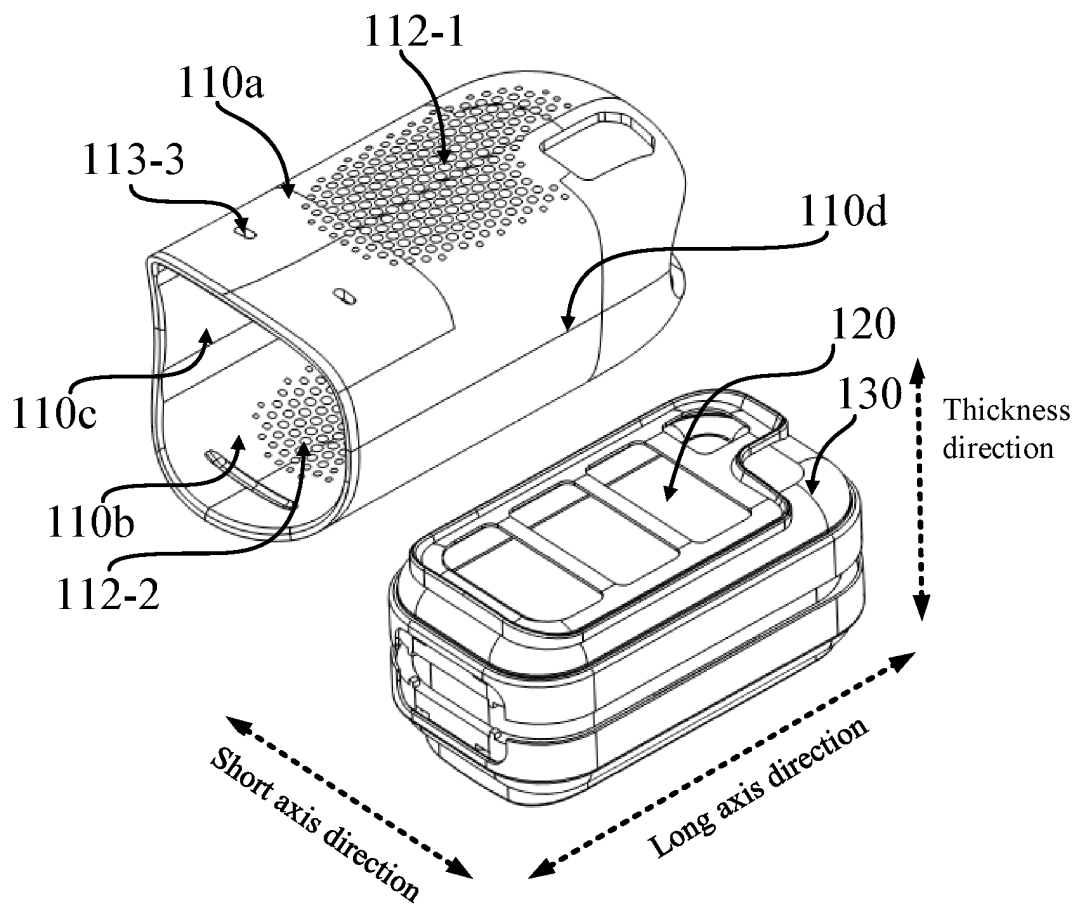


FIG. 21

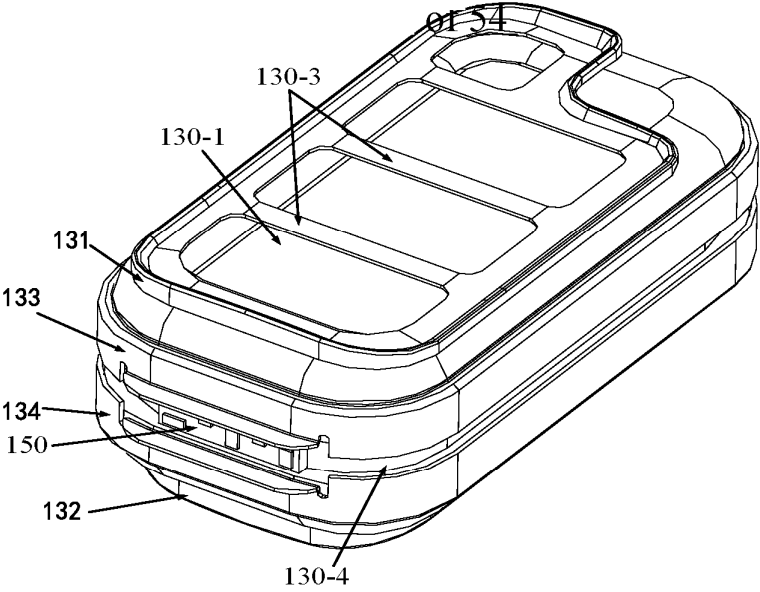


FIG. 22

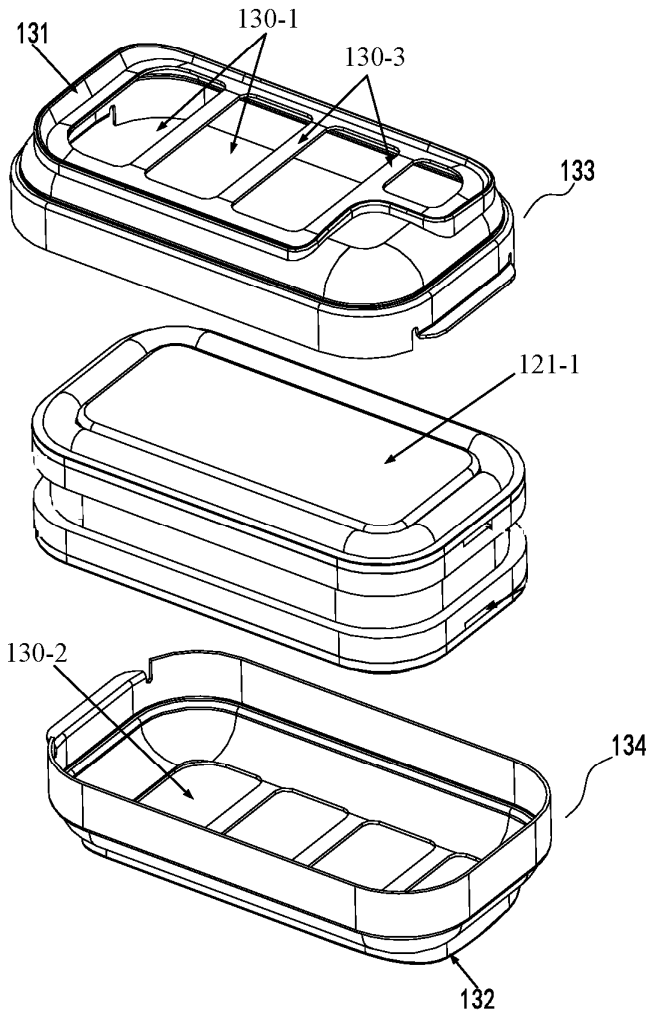


FIG. 23

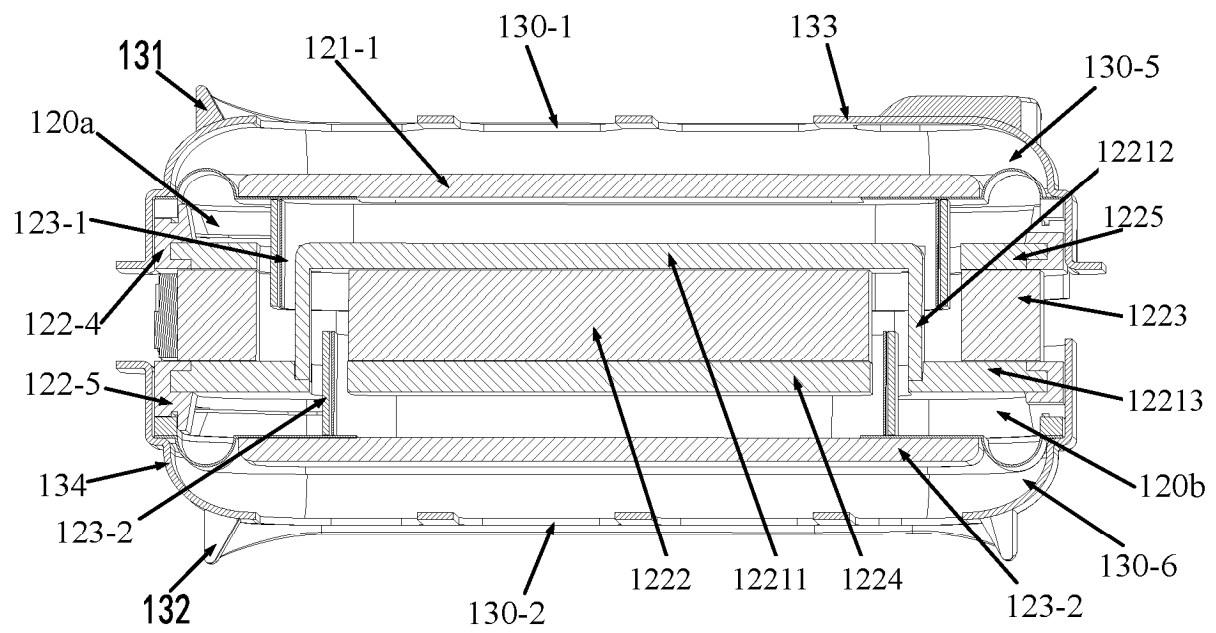


FIG. 24

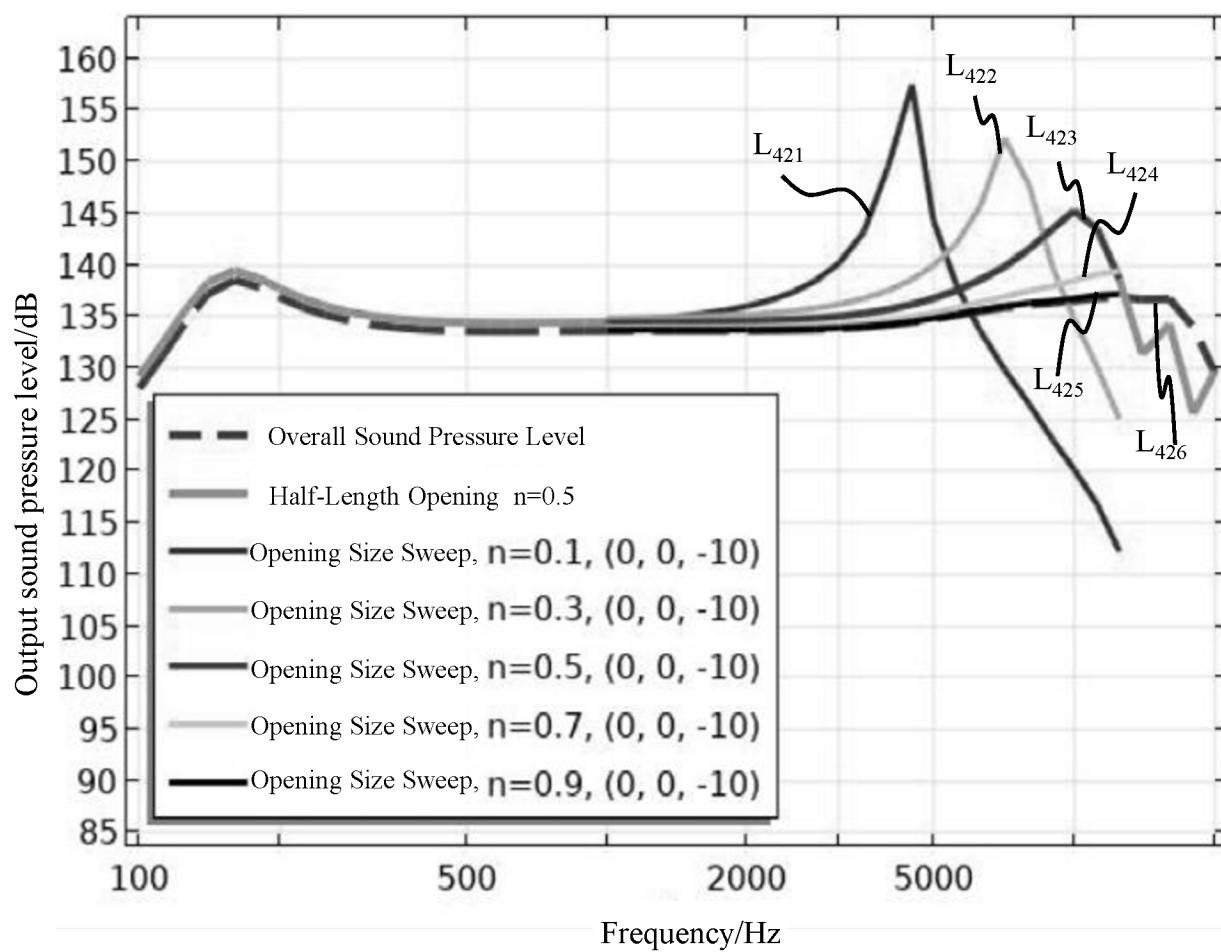


FIG. 25

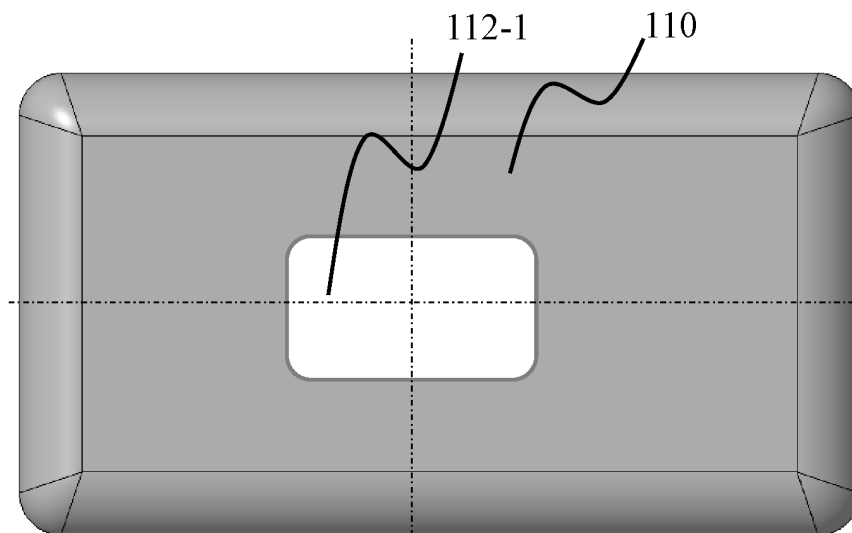


FIG. 26A

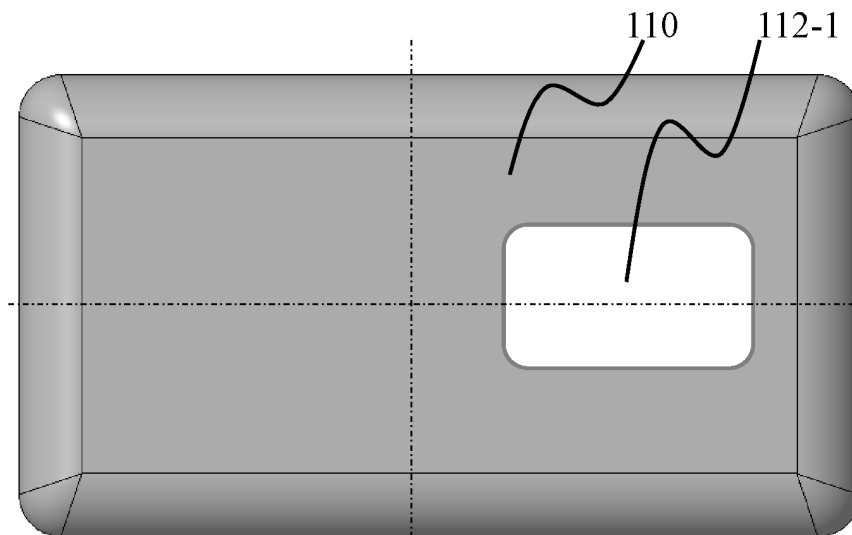


FIG. 26B

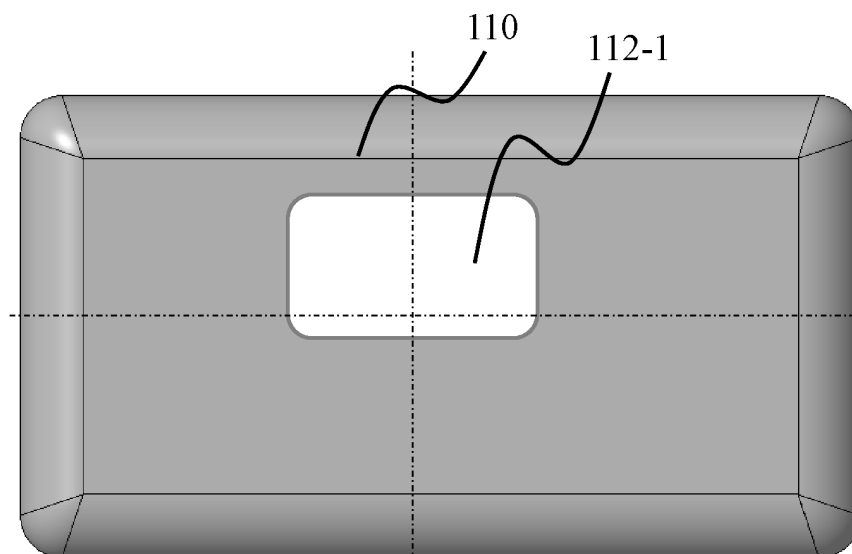


FIG. 26C

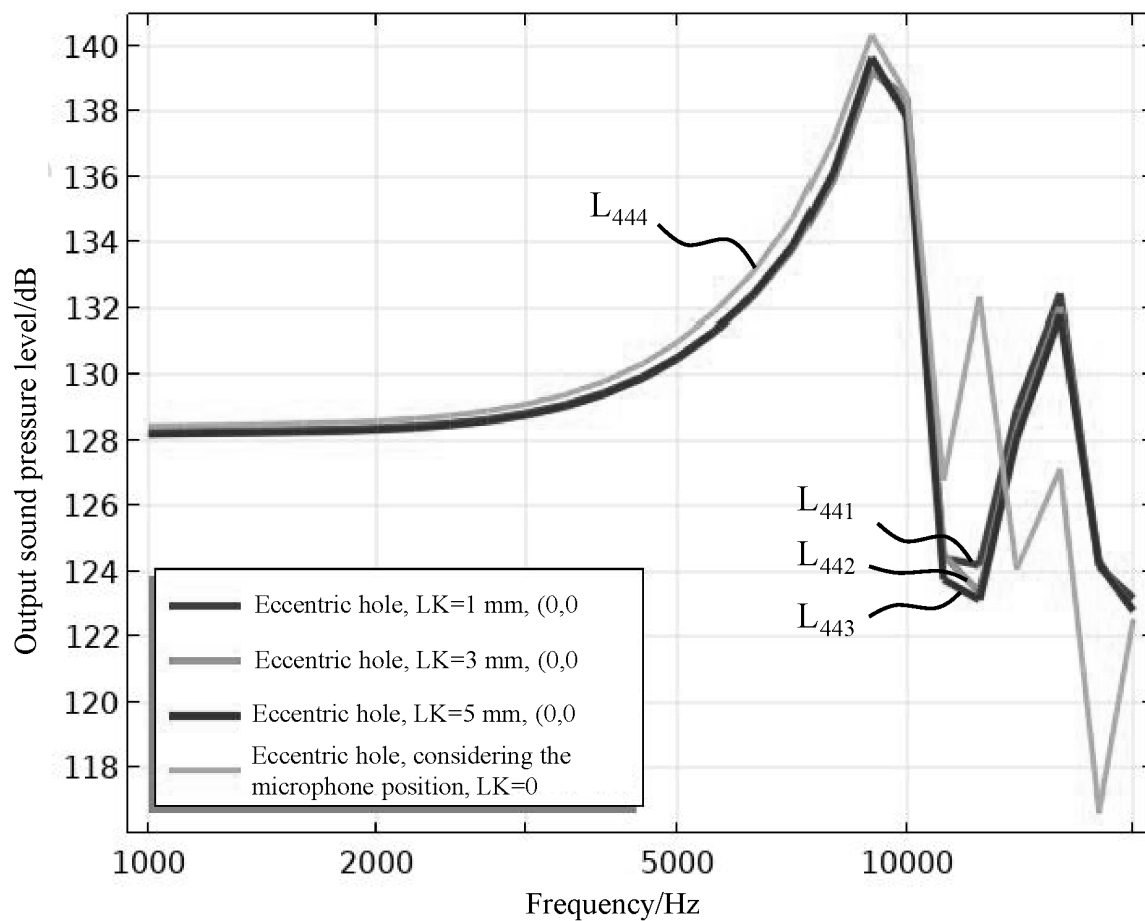


FIG. 27

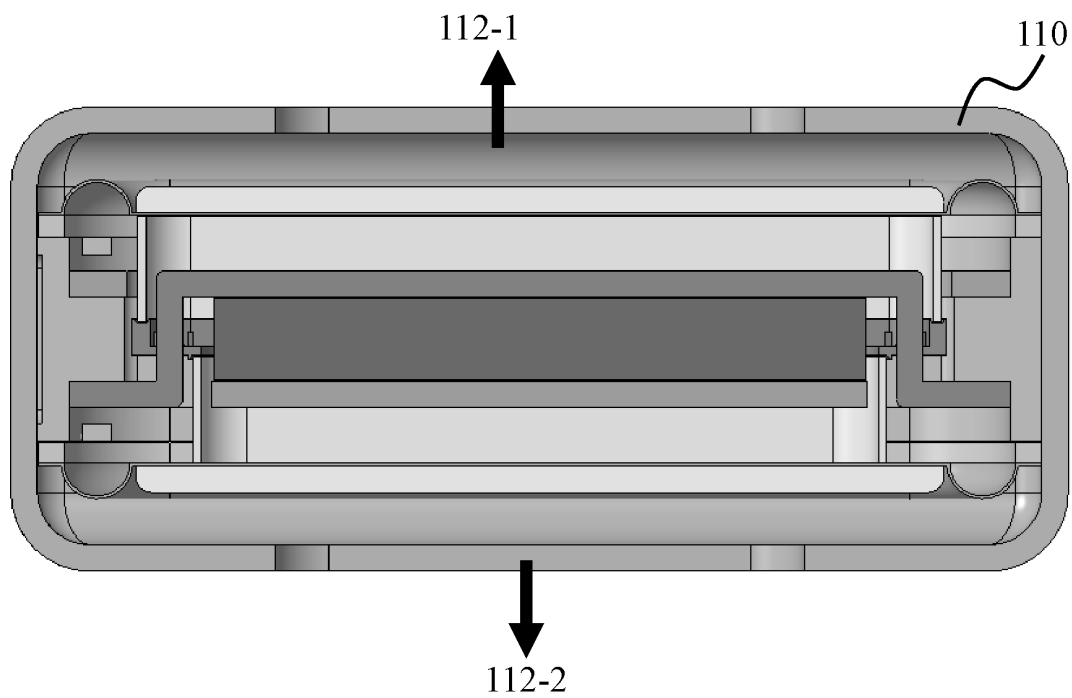


FIG. 28A

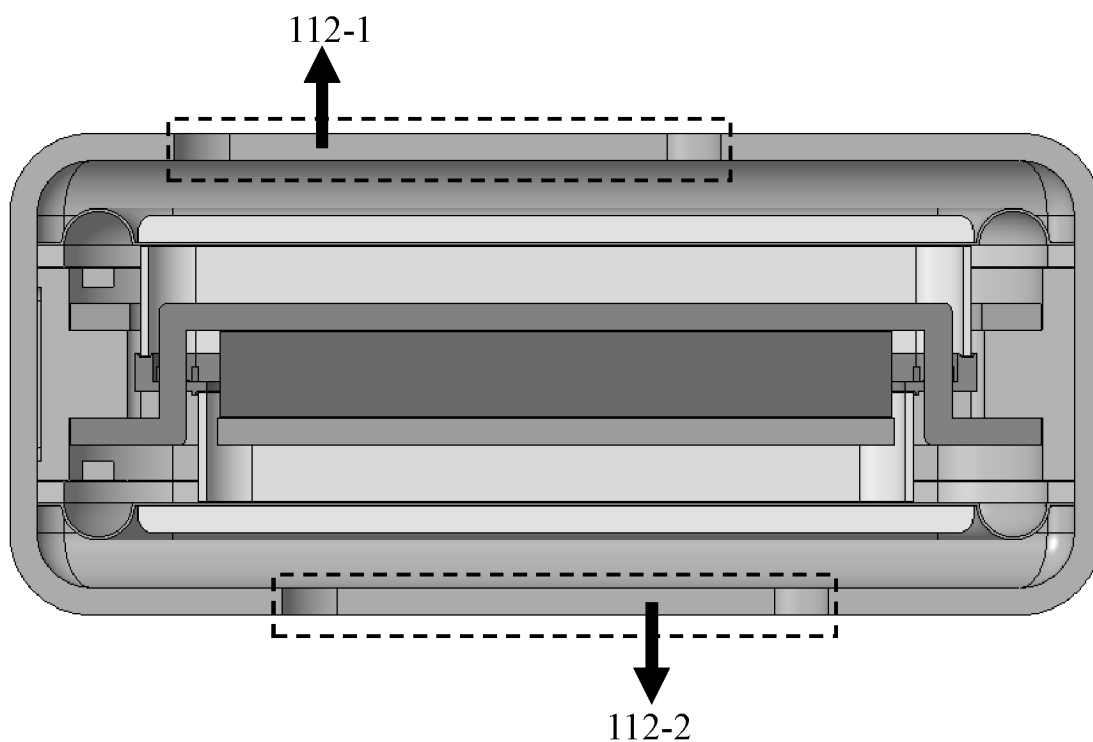


FIG. 28B

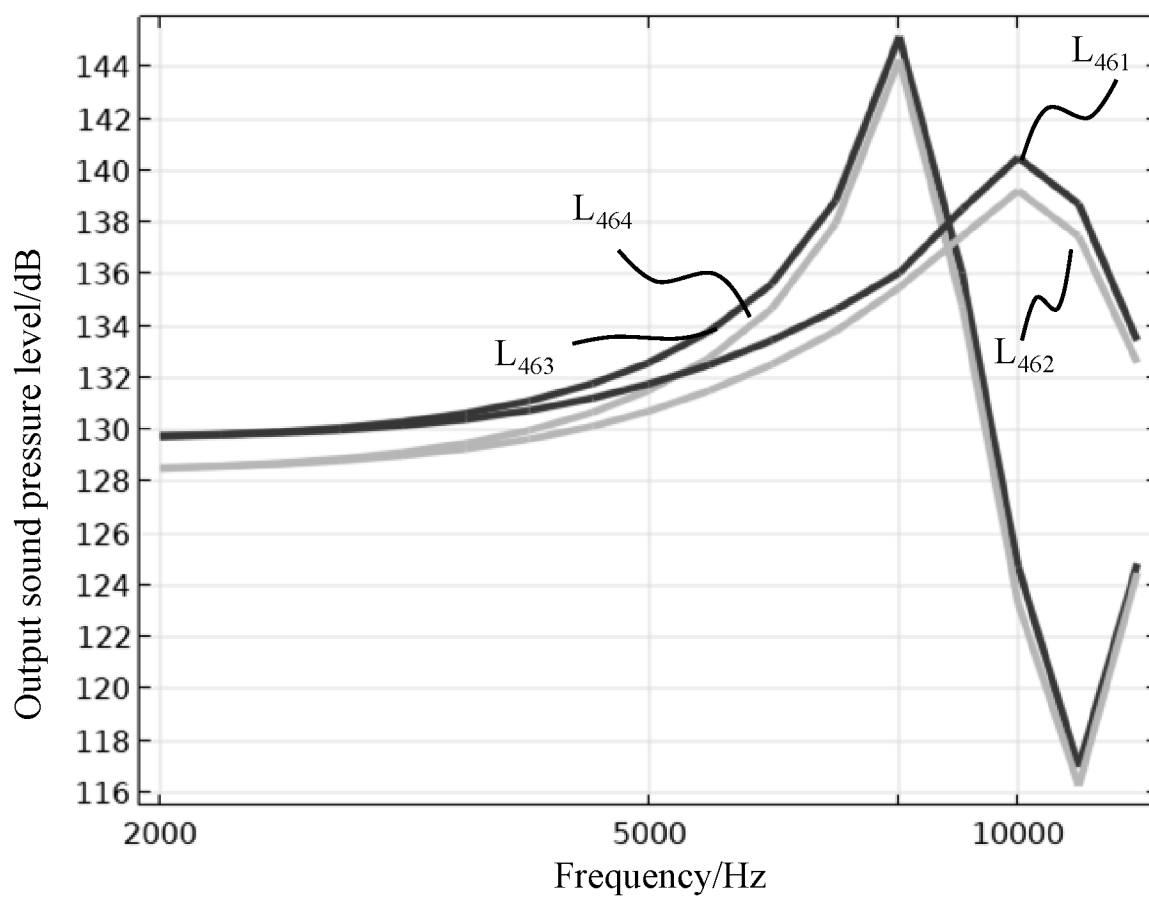


FIG. 29

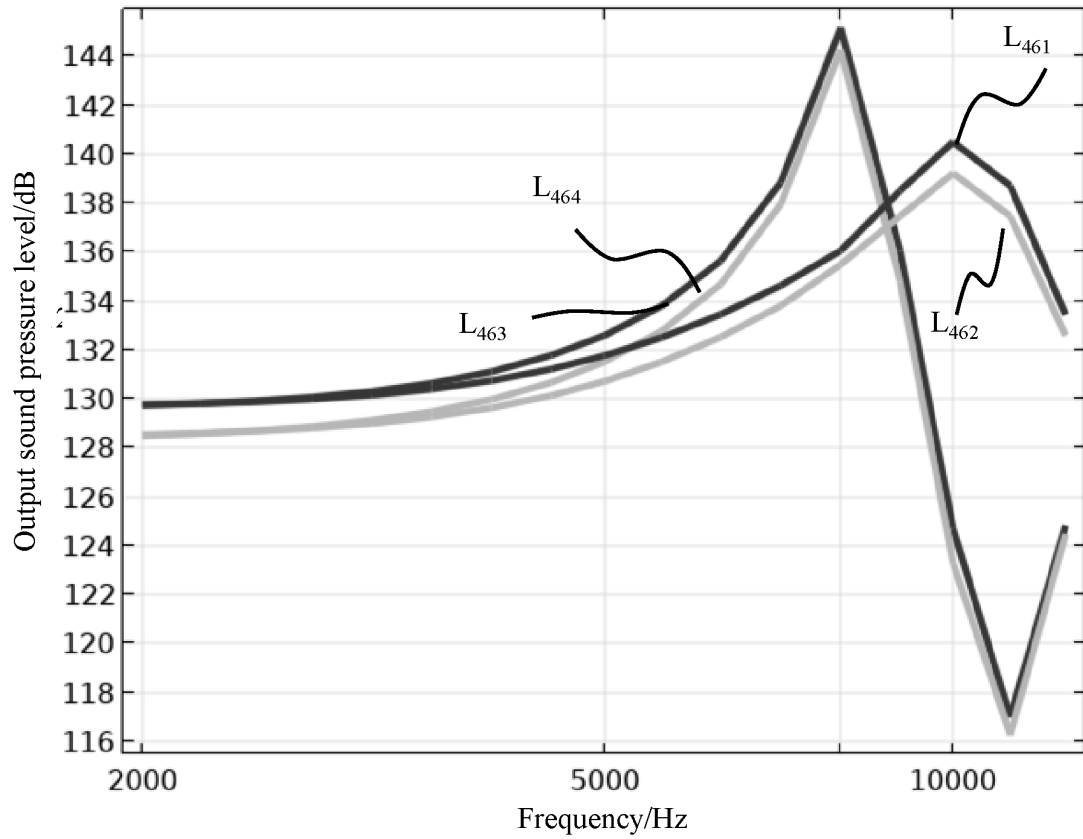


FIG. 30

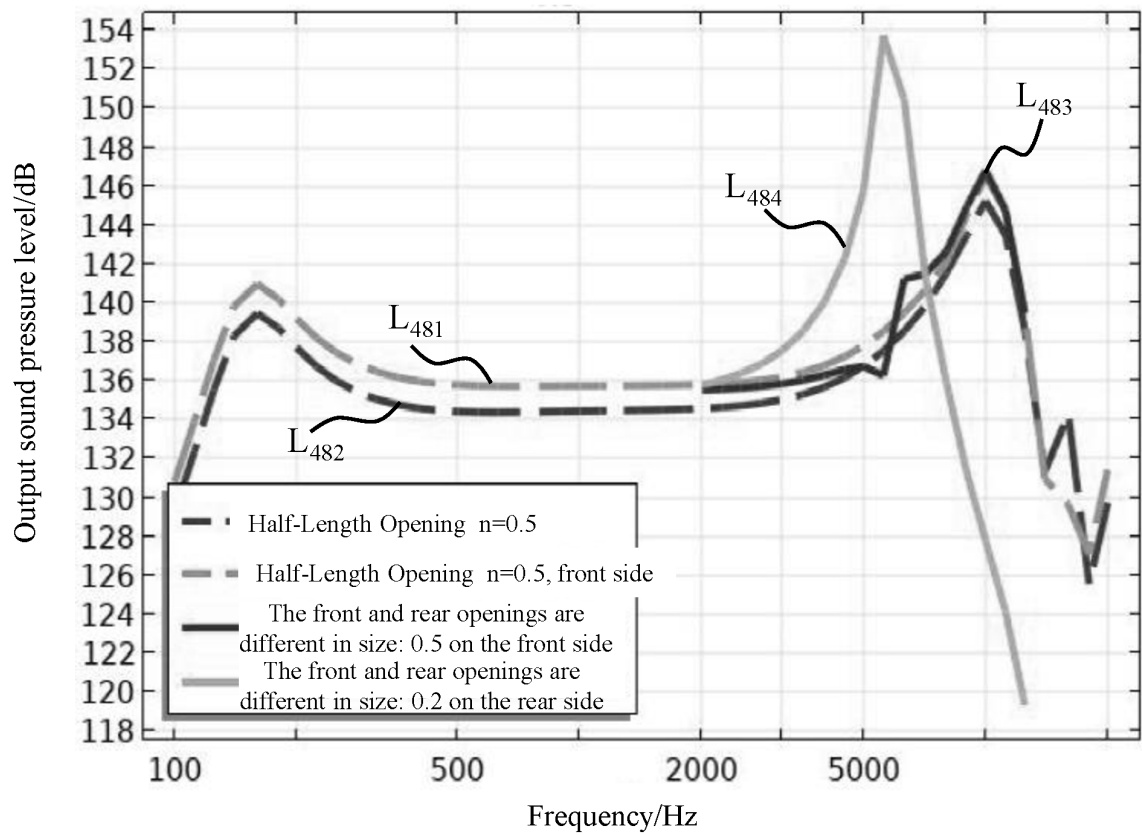


FIG. 31

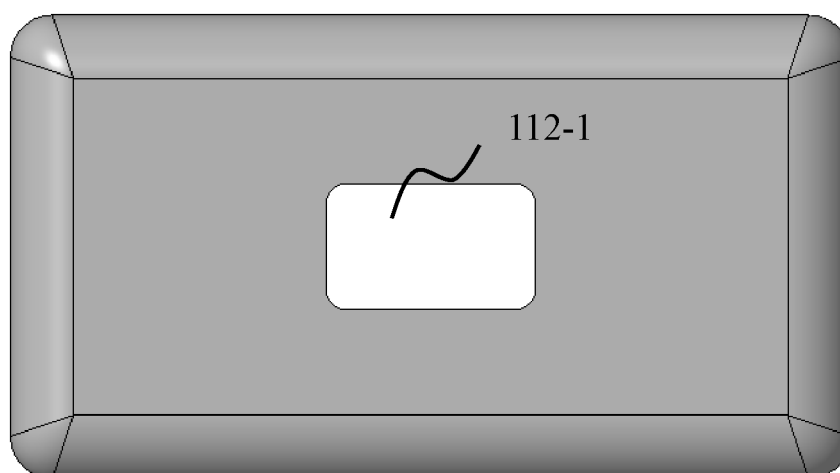


FIG. 32A

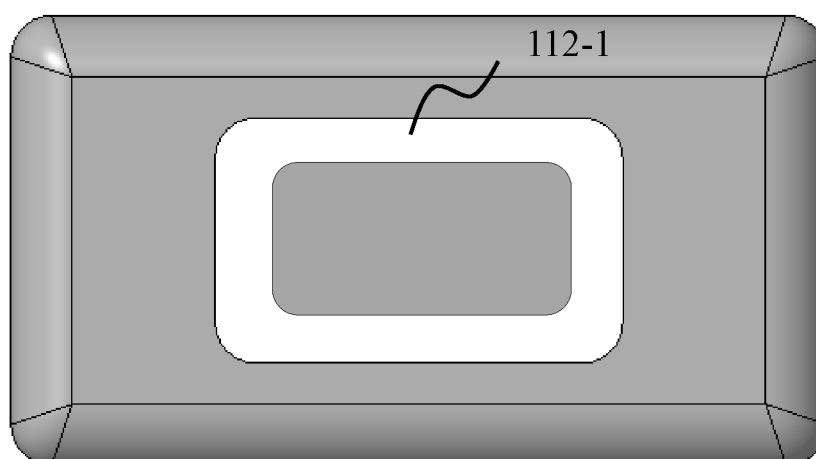


FIG. 32B

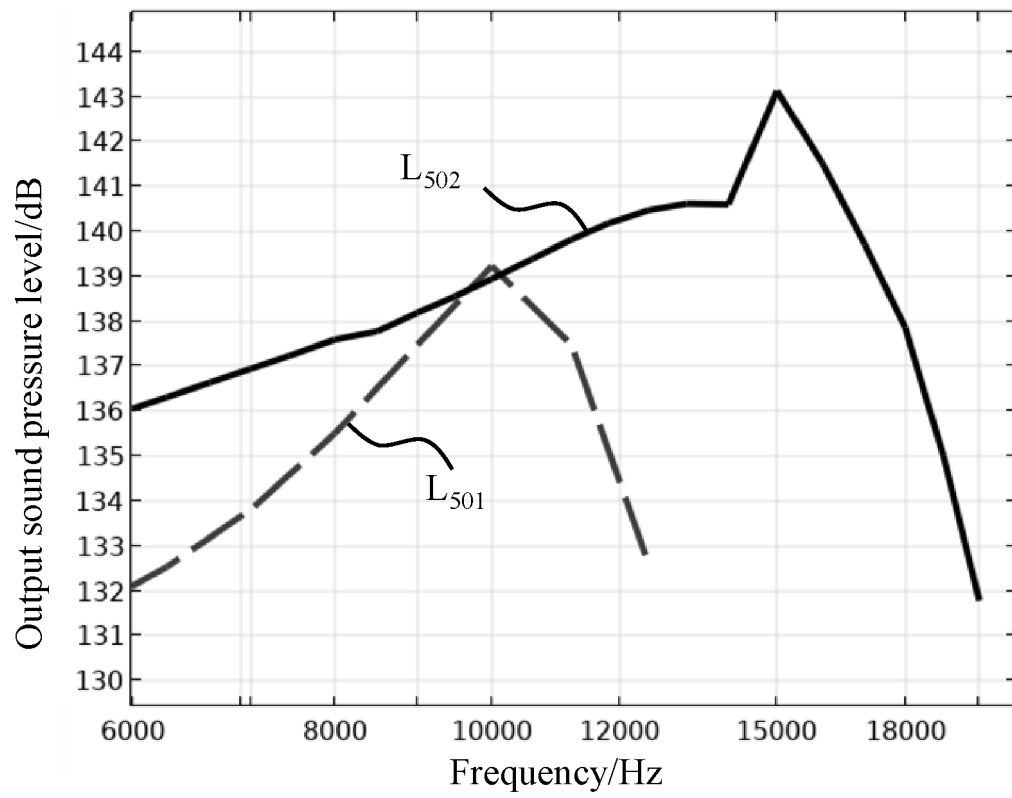


FIG. 33

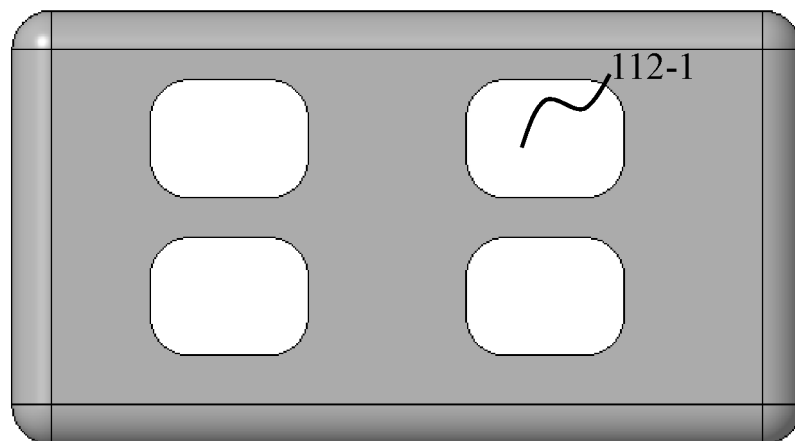


FIG. 34A

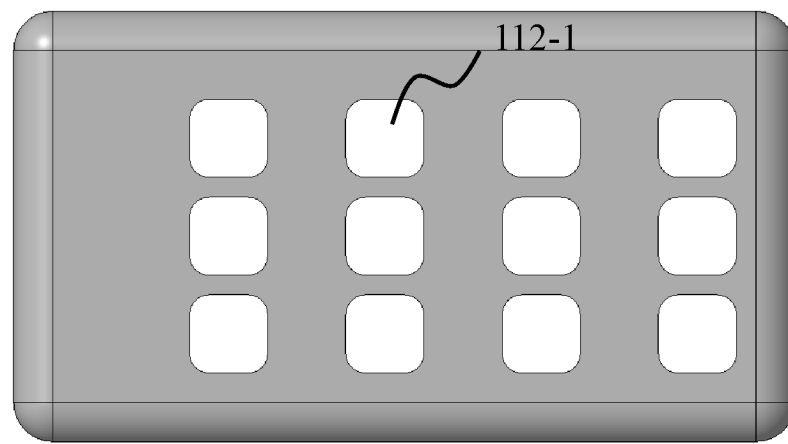


FIG. 34B

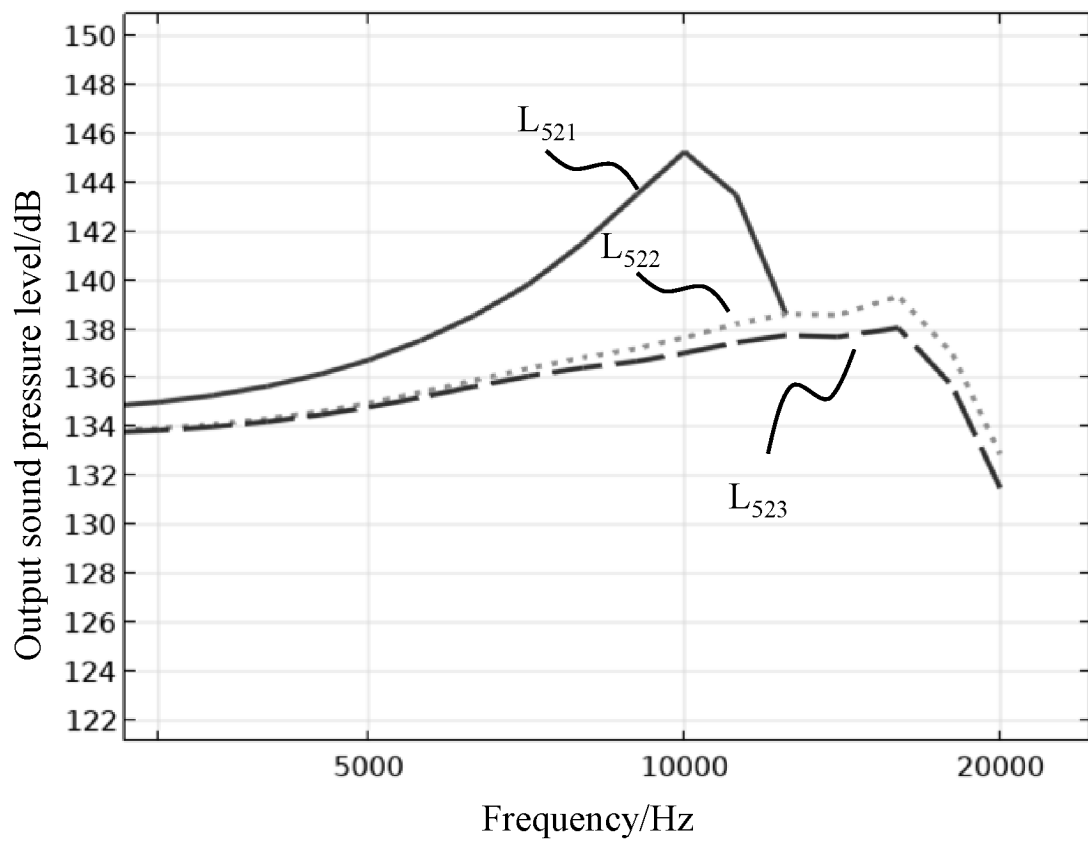


FIG. 35

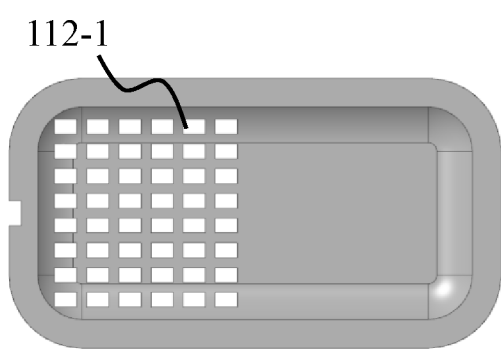


FIG. 36A

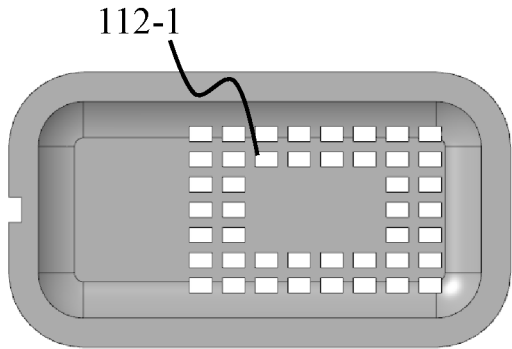


FIG. 36B

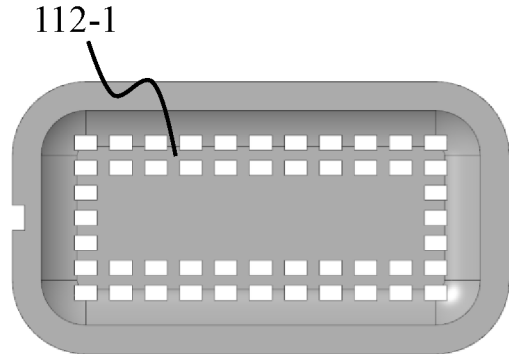


FIG. 36C

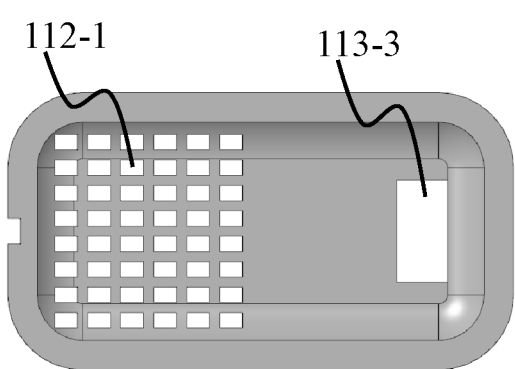


FIG. 36D

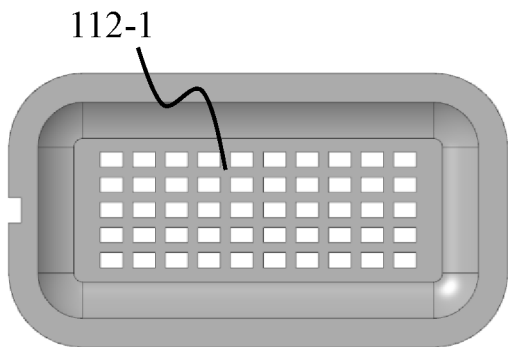


FIG. 36E

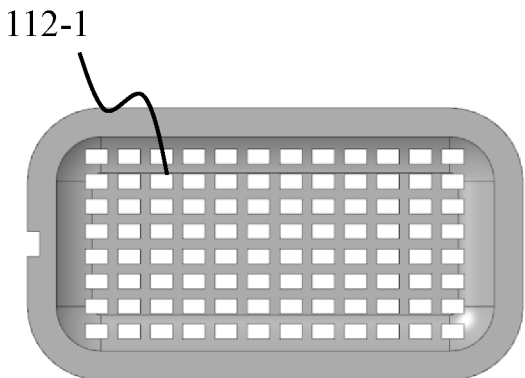


FIG. 36F

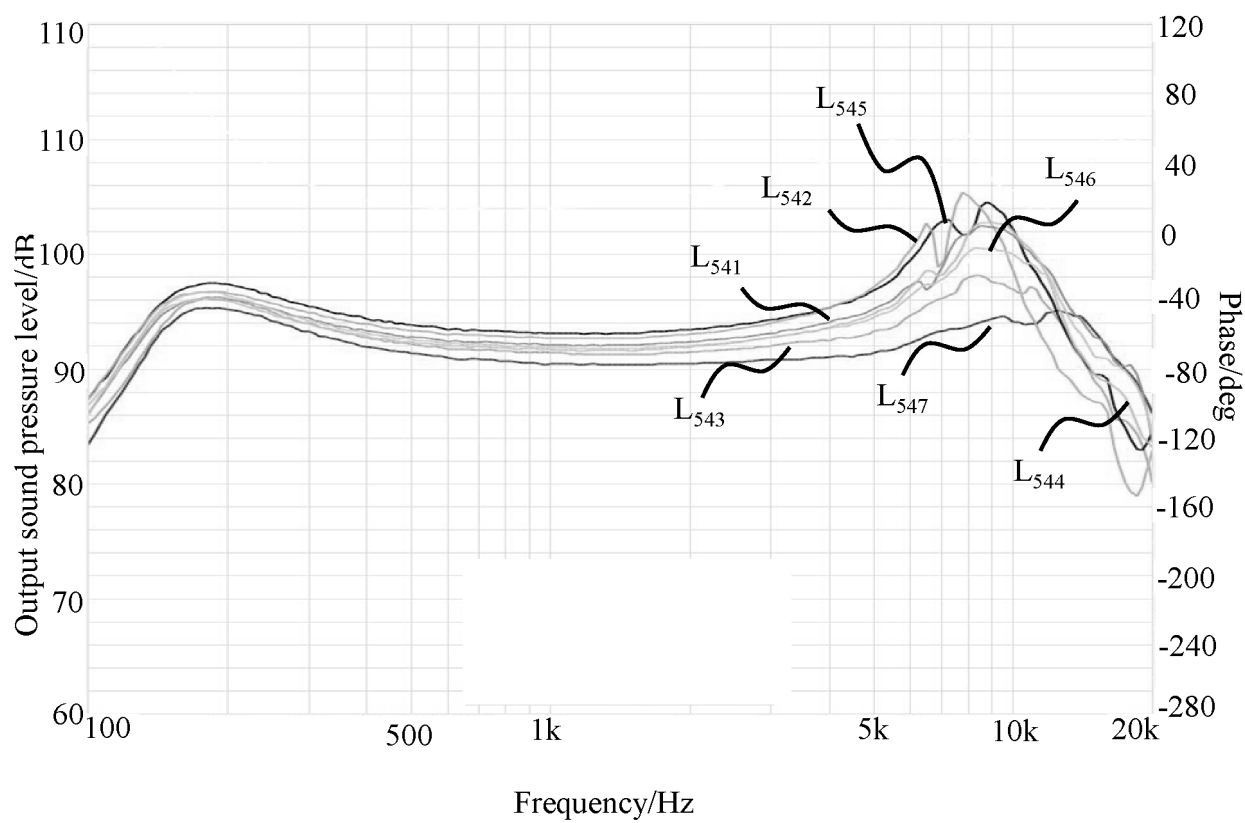


FIG. 37

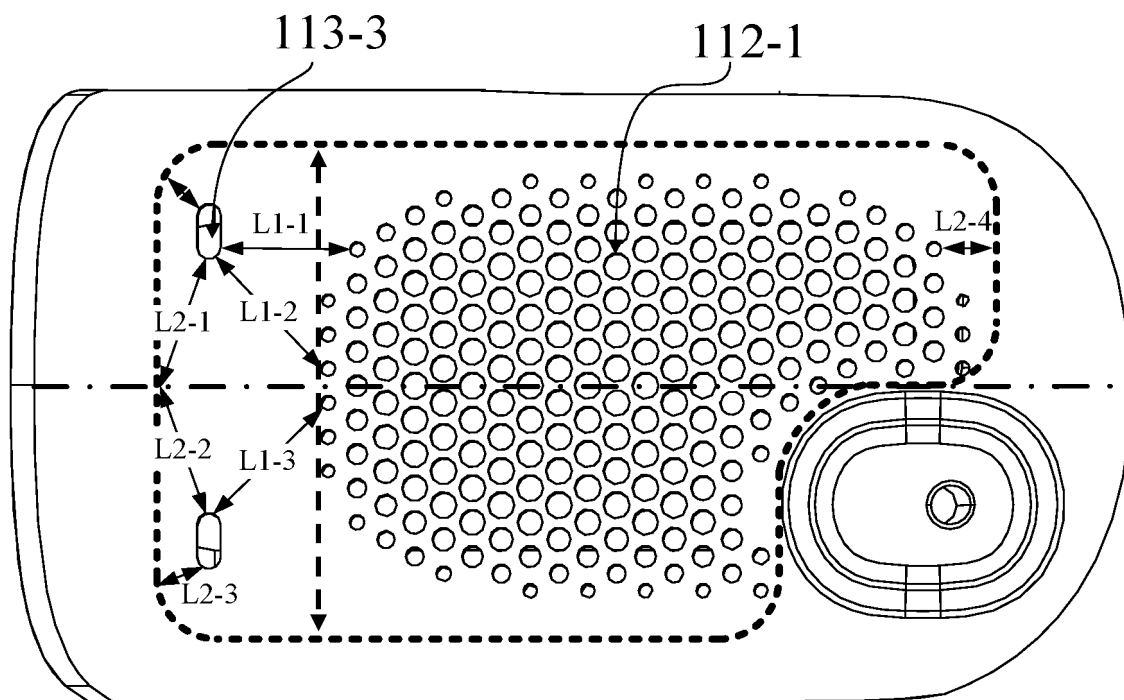


FIG. 38

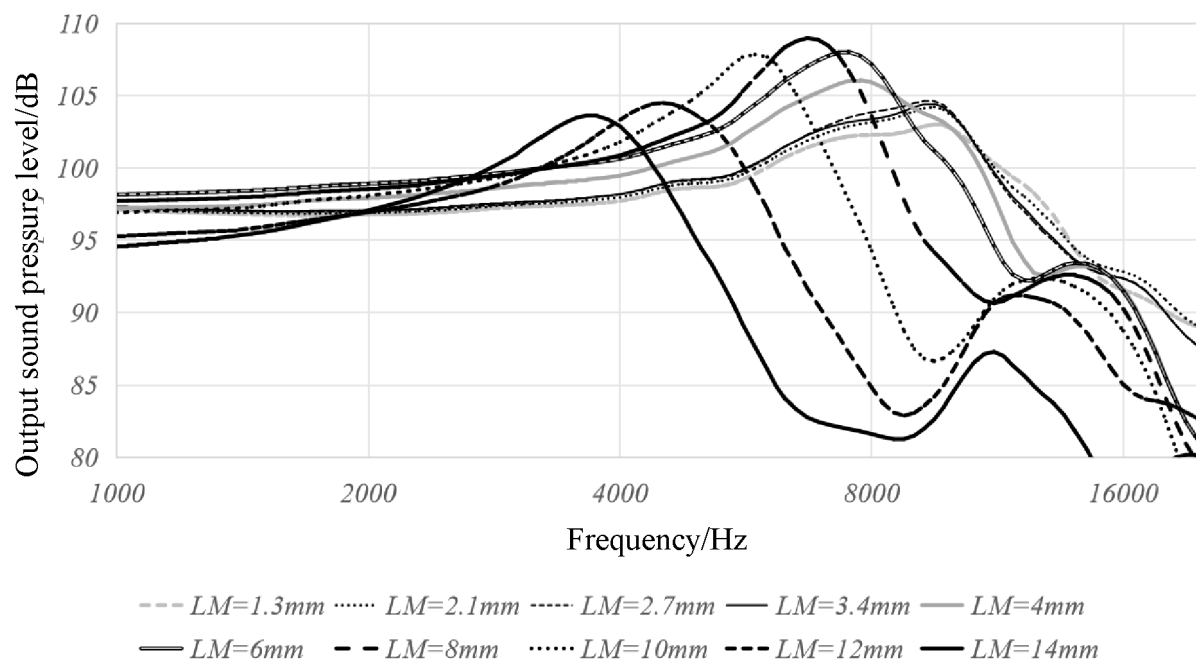


FIG. 39

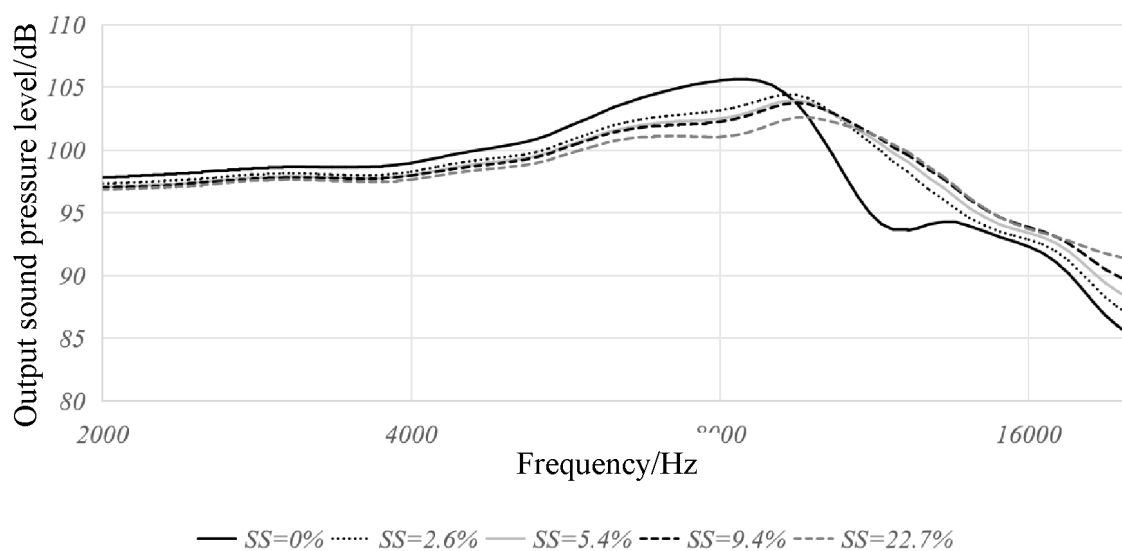


FIG. 40

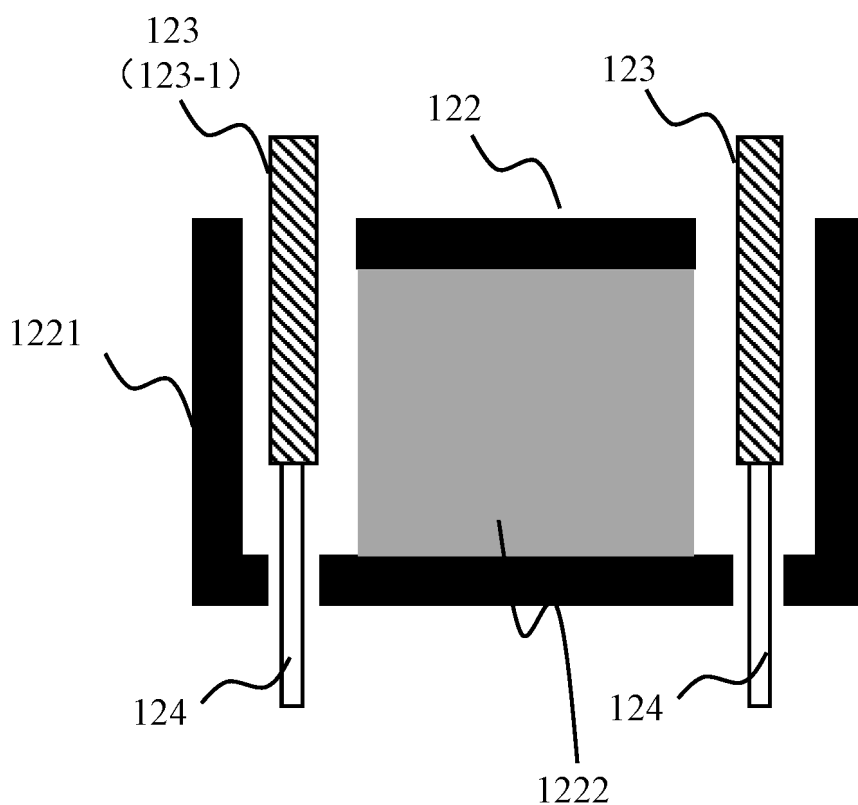


FIG. 41

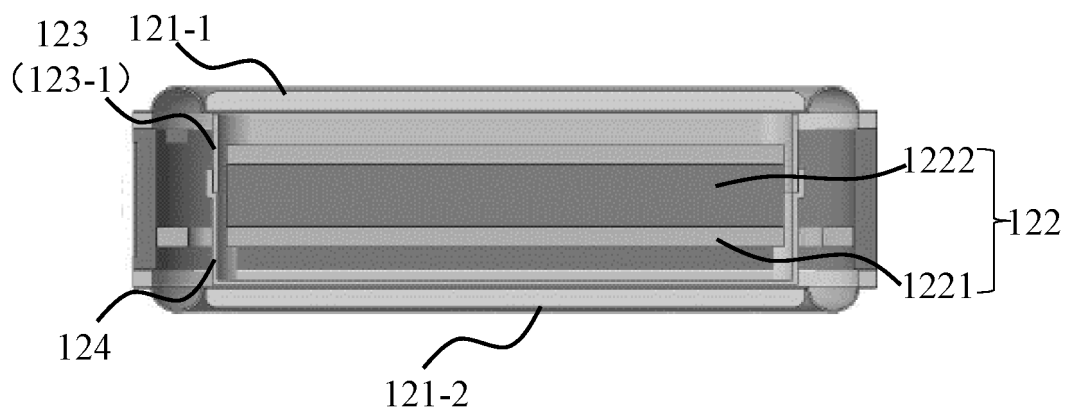


FIG. 42

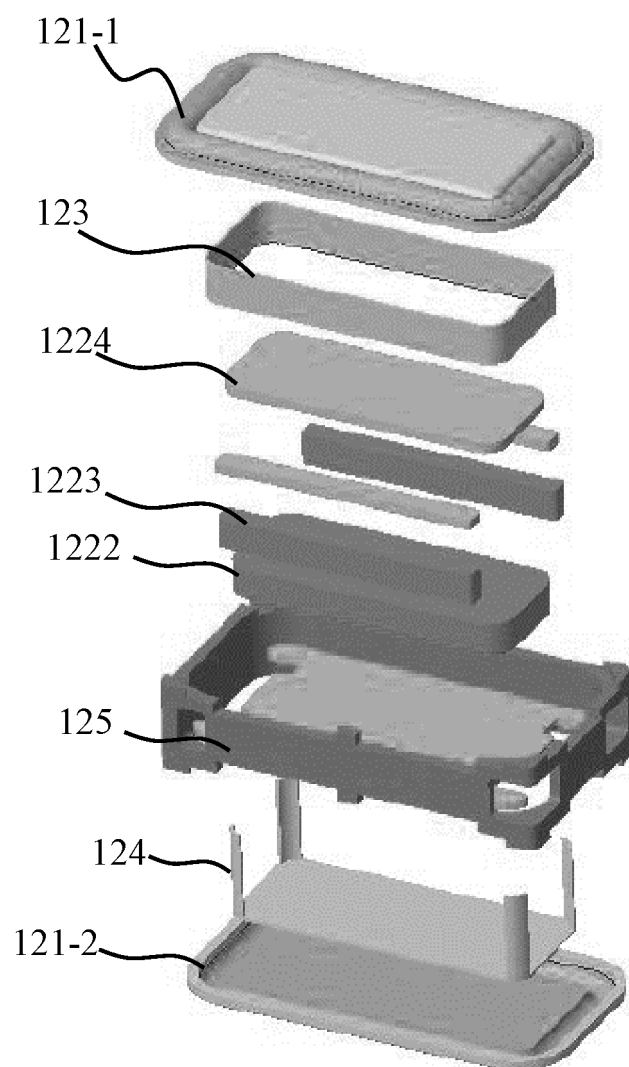


FIG. 43A

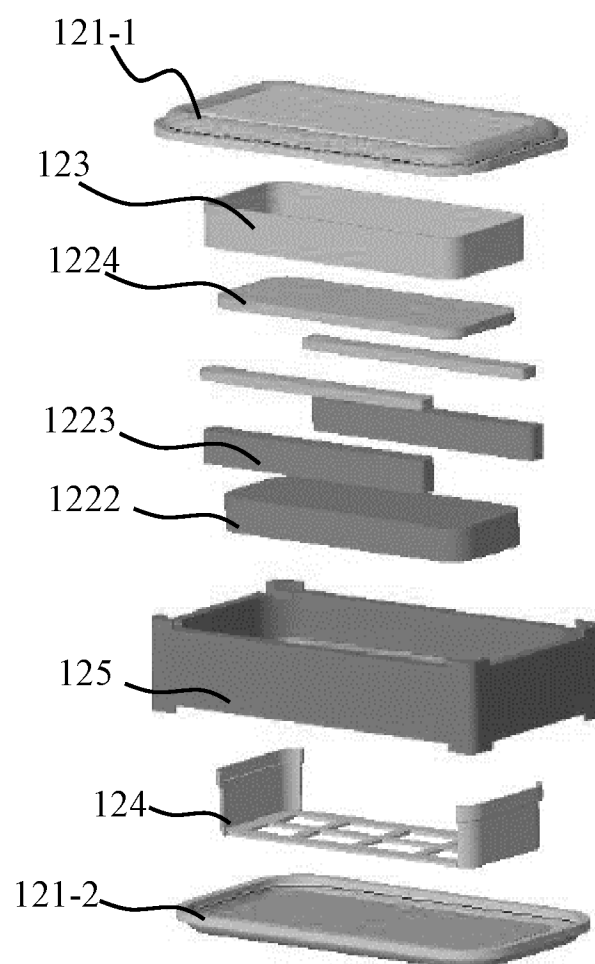


FIG. 43B

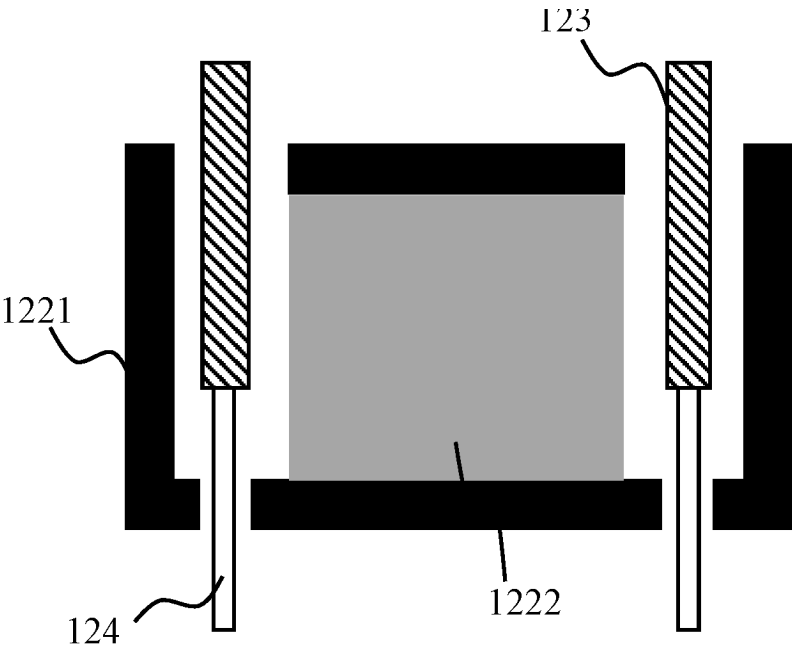


FIG. 44A

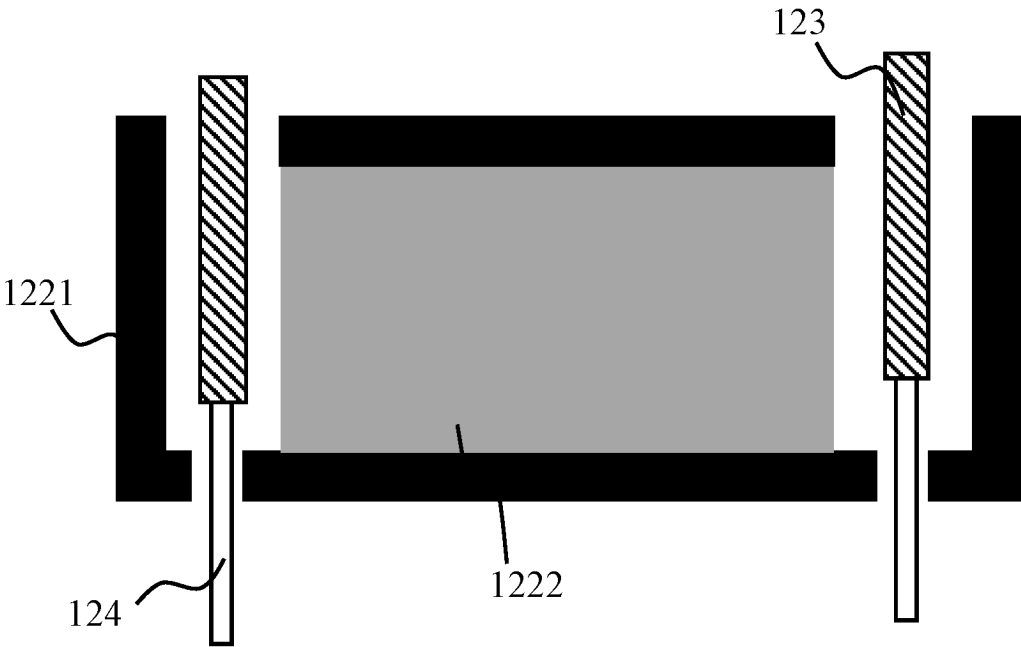


FIG. 44B

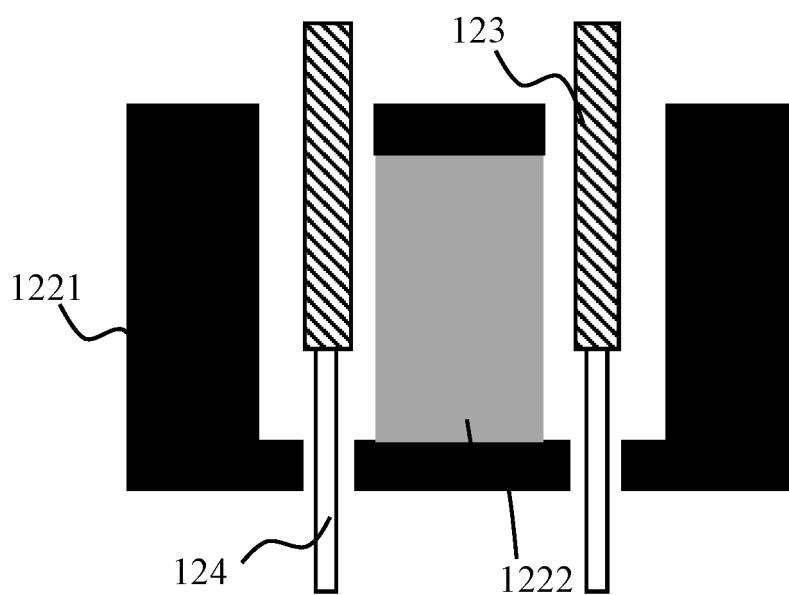


FIG. 45A

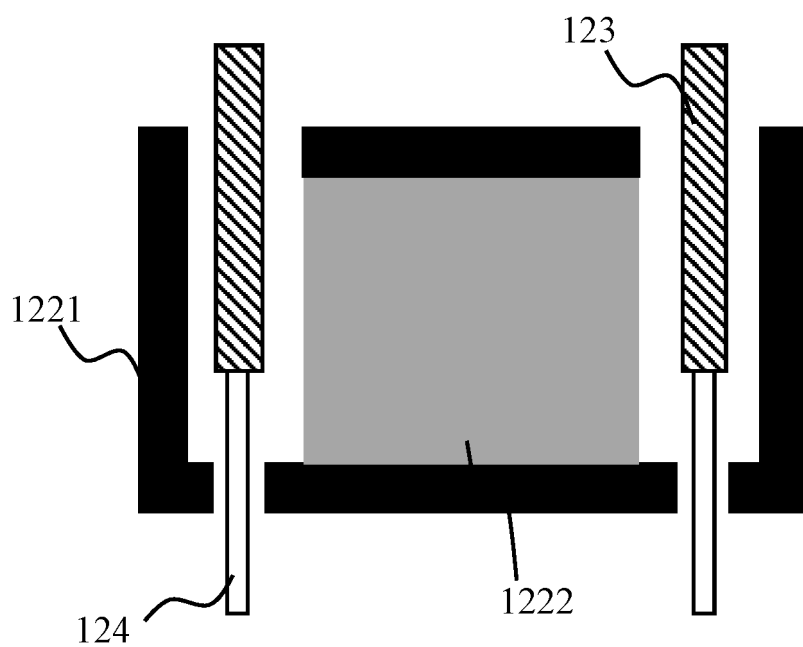


FIG. 45B

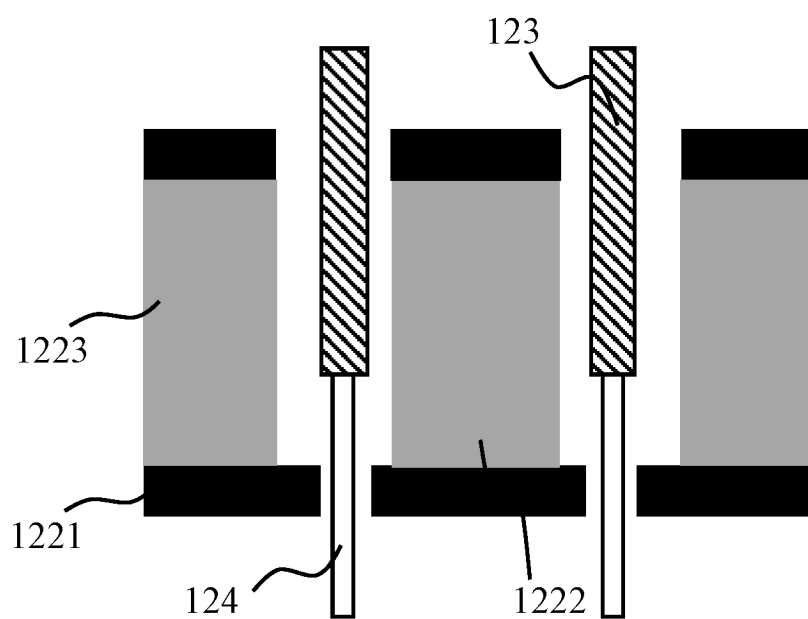


FIG. 46A

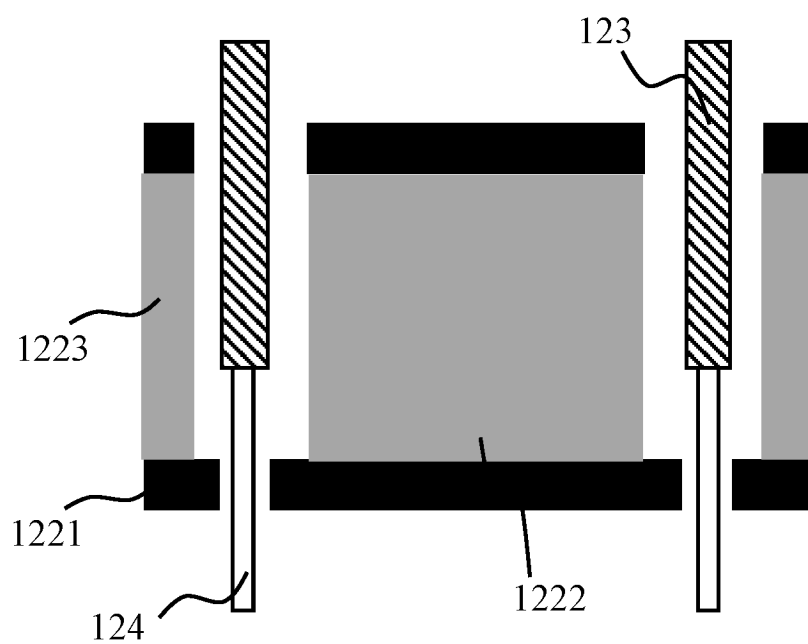


FIG. 46B

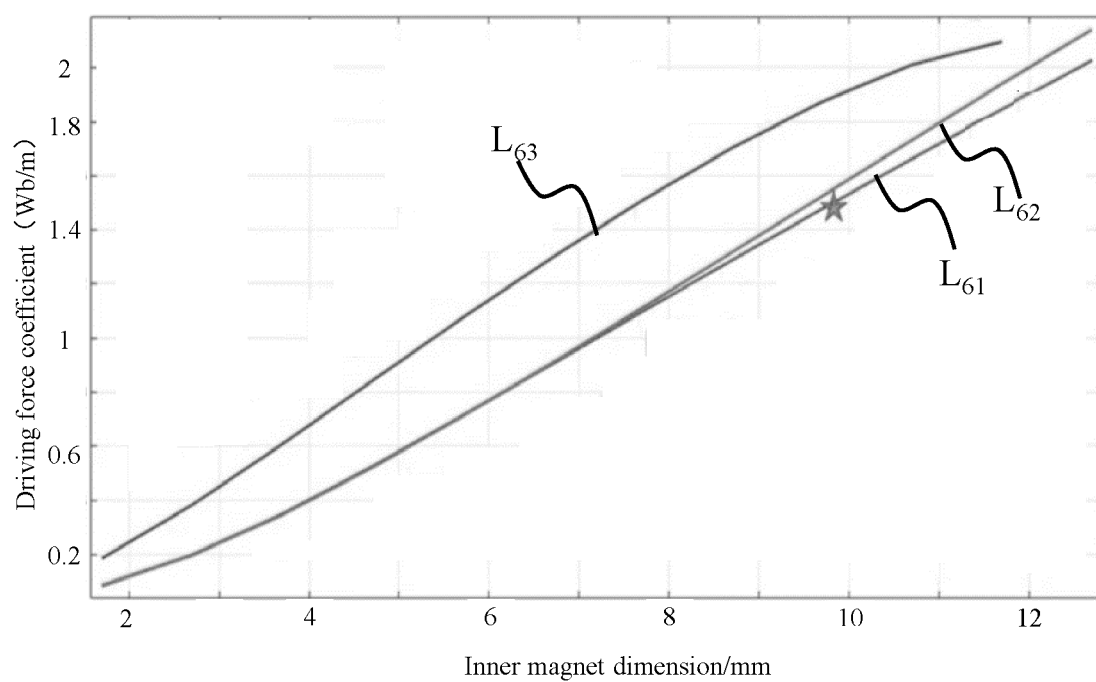


FIG. 47

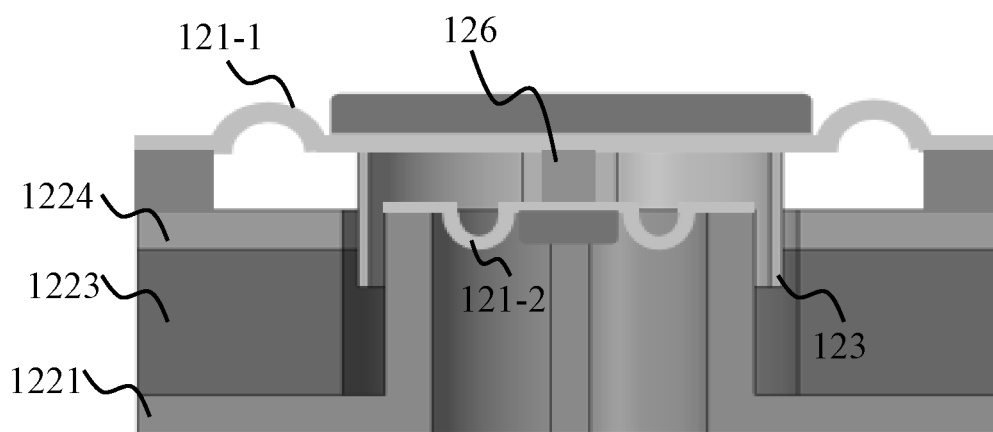


FIG. 48

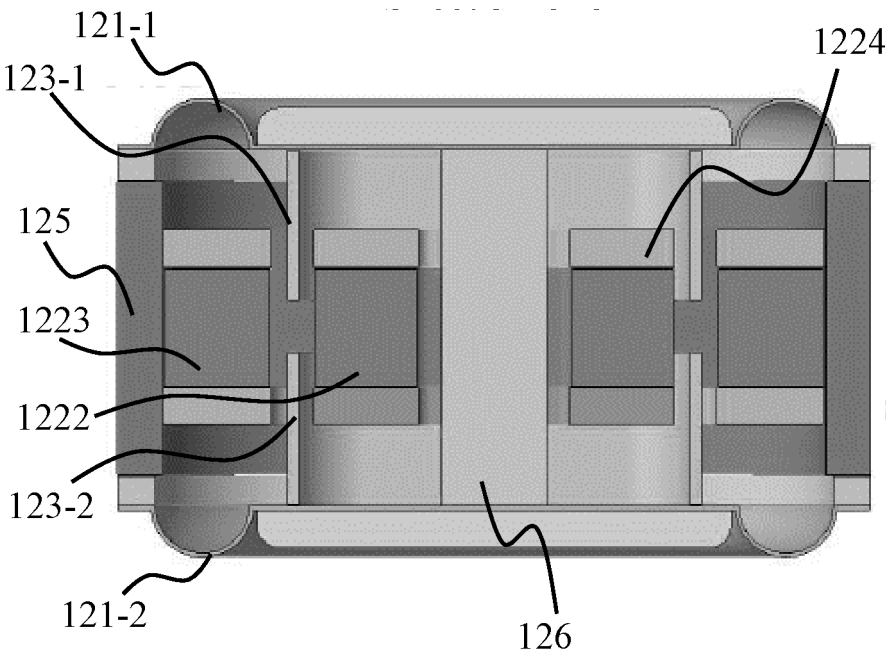


FIG. 49

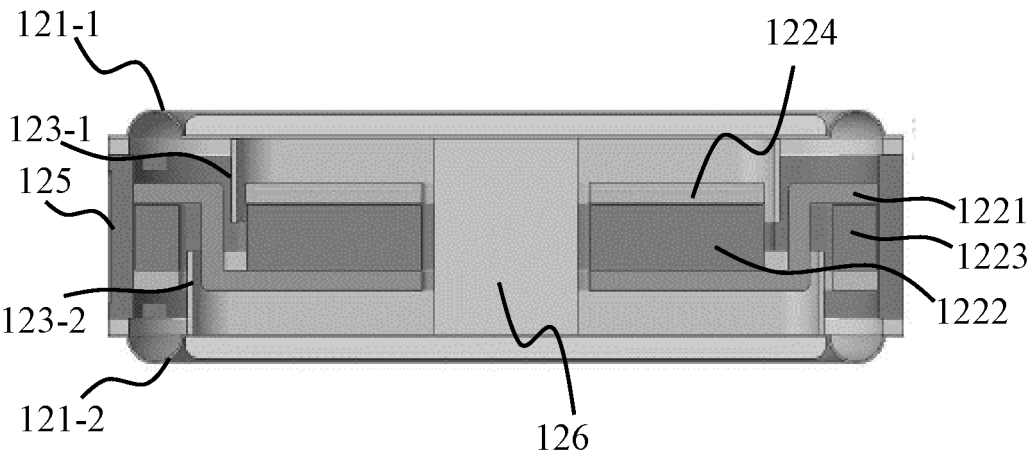


FIG. 50

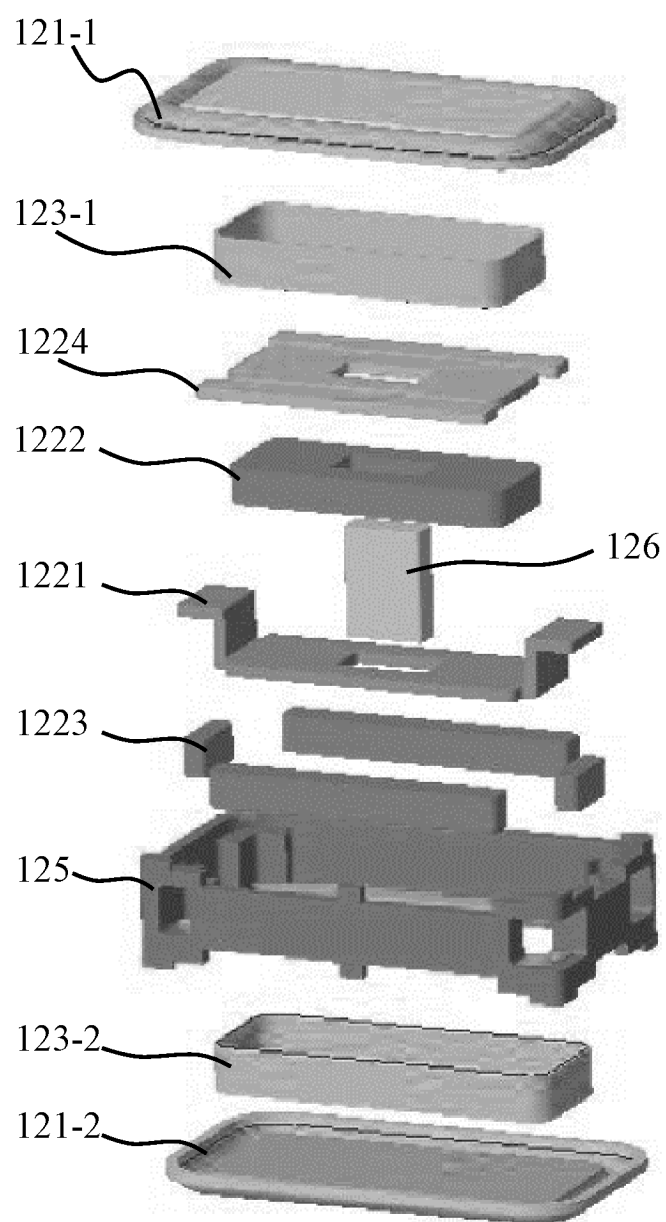


FIG. 51

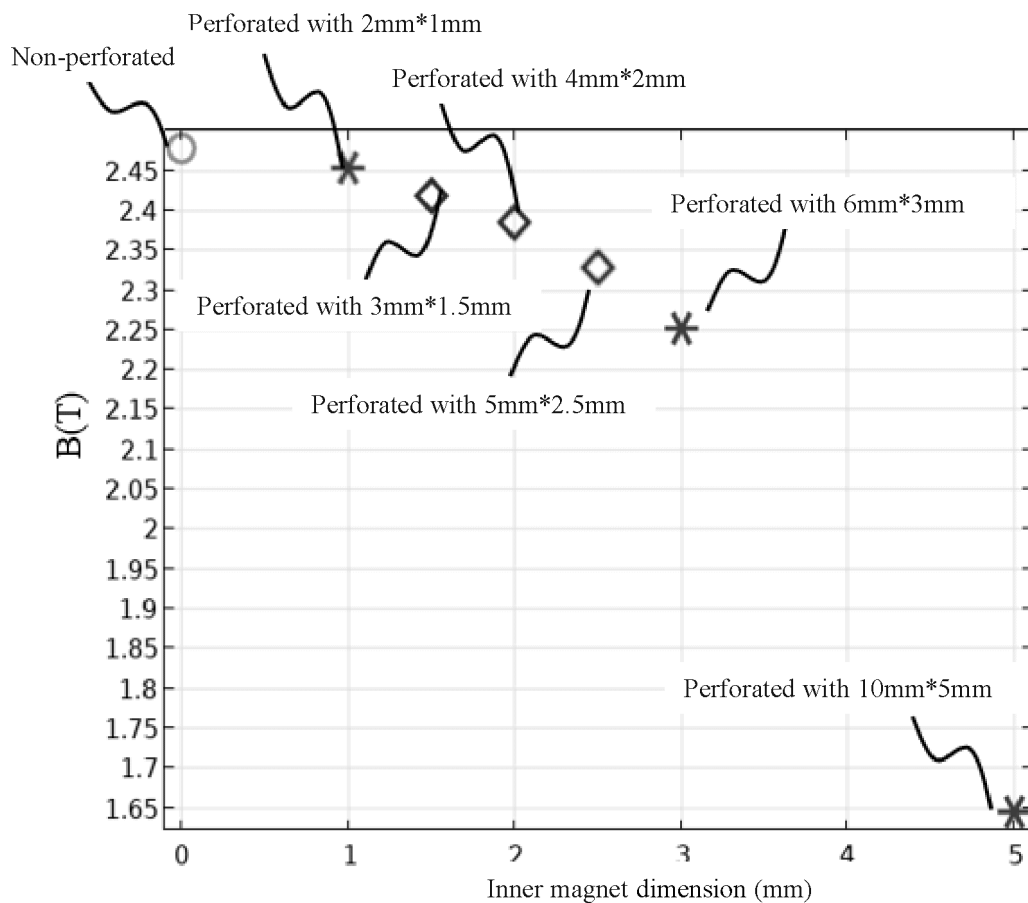


FIG. 52

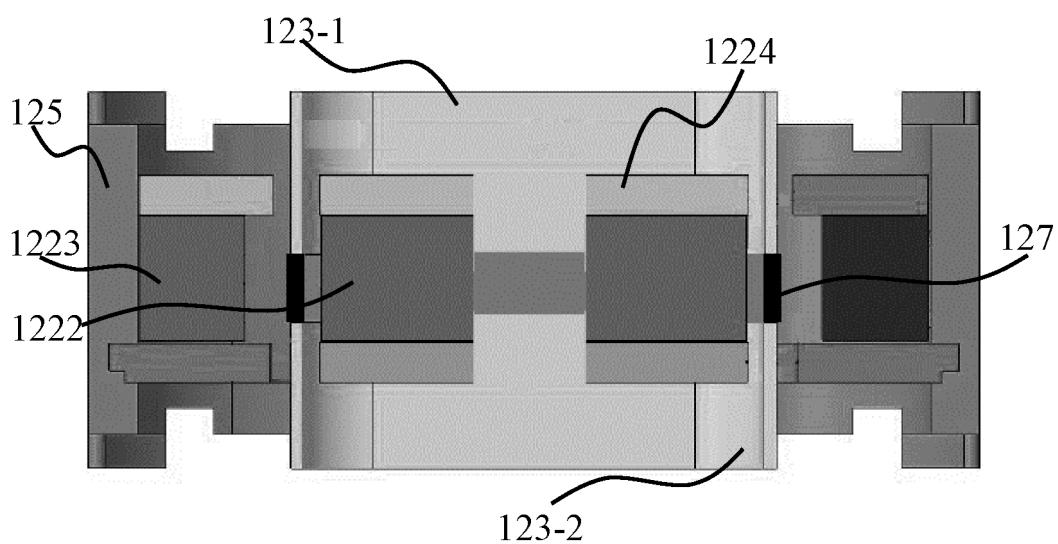


FIG. 53

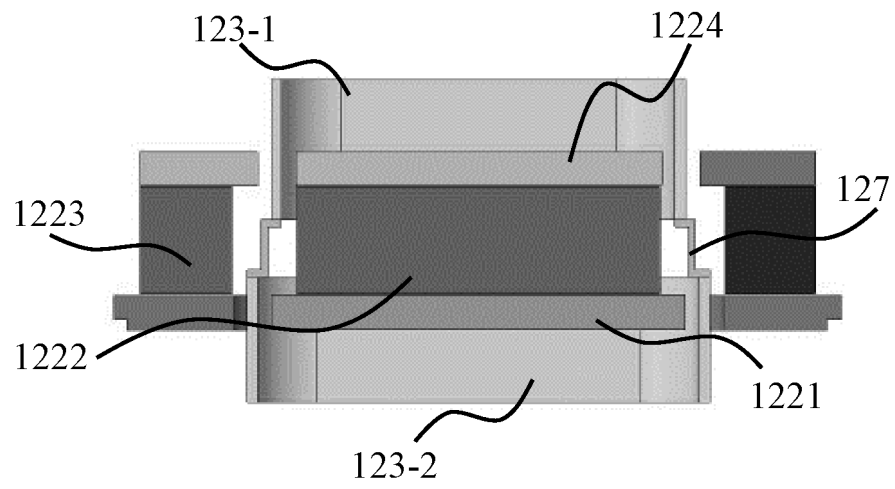


FIG. 54A

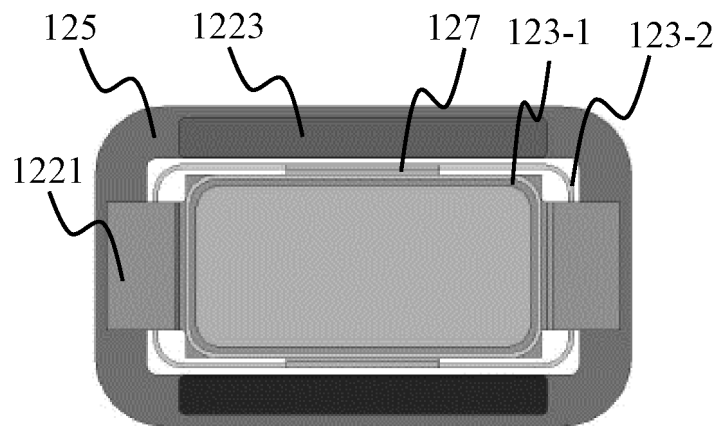


FIG. 54B

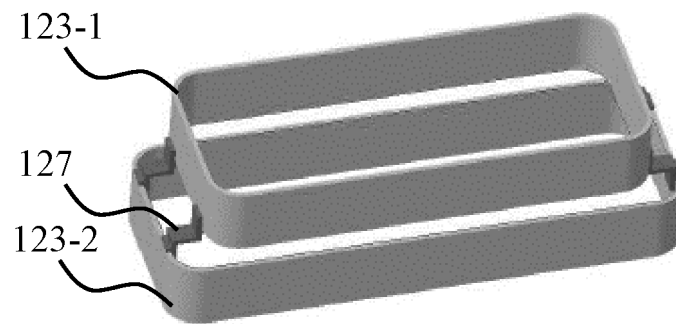


FIG. 55

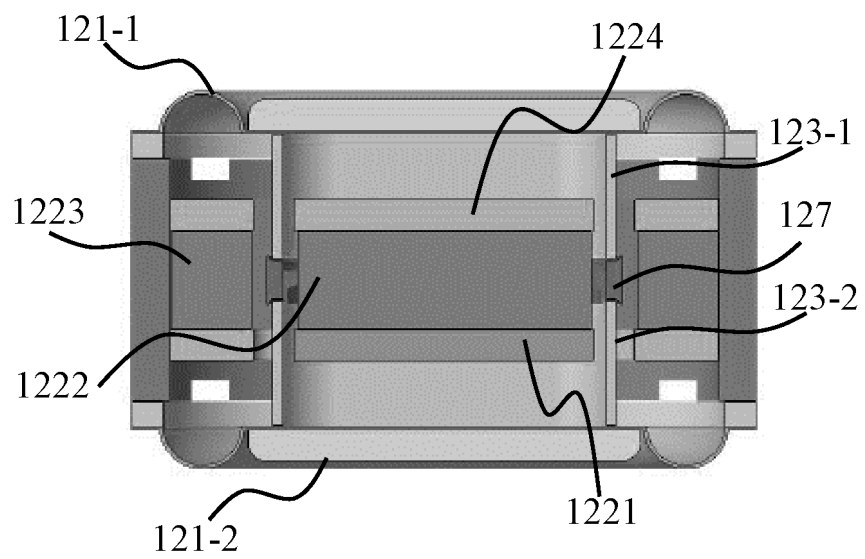


FIG. 56

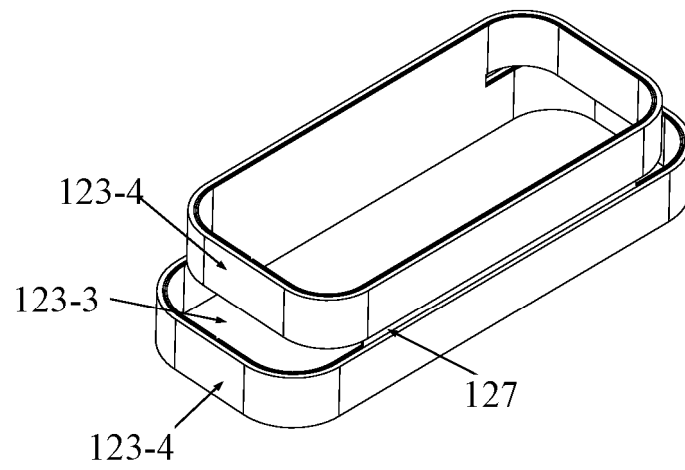


FIG. 57

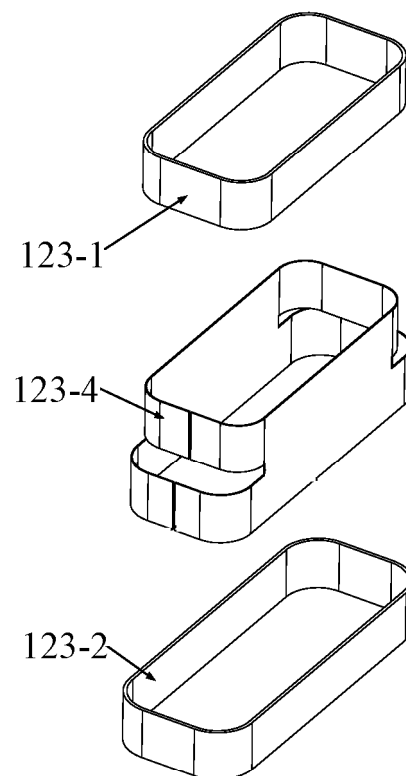


FIG. 58

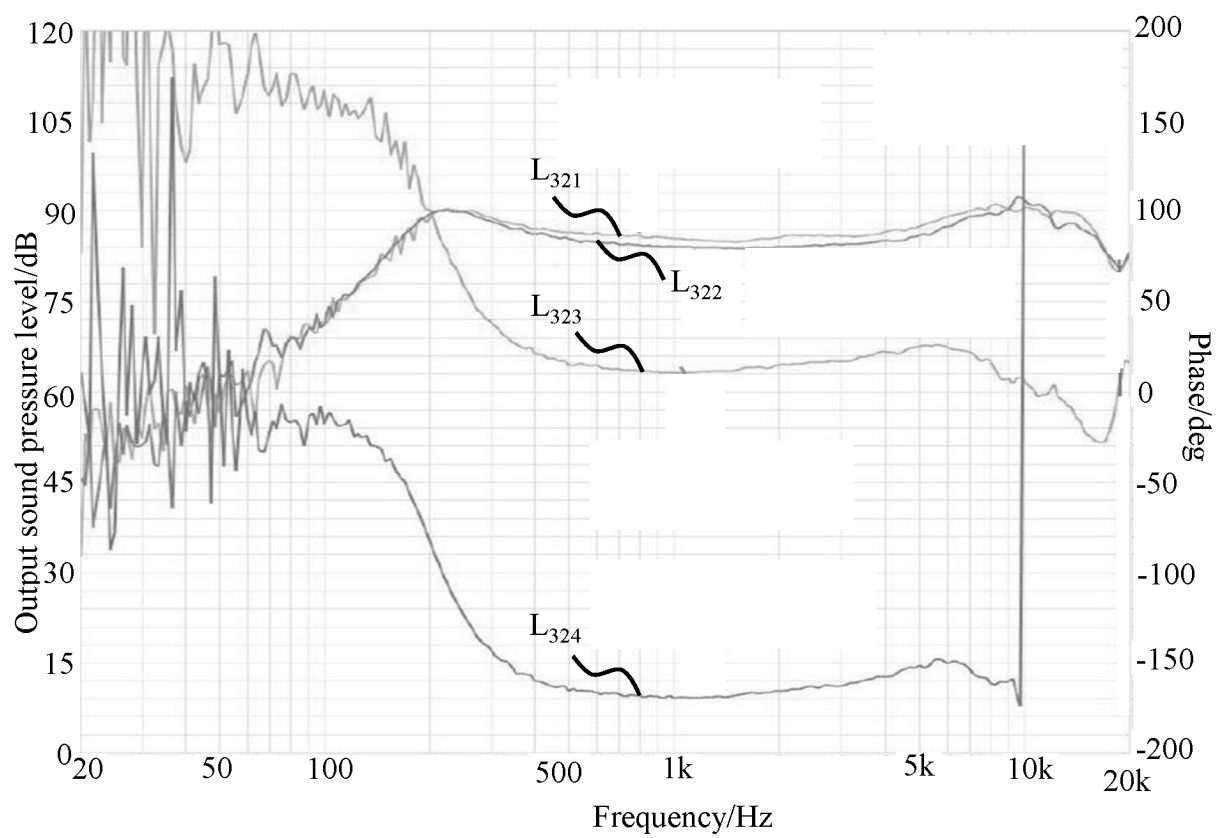


FIG. 59

1221

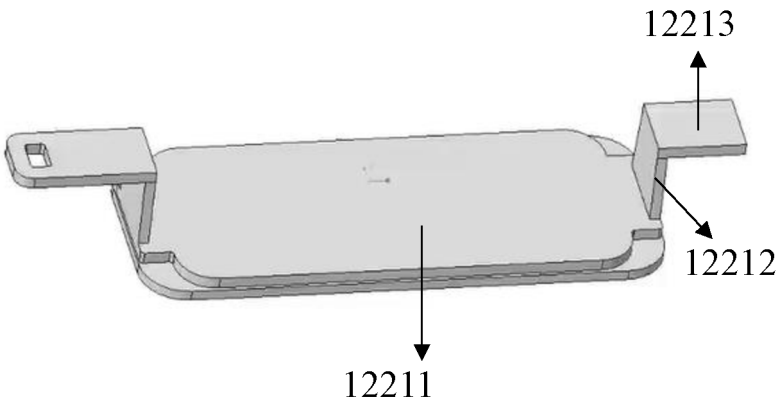


FIG. 60

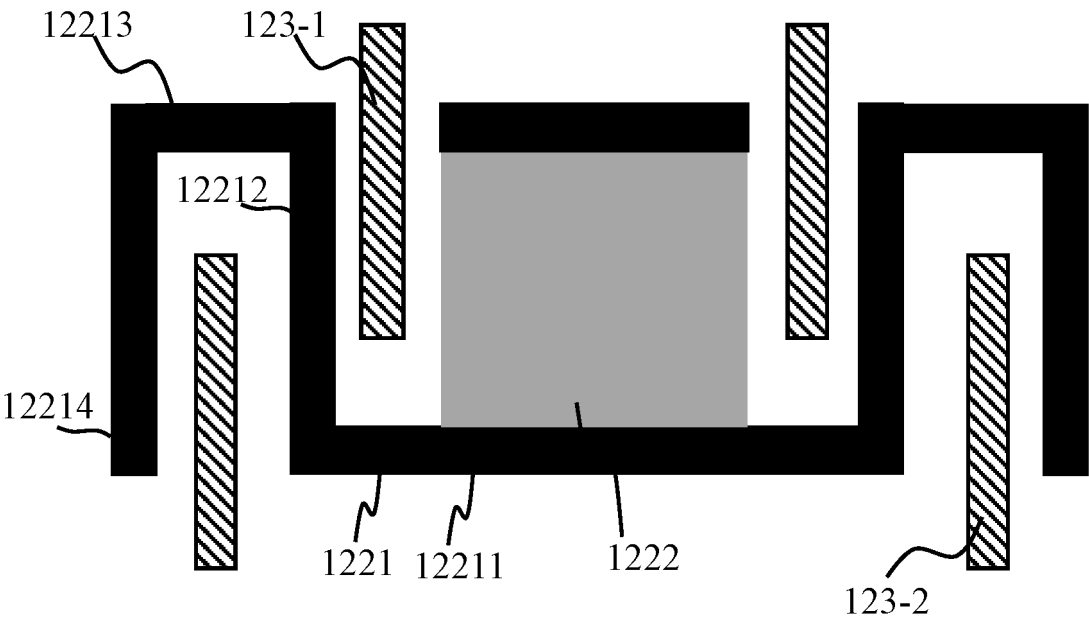


FIG. 61A

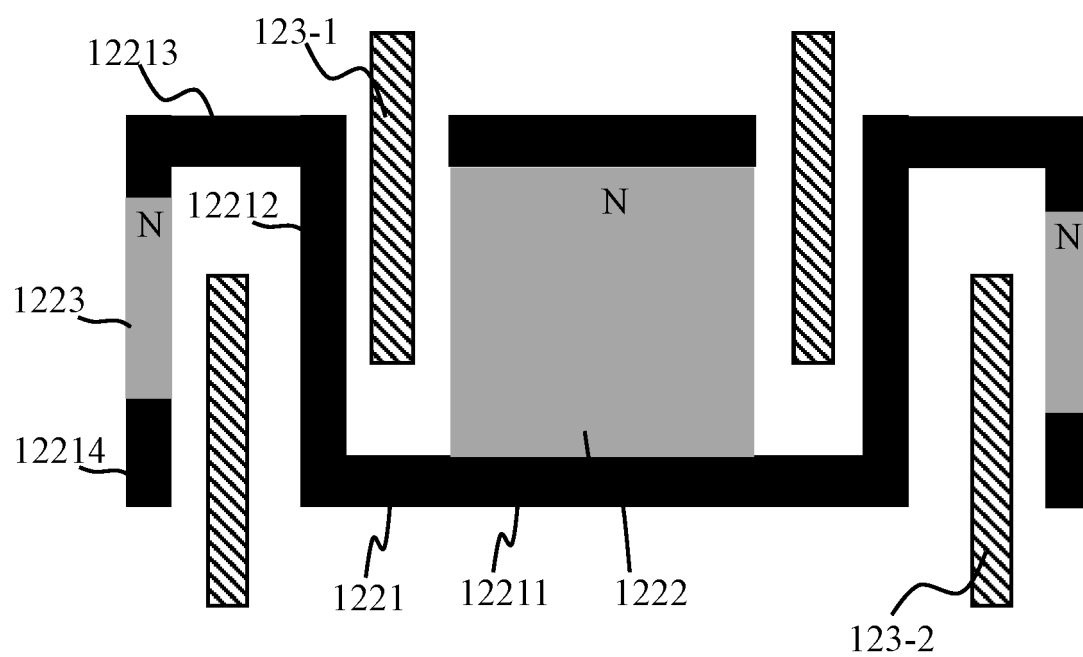


FIG. 61B

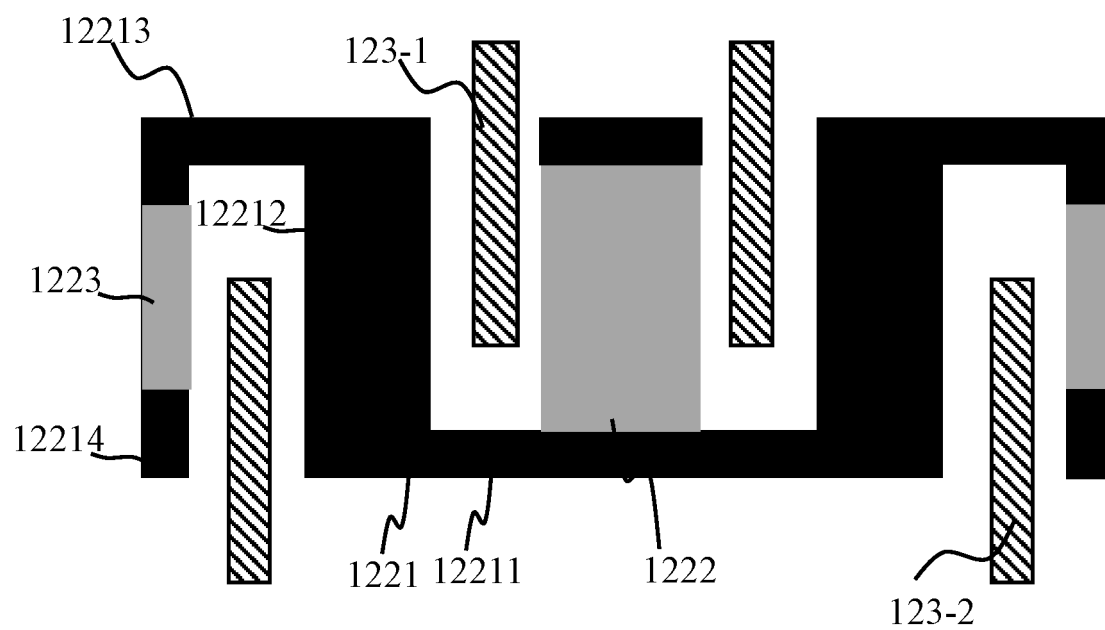


FIG. 61C

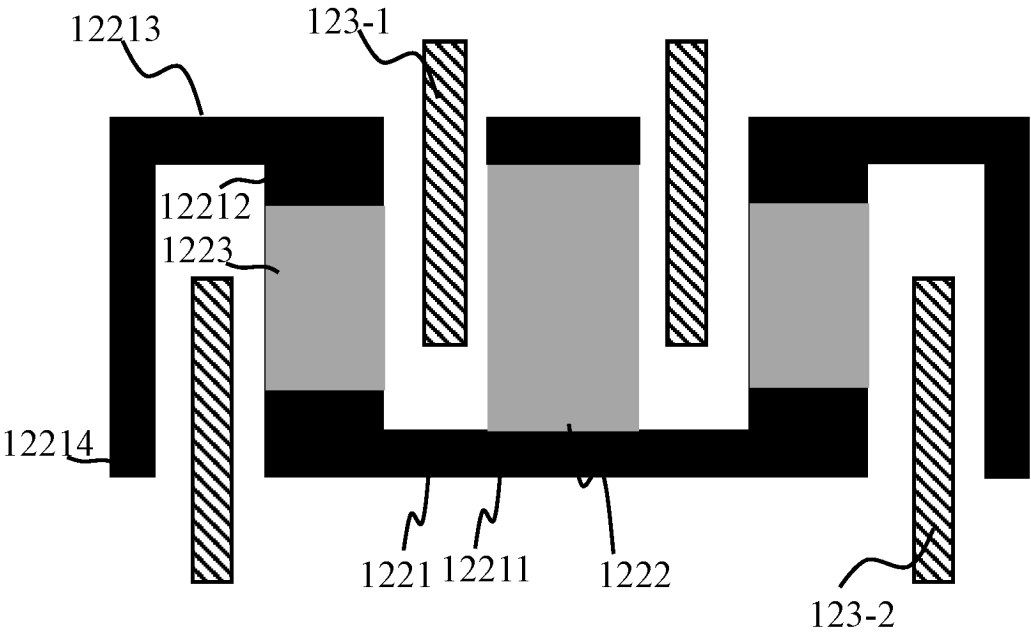


FIG. 61D

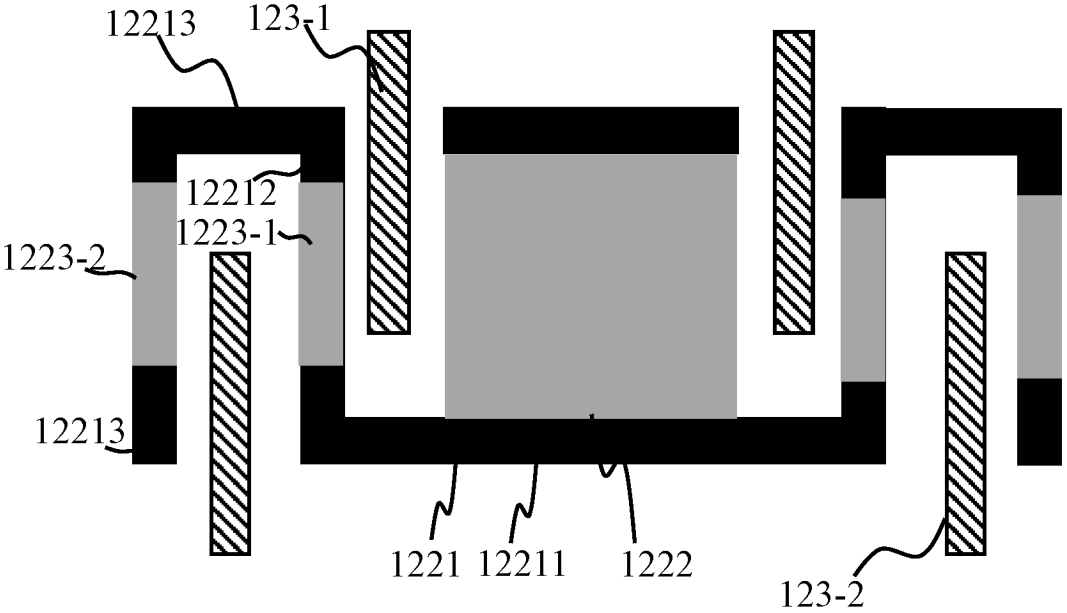


FIG. 61E

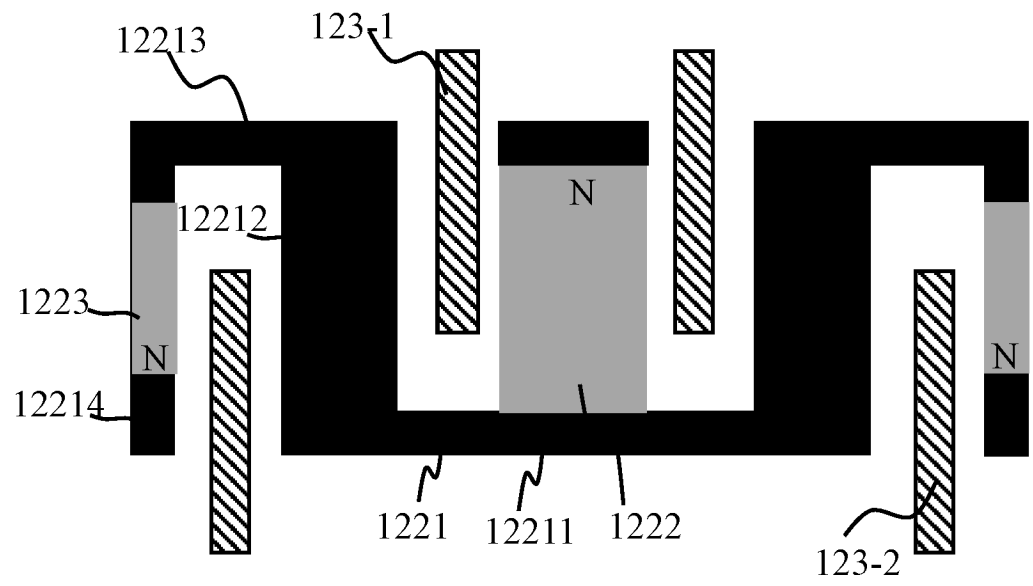


FIG. 61F

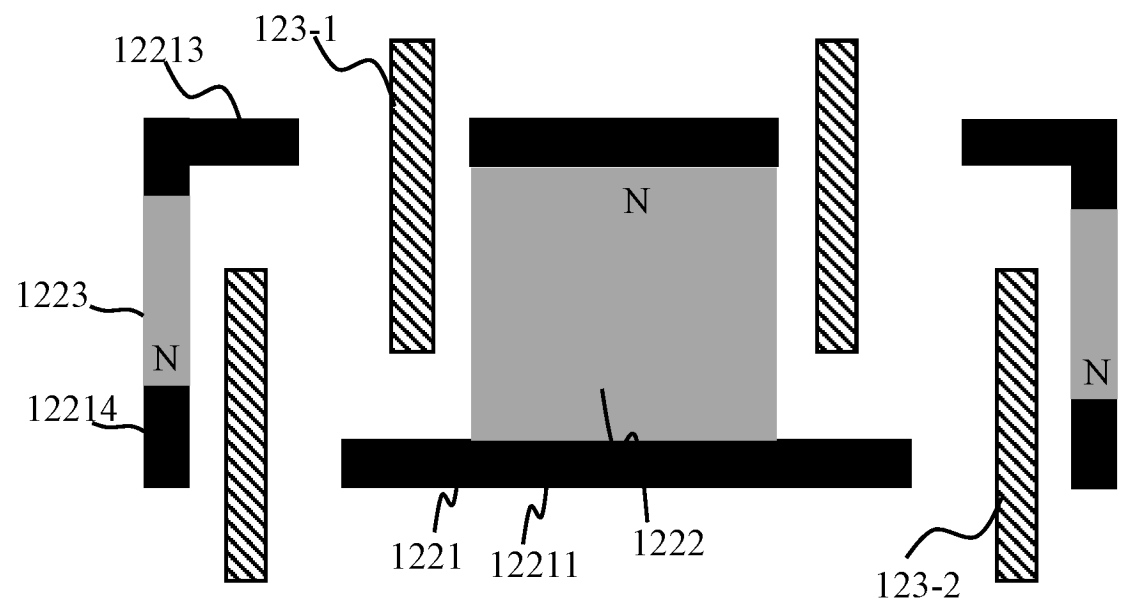


FIG. 61G

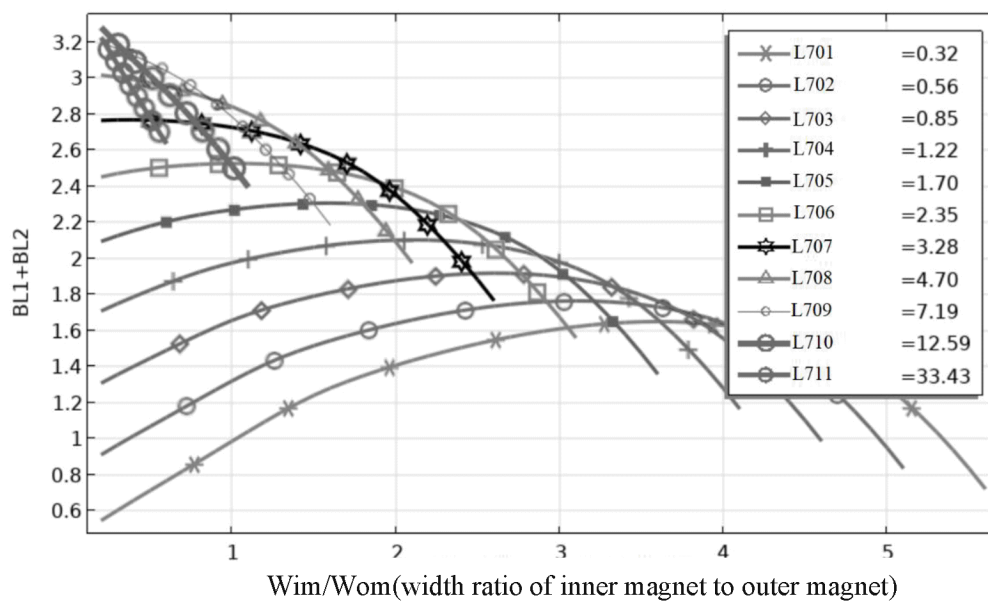


FIG. 62

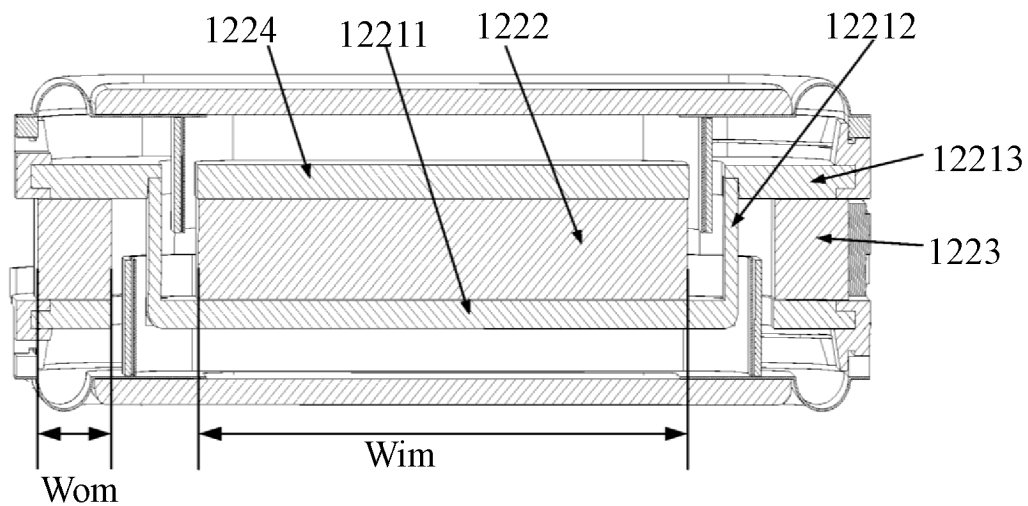


FIG. 63

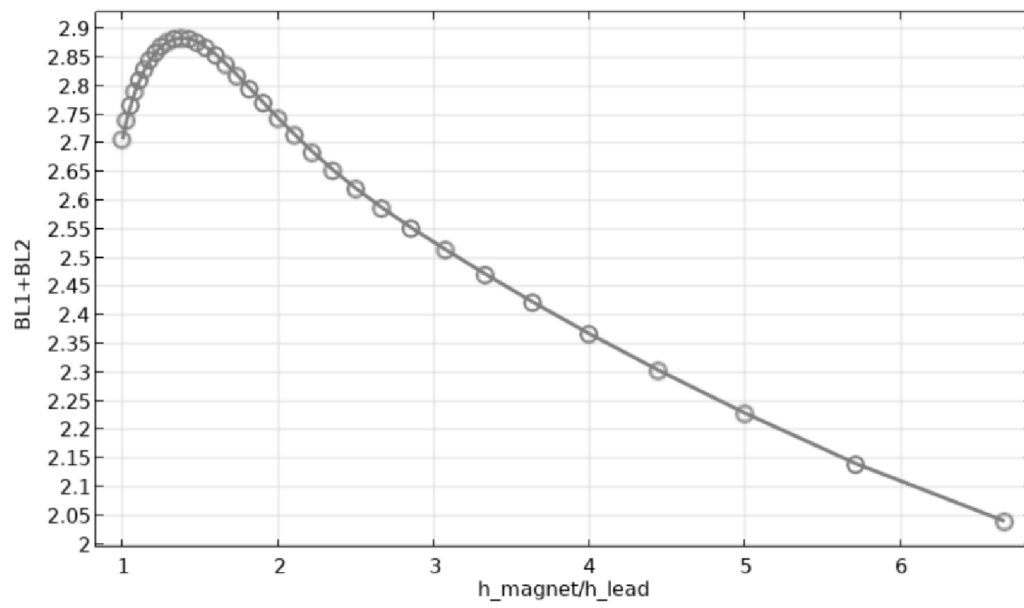


FIG. 64A

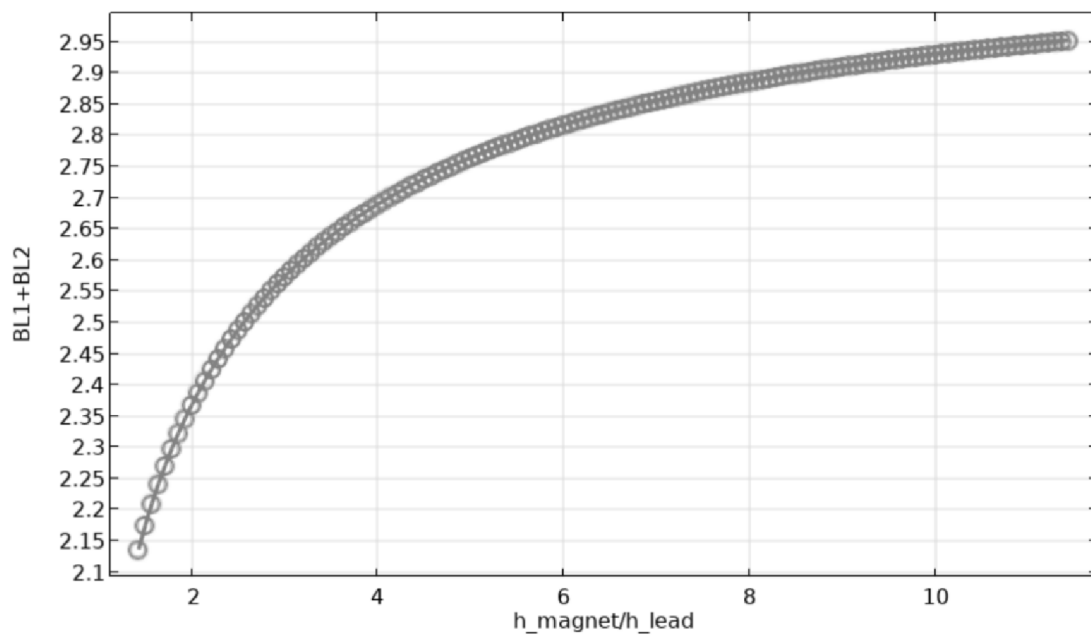


FIG. 64B

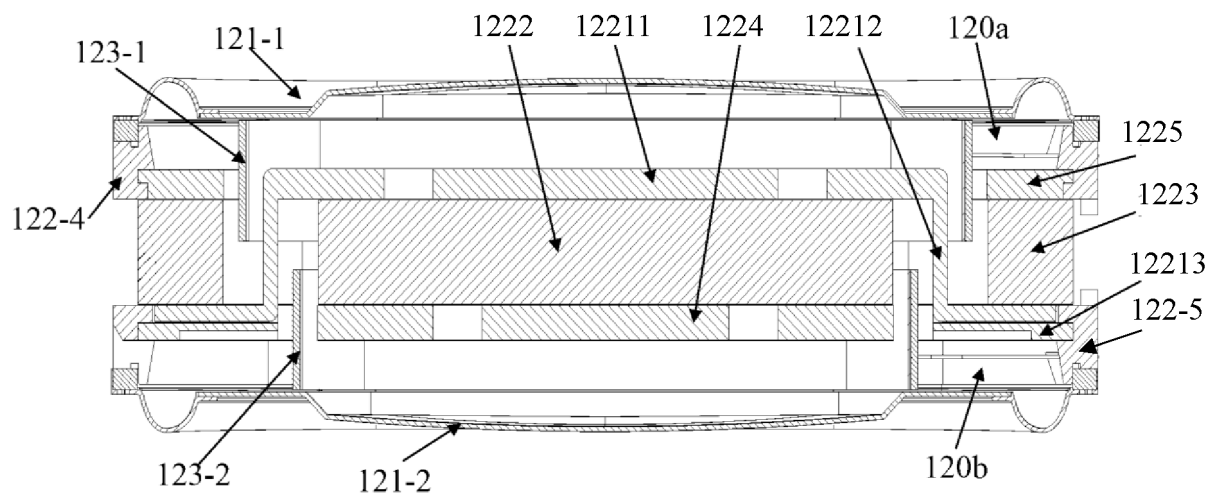


FIG. 65

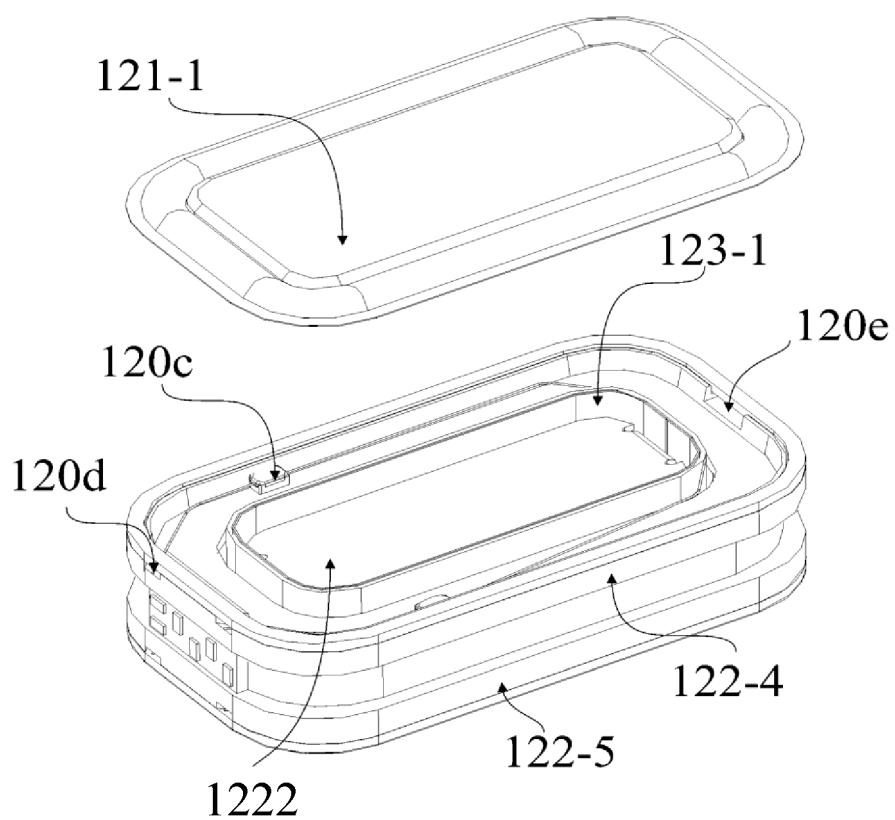


FIG. 66

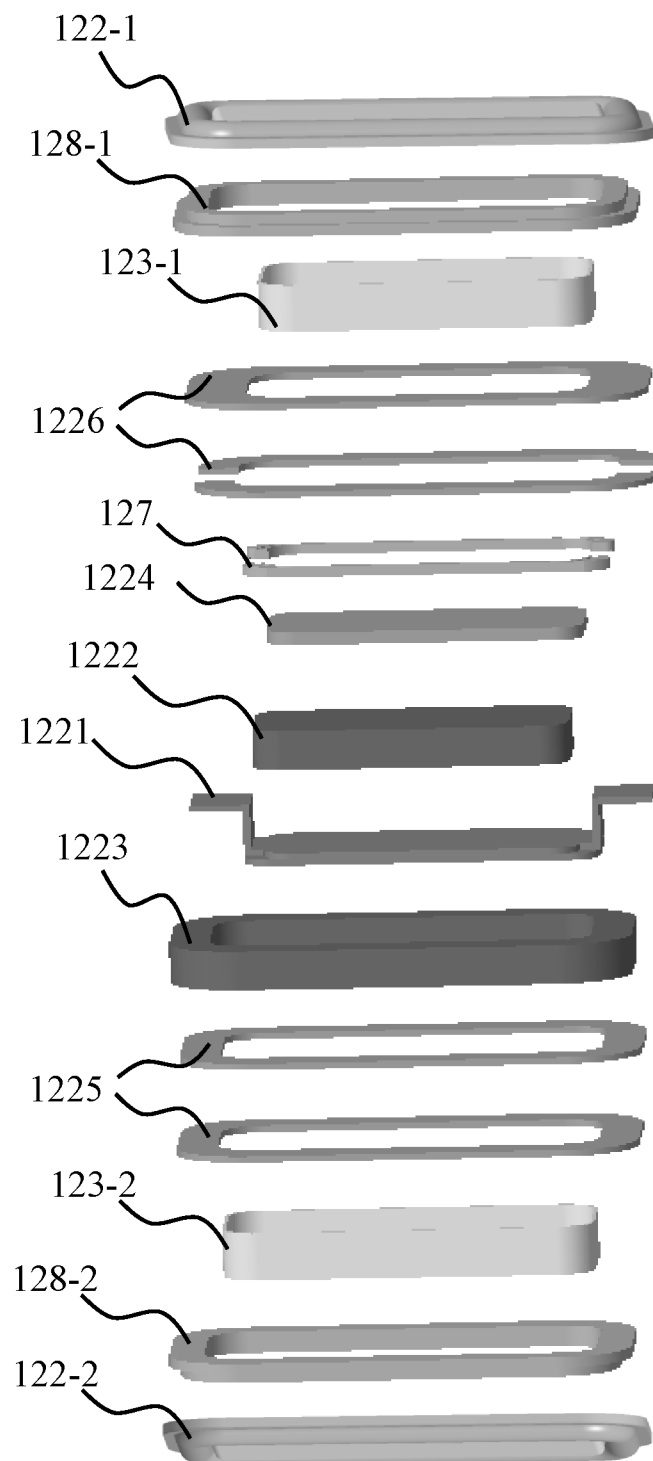


FIG. 67A

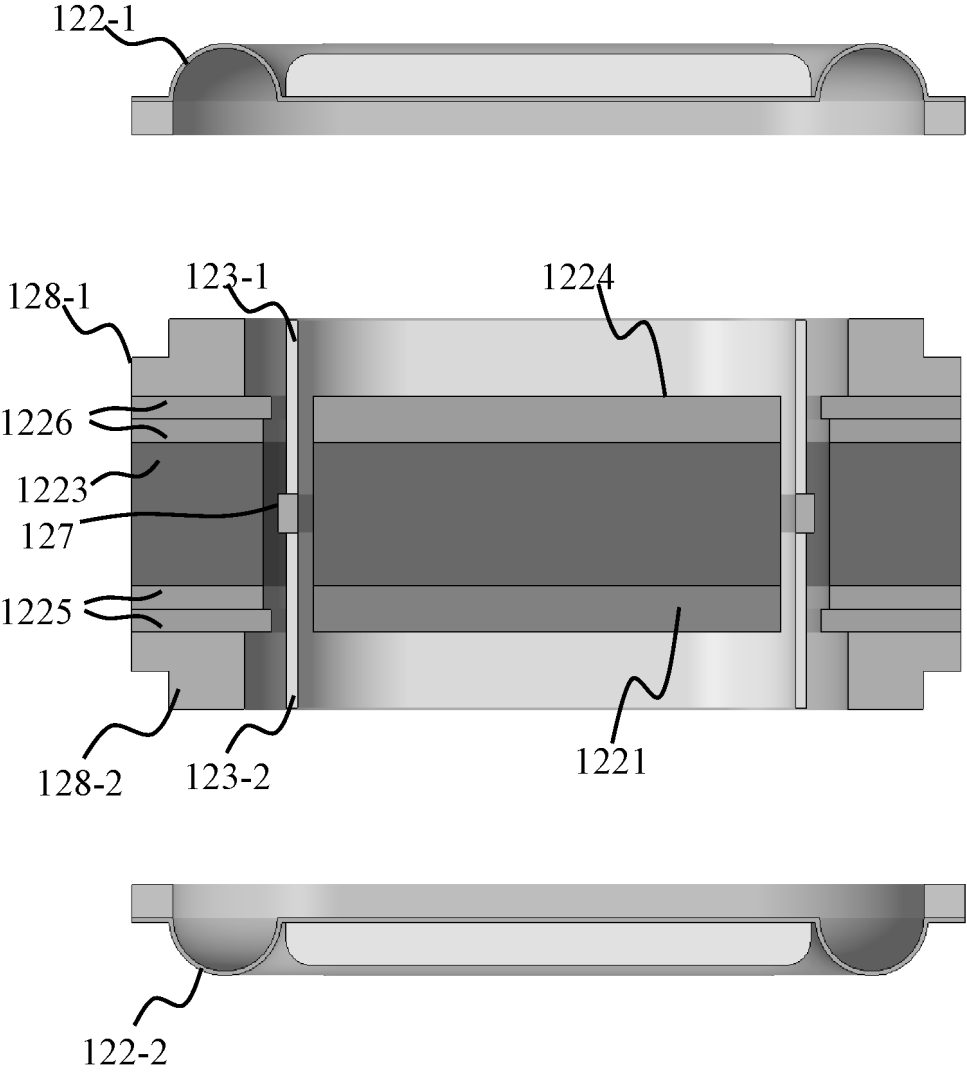


FIG. 67B

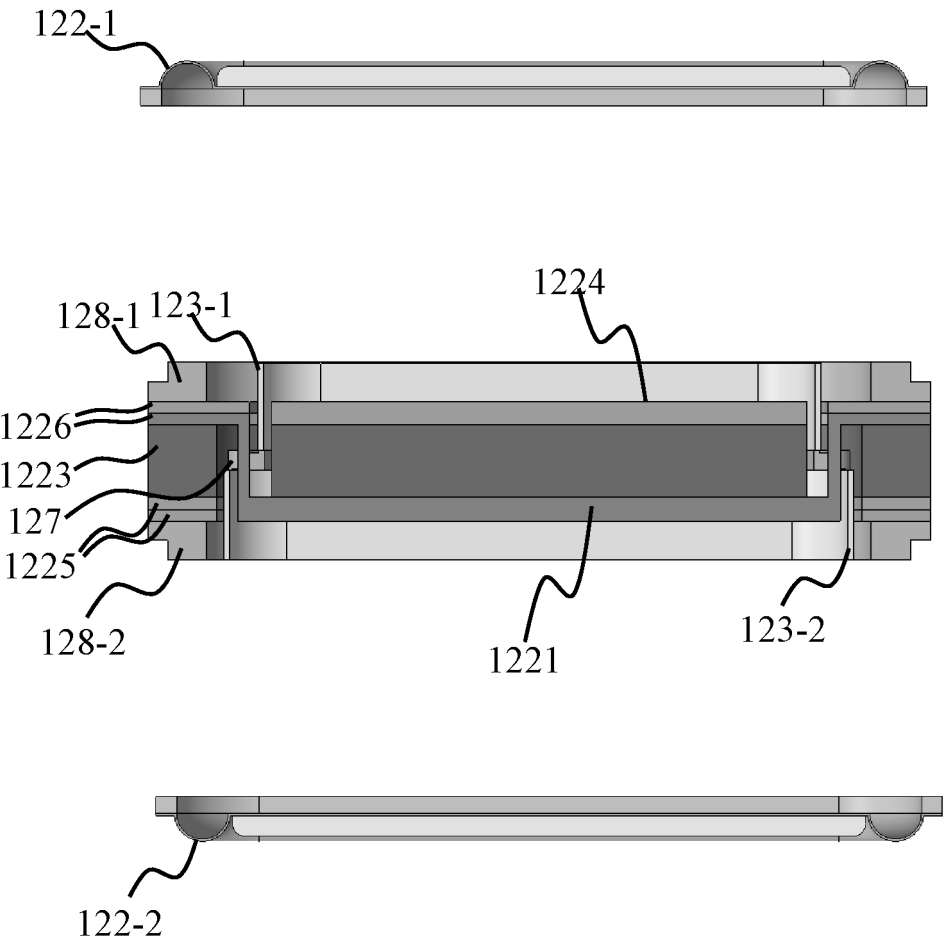


FIG. 67C

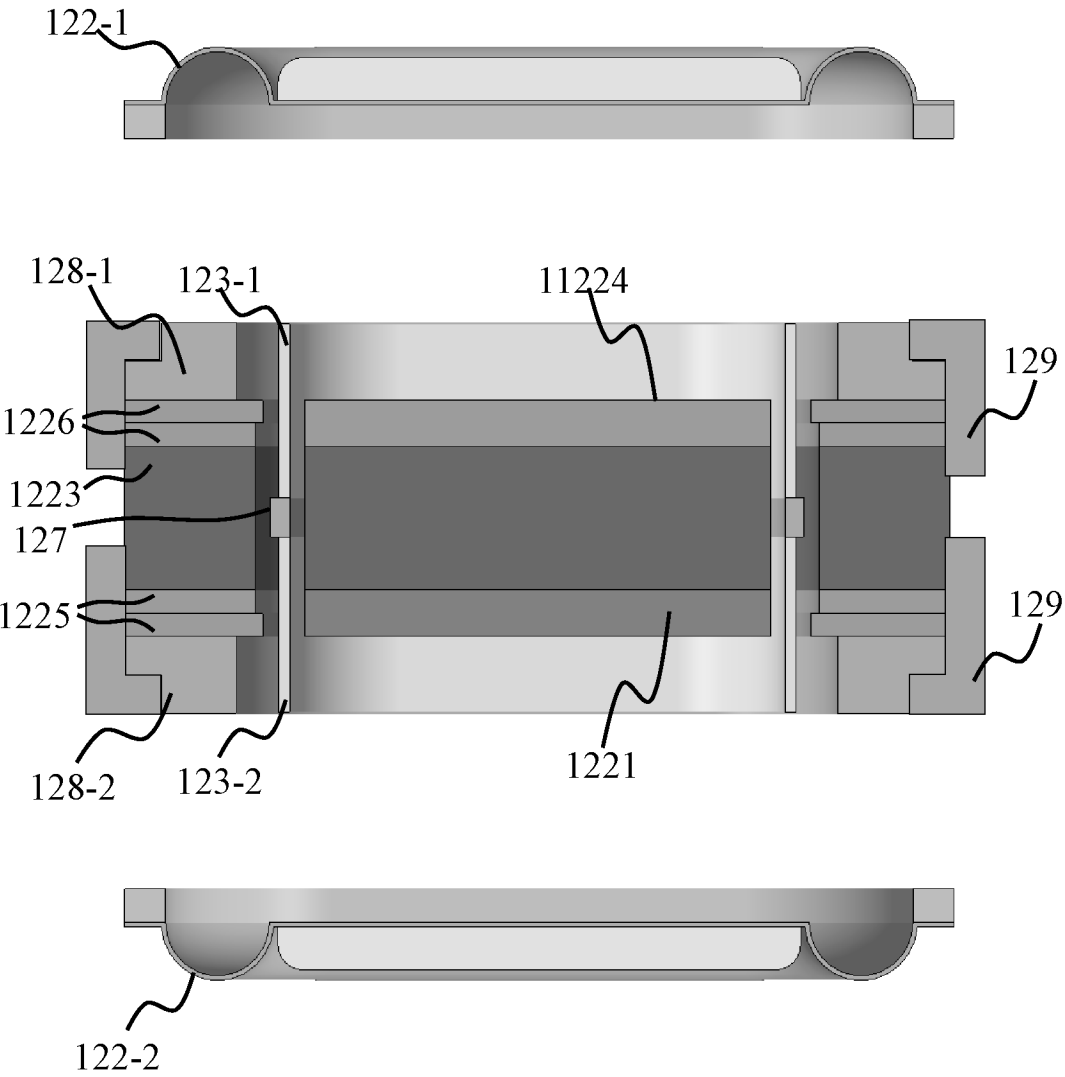


FIG. 68A

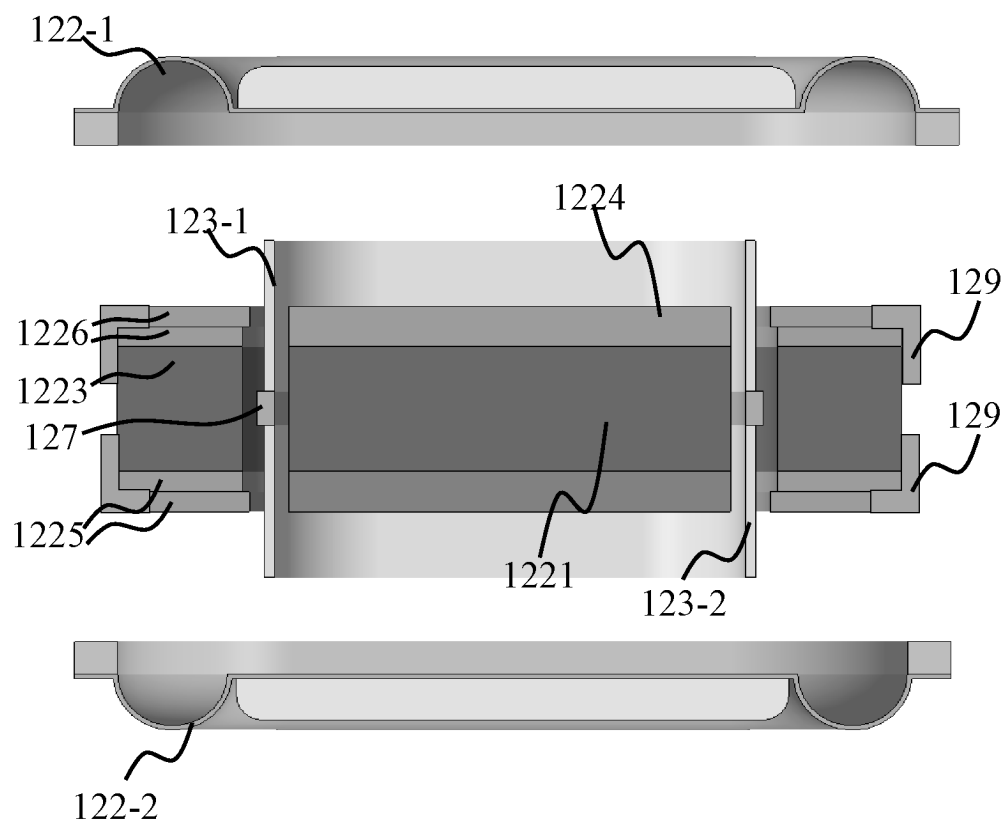


FIG. 68B



FIG. 69A

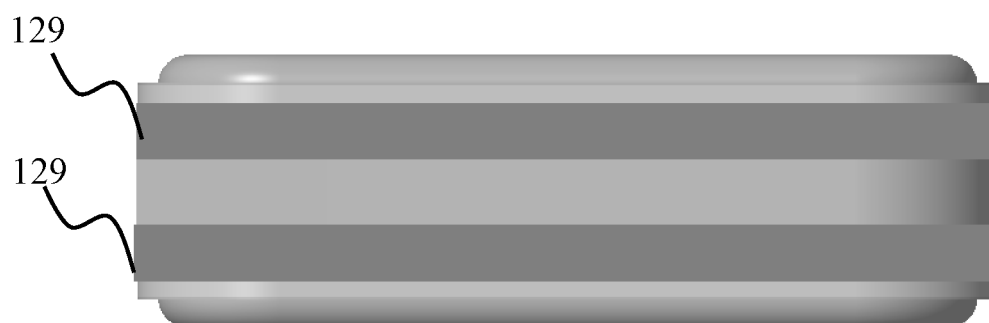


FIG. 69B



FIG. 70A

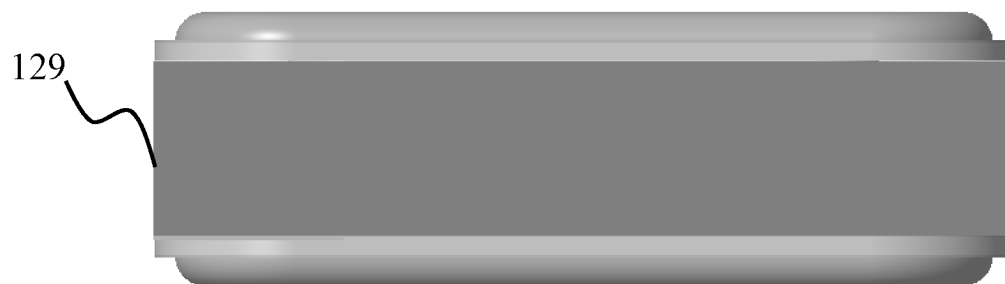


FIG. 70B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/109120

A. CLASSIFICATION OF SUBJECT MATTER

H04R9/06(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)

IPC: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)

CNABS, CNTXT, EPTXT, VEN, CNKI, USTXT, IEEE: 韶音, 周文兵, 张磊, 郭卜瑞, 刘志青, 齐心, 并联, 出声, 出音, 第二, 第一, 主, 耳道, 耳挂, 耳机, 耳塞, 辅助, 副, 换能器, 扬声器, 开放式, 喇叭, 联接, 联结, 连接, 连结, 相连, 另一, 膜, 腔, 受话器, 双, 双面, 同步, 同方向, 同时, 同向, 同一方向, 同轴, 外耳道, 线圈, 音圈, 震动, 振动, another, auxiliary, coil, connect, coupling, first, horn, link, main, receiver, second, side, simultaneously, speaker, synchronization, transducer, vibration, voice coil, same direction, co-directional

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 20060101891 A (LG ELECTRONICS INC.) 27 September 2006 (2006-09-27) description, pages 2-5, and figures 1-5	1-31
X	CN 106792394 A (FAN QIUYAN) 31 May 2017 (2017-05-31) description, paragraphs [0048]-[0073], and figures 1-13	1-31
Y	CN 117956362 A (SHENZHEN VOXTECH CO., LTD.) 30 April 2024 (2024-04-30) description, paragraphs [0119]-[0221], and figures 1-51	32-56
Y	KR 20060101891 A (LG ELECTRONICS INC.) 27 September 2006 (2006-09-27) description, pages 2-5, and figures 1-5	32-56
Y	CN 106792394 A (FAN QIUYAN) 31 May 2017 (2017-05-31) description, paragraphs [0048]-[0073], and figures 1-13	32-56
A	CN 109936803 A (HUAWEI DEVICE CO., LTD.) 25 June 2019 (2019-06-25) entire document	1-56

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

Date of the actual completion of the international search 31 October 2025	Date of mailing of the international search report 01 November 2025
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088	Authorized officer Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2025/109120

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 117440304 A (GOERTEK INC.) 23 January 2024 (2024-01-23) entire document	1-56

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2025/109120

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Patent document cited in search report				Publication date (day/month/year)		Patent family member(s)		Publication date (day/month/year)	
KR	20060101891	A	27 September 2006	KR	100672366	B1	24 January 2007		
CN	106792394	A	31 May 2017	None					
CN	117956362	A	30 April 2024	US	2024406609	A1	05 December 2024		
				JP	2025508589	A	26 March 2025		
CN	109936803	A	25 June 2019	EP	3920553	A1	08 December 2021		
				US	2022174409	A1	02 June 2022		
				US	11997464	B2	28 May 2024		
				WO	2020173395	A1	03 September 2020		
				CN	109936803	B	12 January 2021		
CN	117440304	A	23 January 2024	CN	117440304	B	30 April 2024		

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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- CN 202520976939 [0001]