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(54) **MULTIFUNCTIONAL SOUND DEVICE**

(71) Applicant: **AAC Technologies (Nanjing) Co., Ltd.**, Nanjing (CN)

(72) Inventors: **Xingzhi Huang**, Nanjing (CN); **Wei Song**, Nanjing (CN); **Jie Ma**, Nanjing (CN); **Lubin Mao**, Nanjing (CN); **Yun Tang**, Nanjing (CN); **Ziang Li**, Nanjing (CN)

(73) Assignee: **AAC Technologies (Nanjing) Co., Ltd.**, Nanjing (CN)

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(51) **Int. Cl.**

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H04R 7/04	(2006.01)
H04R 7/18	(2006.01)
H04R 9/04	(2006.01)
H04R 9/06	(2006.01)

(52) **U.S. Cl.**

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(58) **Field of Classification Search**

CPC H04R 9/06; H04R 9/025; H04R 9/046; H04R 2400/11

See application file for complete search history.

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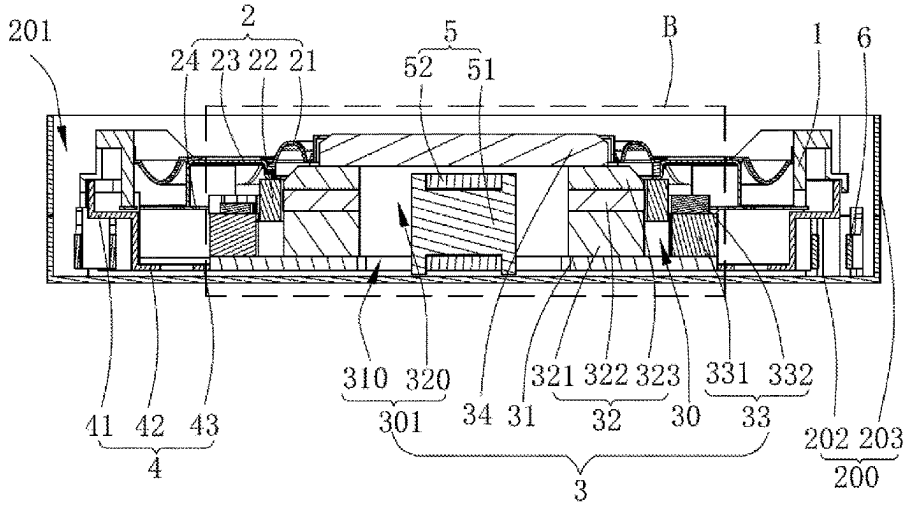
Primary Examiner — Sunita Joshi

(74) *Attorney, Agent, or Firm* — Wiersch Law Group

(57) **ABSTRACT**

A multifunctional sound device includes a housing, a sound unit, and a motor assembly. The sound unit includes a frame, a vibration system, a magnetic circuit system, and a first elastic component. The vibration system includes a vibrating diaphragm and a a voice coil. The voice coil drives the vibrating diaphragm to vibrate and generate sound along a first direction. A first end of the first elastic component is fixed to the frame. A second end of the first elastic component is elastically connected to the magnetic circuit system. The voice coil drives the magnetic circuit system to vibrate along the first direction. A mounting groove is defined on the magnetic circuit system. The motor assembly includes a stator and second elastic components. The stator is fixed to the housing. The stator is spaced apart from the magnetic circuit system and drives the magnetic circuit system to vibrate.

10 Claims, 5 Drawing Sheets



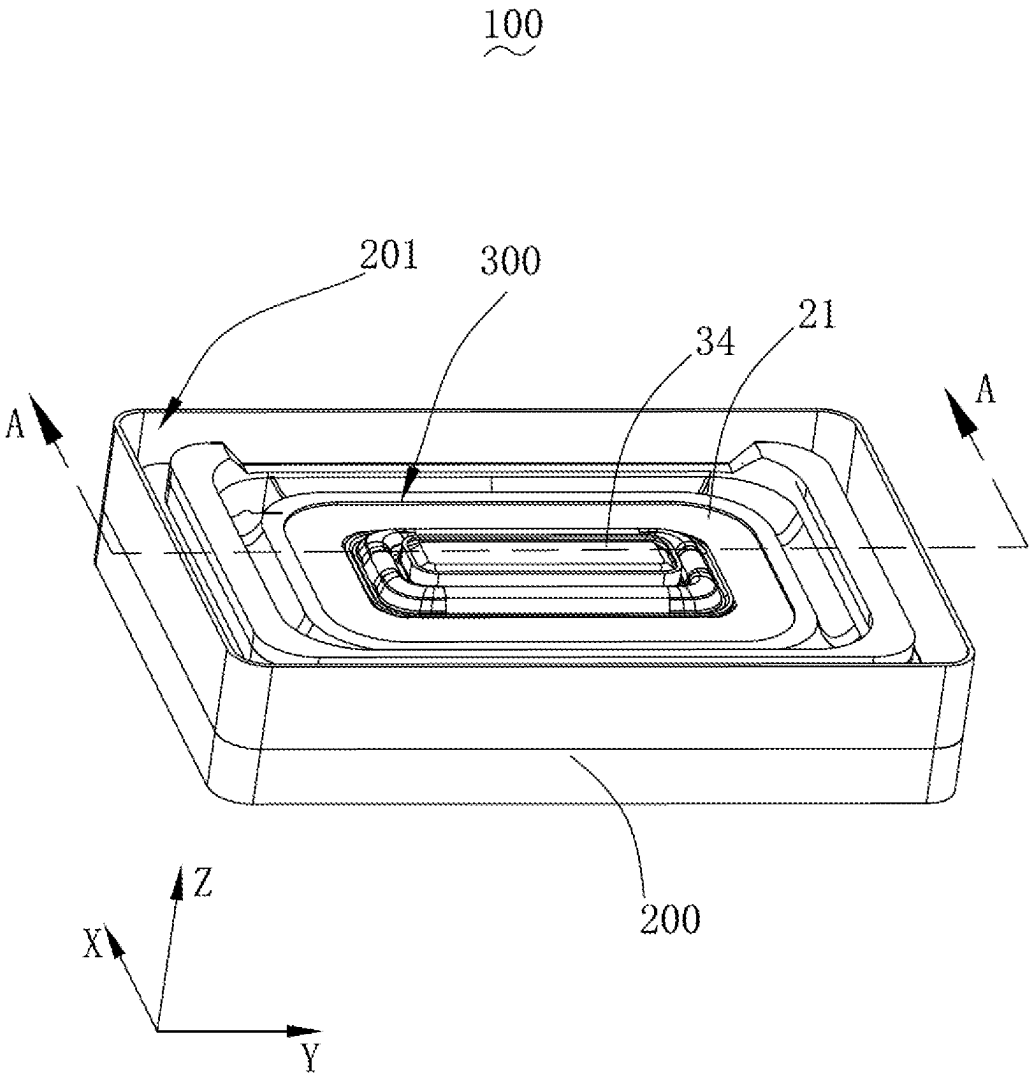
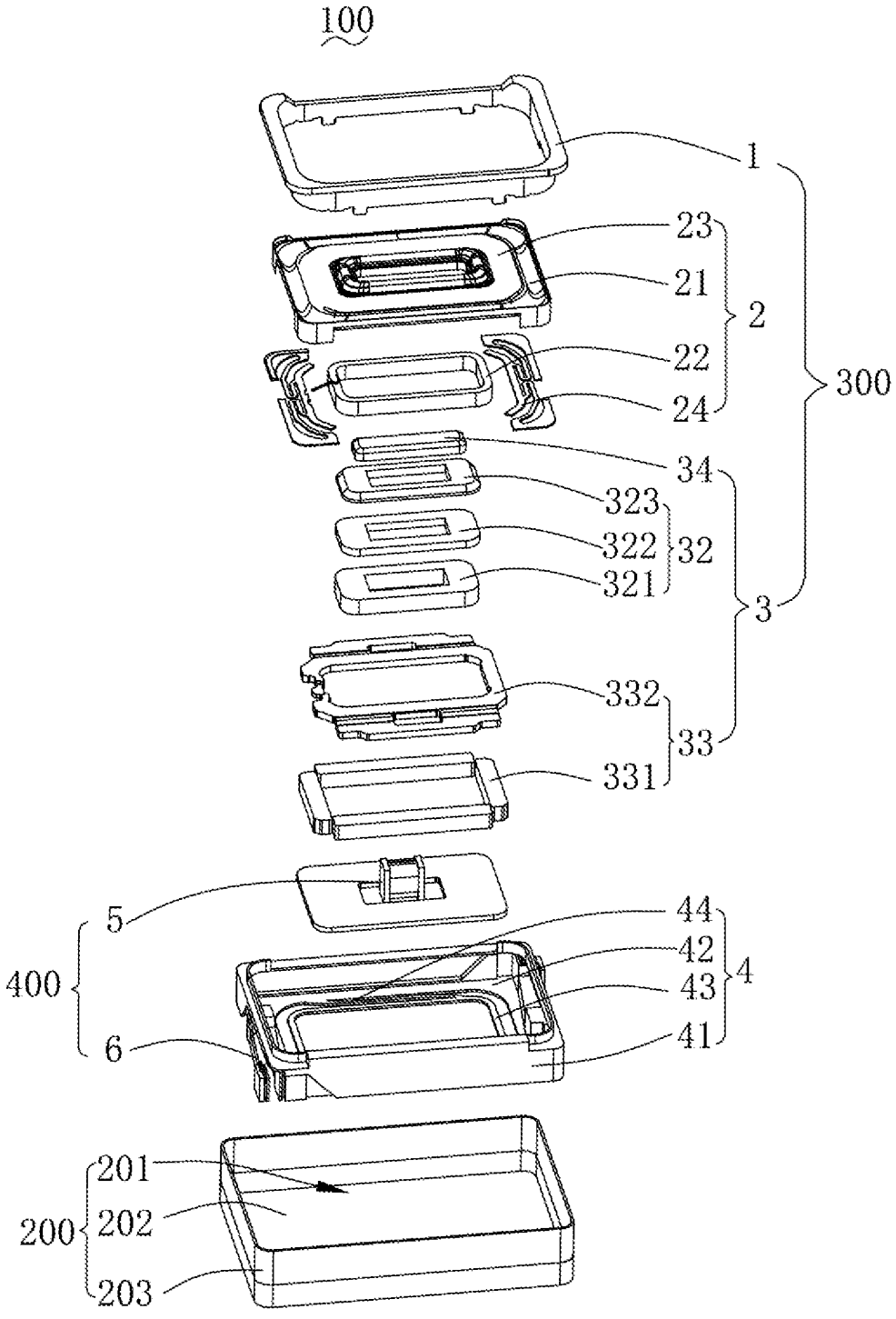


FIG. 1


100
1
23
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22
24
300
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323
322
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332
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400
44
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201
200
202
203

FIG. 2

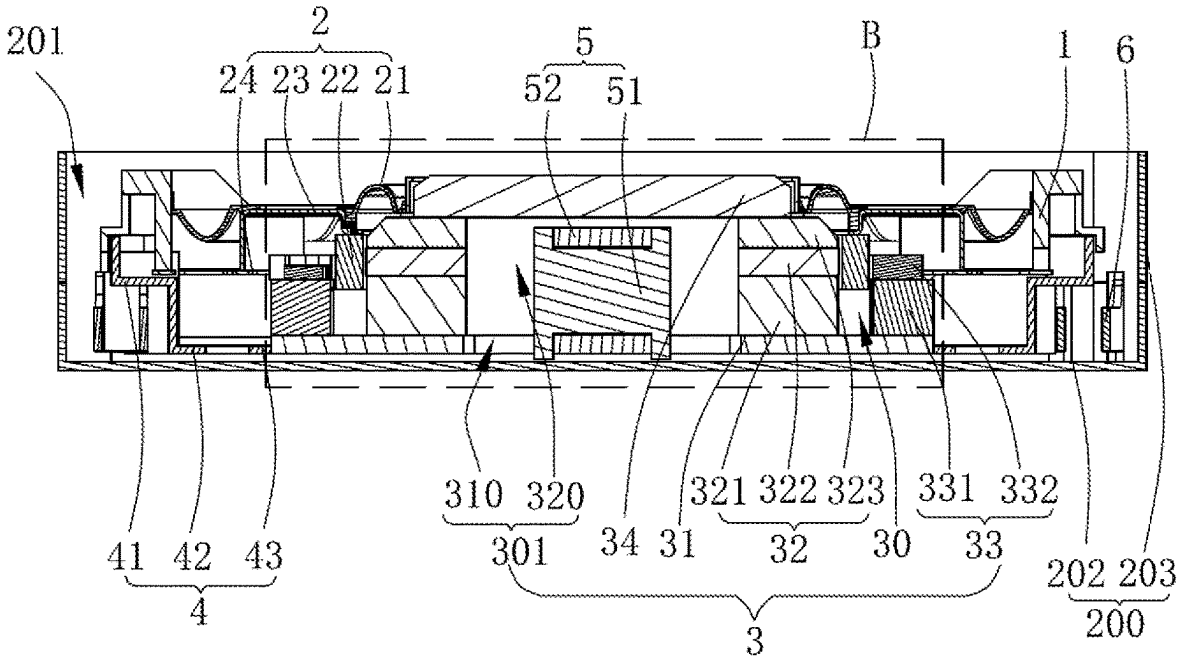
201
2
24 23 22 21
5
52 51
B
1
6
41 42 43
4
310 320
301
34 31
321 322 323
32
30
331 332
33
3
202 203
200

FIG. 3

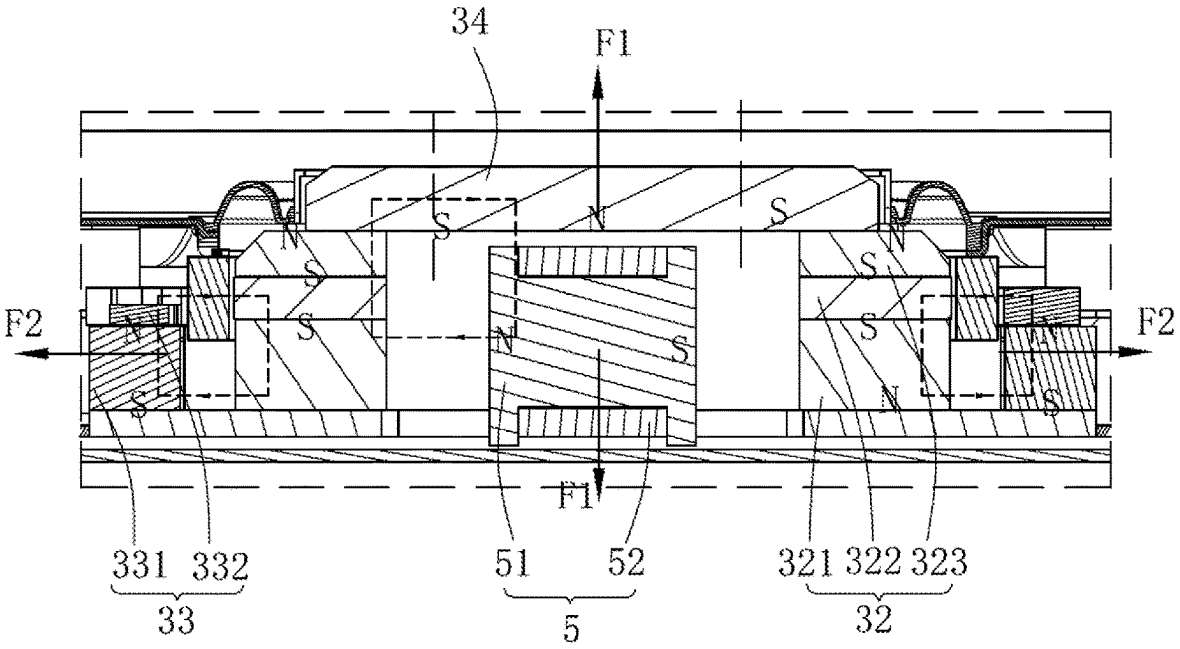

FIG. 4

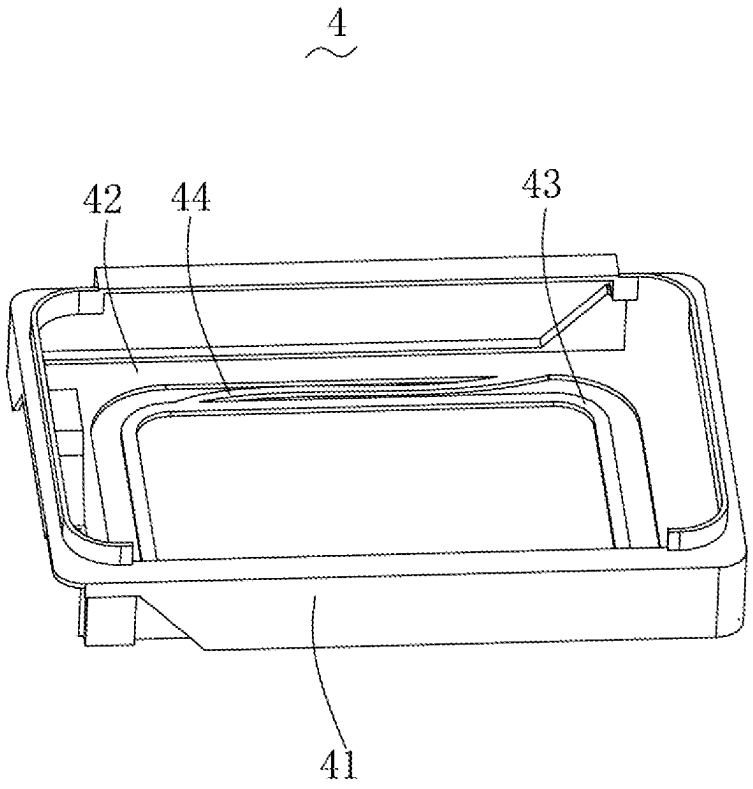

FIG. 5

MULTIFUNCTIONAL SOUND DEVICE

TECHNICAL FIELD

The present invention relates to a field of electroacoustic conversion, and in particular to a multifunctional sound device for electronic speakers.

BACKGROUND

With advent of the mobile Internet era, the number of intelligent mobile equipment continuously rises. Among various intelligent mobile equipment, there is no doubt that mobile phones are the most common and the most portable mobile terminal equipment. At present, the mobile phones have a variety of functions, such as a high-quality music playing function and a vibration function. Therefore, multifunctional sound devices having the vibration function and sound playing function are widely applied to current intelligent mobile equipment.

A conventional multifunctional sound devices in the prior art includes a housing, a sound unit, and a motor assembly. The sound unit and the motor assembly are accommodated in the housing. The sound unit includes a frame, a vibration system, and a magnetic circuit system. The vibration system and the magnetic circuit system are respectively fixed on the frame, and the magnetic circuit system defines a magnetic gap. The motor assembly is attached to one side, away from the vibration system, of the magnetic circuit system.

However, in the prior art, the sound unit and the motor assembly in the conventional multifunctional sound devices are independently controlled. Since the motor assembly is disposed below the sound unit, a thicknesses of the conventional multifunctional sound devices is increased, and the conventional multifunctional sound device is difficult to be light and thin. Moreover, a magnet of the sound unit and a magnet of the motor assembly are not on the same plane, and magnetic field driving forces of the sound unit and the motor assembly interfere with each other and affect each other, so that there is a large number of the magnets in the conventional multifunctional sound device, making the conventional multifunctional sound device large in volume and making it difficult for the conventional multifunctional sound device to be miniaturized, thereby resulting in poor acoustic performance and poor vibration performance of the conventional multifunctional sound device. In addition, in the prior art, a vibration direction of the conventional multifunctional sound device is generally perpendicular to a vibration direction of the vibrating diaphragm of the sound unit, which only achieves vibration in one direction.

Therefore, it is necessary to provide a multifunctional sound device to solve above technical problems.

SUMMARY

The present invention aims to provide a multifunctional sound device.

In order to achieve above aims, the present invention provides the multifunctional sound device including: a housing, a sound unit, and a motor assembly. The housing includes an accommodating space. The sound unit and the motor assembly are fixedly accommodated in the accommodating space. The sound unit includes a frame, a vibration system, and a magnetic circuit system. The vibration system and the magnetic circuit system are respectively fixed on the frame. The magnetic circuit system includes a magnetic gap. The vibration system includes a vibrating diaphragm and a voice coil. The vibrating diaphragm is fixed to the frame. The voice coil is configured to drive the vibrating diaphragm to sound. The voice coil is inserted into the magnetic gap to drive the vibrating diaphragm to vibrate and generate sound along a first direction. The sound unit further includes a first elastic component. The first elastic component suspends the magnetic circuit system in the accommodating space. A first end of the first elastic component is fixed to the frame. A second end of the first elastic component is elastically connected to the magnetic circuit system. The voice coil is inserted into the magnetic gap to drive the magnetic circuit system to vibrate along the first direction, so as to drive the sound unit to vibrate along the first direction. The magnetic circuit system is recessed along the first direction to from a mounting groove. The motor assembly includes a stator and second elastic components. The stator is accommodated in the mounting groove. The second elastic components suspend the sound unit in the accommodating space. The stator is fixed to the housing. The stator is spaced apart from the magnetic circuit system and drives the magnetic circuit system to vibrate along a second direction, so as to drive the sound unit to vibrate along the second direction. The first direction and the second direction are perpendicular to each other.

Optionally, the magnetic circuit system includes a magnetic yoke, a main magnetic circuit, an auxiliary magnetic circuit, and a top magnet. The main magnetic circuit is fixed to the magnetic yoke. The auxiliary magnetic circuit surrounds the main magnetic circuit and is spaced apart from the main magnetic circuit to form the magnetic gap. The top magnet is stacked on and fixed to one side, close to the vibration system, of the main magnetic circuit. The magnetic yoke is spaced apart from the housing and is located on one side, away from the vibration system, of the magnetic circuit system. The second end of the first elastic component is elastically connected to the magnetic yoke. A magnetic yoke center hole is defined in a center of the magnetic yoke. The magnetic yoke center hole penetrates the magnetic yoke. The main magnetic circuit is annular and defines a guide space. The main magnetic circuit is disposed around the magnetic yoke center hole. The guide space is communicated with the magnetic yoke center hole. The top magnet completely covers the guide space. The main magnetic circuit, the top magnet, and the magnetic yoke enclose to define the mounting groove.

Optionally, the vibrating diaphragm is annular. The vibrating diaphragm is disposed around the top magnet. An outer side of the vibrating diaphragm is fixed to the frame. An inner side of the vibrating diaphragm is fixed to the main magnetic circuit and/or the top magnet.

Optionally, the main magnetic circuit includes a first main magnet, a main pole core, and a second main magnet. The first main magnet is annular and is fixed to the magnetic yoke. The main pole core is annular and is stacked on and fixed to the first main magnet. The second main magnet is annular and is stacked on and fixed to the main pole core. The auxiliary magnetic circuit includes an auxiliary magnet and an auxiliary pole core. The auxiliary magnet is annular and is fixed to the magnetic yoke. The auxiliary pole core is annular and is stacked on and fixed to the auxiliary magnet. The auxiliary pole core and the main pole core are spaced apart to form the magnetic gap.

Optionally, a magnetizing direction of the first main magnet, a magnetizing direction of the second main magnet, a magnetizing direction of the auxiliary magnet, and a magnetizing direction of the top magnet are all along the first direction. The magnetizing direction of the first main magnet

is opposite to the magnetizing direction of the second main magnet and the magnetizing direction of the auxiliary magnet. A magnetic pole of one side, close to the main pole core, of the first main magnet is same as a magnetic pole of one side, close to the main pole core, of the second main magnet. The magnetic pole of the one side, close to the main pole core, of the first main magnet is opposite to a magnetic pole of one side, close to the auxiliary pole core, of the auxiliary magnet.

Optionally, the top magnet is of a multi-pole magnetizing structure including a plurality of magnetizing directions. One of the plurality of magnetizing directions is opposite to an adjacent magnetizing direction of the plurality of magnetizing directions along the second direction. A magnetic pole of one side, close to the second main magnet, of the top magnet is opposite to a magnetic pole of one side, close to the top magnet, of the second main magnet.

Optionally, the first elastic component includes a first section, a second section, a third section, and elastic arms. The first section is fixed to the frame. The second section is bent and extends from the first section to the magnetic yoke. The third section is fixed to the magnetic yoke. The elastic arms elastically connect the second section with the third section. A first end of each of the second elastic components is fixed to the housing. A second end of each of the second elastic components is fixed to the first section.

Optionally, the sound unit is rectangular. There are two second elastic components. The two second elastic components are respectively located on two opposite short sides of the sound unit.

Optionally, the stator includes an iron core and a coil. The iron core is fixed to the housing. The coil is wound on the iron core. The iron core is fixed to the housing and is at least partially accommodated in the guide space after passing through the magnetic yoke center hole. The coil is spaced apart from the main magnetic circuit and the top magnet and drive the magnetic circuit system to vibrate along the second direction, so as to drive the sound unit to vibrate along the second direction.

Optionally, the vibration system further includes a support frame and elastic supporting components. The support frame is fixed to the vibrating diaphragm. The elastic supporting components are spaced apart from the vibrating diaphragm. The voice coil is suspended in the magnetic gap through the support frame. A first end of each of the elastic supporting components is fixed to the frame. A second end of each of the elastic supporting components is fixed to the support frame.

Compared with the prior art, the multifunctional sound device includes the mounting groove. The mounting groove is formed in a center position of the magnetic circuit system, and since there are few magnetic field lines in the center position of the magnetic circuit system, after the mounting groove is formed in the center position of the magnetic circuit system, a magnetic energy product utilization rate of the magnetic circuit system is increased, and acoustic performance of the multifunctional sound device is excellent. The motor assembly is accommodated in the mounting groove, so that an overall thickness of the multifunctional sound device is small, which makes the multifunctional sound device light and thin. The sound unit includes the first elastic component. The first end of the first elastic component is fixed to the frame. The second end of the first elastic component is elastically connected to the magnetic circuit system. The voice coil is inserted into the magnetic gap to drive the magnetic circuit system to vibrate along the first direction, so as to drive the sound unit to vibrate along the first direction. The motor assembly includes the stator and the second elastic components. The stator is accommodated in the mounting groove. The second elastic components suspend the sound unit in the accommodating space. The stator is fixed to the one side, away from the vibration system, of the housing. The stator is spaced apart from the magnetic circuit system and drives the magnetic circuit system to vibrate, so as to drive the sound unit to vibrate along the second direction. The multifunctional sound device is enabled to vibrate along the first direction and vibrate along the second direction. Furthermore, the first direction and the second direction are perpendicular to each other. When the motor assembly drives the sound unit to vibrate along the second direction, the stator of the motor assembly has little influence on a driving force of the magnetic circuit system of the sound unit along the first direction, and mutual interference is small. When the voice coil drives the sound unit to vibrate along the first direction, the magnetic circuit system is reused, so that the multifunctional sound device is small in size, excellent in the acoustic performance, and excellent in vibration performance.

BRIEF DESCRIPTION OF DRAWINGS

In order to more clearly illustrate technical solutions in embodiments of the present invention, drawings required in description of the embodiments are briefly described below. Obviously, the drawings in the following description are merely some embodiments of the present invention. For a person of ordinary skill in art, other drawings may be obtained according to the drawings without creative efforts.

FIG. **1** is a perspective schematic diagram of a multifunctional sound device according to one embodiment of the present invention.

FIG. **2** is an exploded perspective schematic diagram of parts of the multifunctional sound device according to one embodiment of the present invention.

FIG. **3** is a cross-sectional schematic diagram taken along the line A-A shown in FIG. **1**.

FIG. **4** is an enlarged schematic diagram of the portion B shown in FIG. **3**;

FIG. **5** is a perspective schematic diagram of a first elastic component of the multifunctional sound device according to one embodiment of the present invention.

DETAILED DESCRIPTION

Technical solutions in embodiments of the present invention are clearly and completely described below with reference to accompanying drawings in the embodiments of the present invention. Obviously, the described embodiments are only a part of the embodiments of the present invention, not all of the embodiments. Based on the embodiments of the present invention, all other embodiments obtained by a person of ordinary skill in art without creative efforts shall fall within a protection scope of the present invention.

Referring to FIGS. **1-5**, the present invention provides a multifunctional sound device **100**.

Specifically, the multifunctional sound device **100** includes a housing **200**, a sound unit **300**, and a motor assembly **400**. The housing **200** defines an accommodating space **201**. The sound unit **300** and the motor assembly **400** are fixedly accommodated in the accommodating space **201**.

The housing **200** includes a bottom wall **202** and a side wall **203**. The side wall **203** is bent and extends from a periphery of the bottom wall **202**. The bottom wall **202** and

the side wall **203** together enclose the accommodating space **201**. Certainly, the housing **200** may be integrally formed.

The sound unit **300** includes a frame **1**, a vibration system **2**, a magnetic circuit system **3**, and a first elastic component **4**. The vibration system **2** and the magnetic circuit system **3** are respectively fixed on the frame **1**. The magnetic circuit system **3** includes a magnetic gap **30**. The first elastic component **4** suspends the magnetic circuit system **3** in the accommodating space **201**.

The magnetic circuit system **3** drives the vibration system **2** to vibrate and generate sound along a first direction. In the embodiment, the first direction Z is a thickness direction of the sound unit **300**.

The vibration system **2** includes a vibrating diaphragm **21**, a voice coil **22**, a support frame **23**, and elastic supporting components **24**. The vibrating diaphragm **21** is fixed to the frame **1**. The voice coil **22** is configured to drive the vibrating diaphragm **21** to sound. The support frame **23** is fixed to the vibrating diaphragm **21**. The elastic supporting components **24** are spaced apart from the vibrating diaphragm **21**.

The voice coil **22** is inserted into the magnetic gap **30** to drive the vibrating diaphragm **21** to vibrate and generate sound along the first direction Z. The elastic supporting components **24** are directly fixed to the voice coil **22**.

By arrangements of the elastic supporting components **24**, the voice coil **22** is prevented from horizontally vibrating during vibration, thereby ensuring good stability of the multifunctional sound device **100**. Of course, arrangements of the elastic supporting components **24** are not limited as described above, in another embodiment, the elastic supporting components **24** are directly fixed to the voice coil **22**.

A first end of each of the elastic supporting components **24** is fixed to the frame **1**. A second end of each of the elastic supporting components **24** is fixed to the support frame **23**. By the arrangements of the elastic supporting components **24**, the voice coil **22** is prevented from horizontally vibrating during vibration, and vibration performance of the voice coil **22** is improved, thereby ensuring the good stability of the multifunctional sound device **100**. The elastic supporting components **24** are flexible circuit boards and are configured to supply power to the voice coil **22** and prevent lead of the voice coil **22** from being disconnected, so that the multifunctional sound device **100** is good in stability.

In the embodiment, the sound unit **300** is rectangular. There are two elastic supporting components. The two elastic supporting components **24** are respectively located on two opposite short sides of the magnetic circuit system **3**.

In the embodiment, the support frame **23** is made of metal materials, which is configured to realize rigid connection between a dome of the vibrating diaphragm **21** and the voice coil **22**.

The magnetic circuit system **3** drives the vibration system **2** to vibrate and generate sound. The magnetic circuit system **3** is recessed along the first direction Z to define a mounting groove **301**. In the embodiment, the mounting groove **301** is formed in a center position of the magnetic circuit system **3**. The motor assembly **400** is accommodated in the mounting groove **301**. Since there are few magnetic field lines in the center position of the magnetic circuit system **3**, after the mounting groove **301** is formed in the center position of the magnetic circuit system **3**, a magnetic energy product utilization rate of the magnetic circuit system **3** is increased, making acoustic performance of the multifunctional sound device **100** excellent.

The magnetic circuit system **3** includes a magnetic yoke **31**, a main magnetic circuit **32**, an auxiliary magnetic circuit **33**, and a top magnet **34**.

The magnetic yoke **31** is spaced apart from the housing **200** and is located on one side, away from the vibration system **2**, of the magnetic circuit system **3**. A magnetic yoke center hole **310** is defined in a center of the magnetic yoke **31**. The magnetic yoke center hole **310** penetrates the magnetic yoke **31**. The magnetic yoke center hole **310** is communicated with the accommodating space **201**.

The main magnetic circuit **32** is fixed to the magnetic yoke **31** and is disposed around the magnetic yoke center hole **310**.

The main magnetic circuit **32** is annular and defines a guide space **320**. The guide space **320** is communicated with the magnetic yoke center hole **310**. The main magnetic circuit **32** that is annular increases a space of the magnetic gap **30** of the magnetic circuit system **3** and improves the acoustic performance of the multifunctional sound device **100**. The guide space **320** is communicated with the magnetic yoke center hole **310**, and the guide space **320** and the magnetic yoke center hole **310** enclose to define the mounting groove **301**. The guide space **320** is configured to accommodate the motor assembly **400**. By such arrangement, the motor assembly **400** is disposed in the guide space **320**, so that an overall thickness of the multifunctional sound device **100** is small, making the multifunctional sound device **100** light and thin.

Specifically, the main magnetic circuit **32** includes a first main magnet **321**, a main pole core **322**, and a second main magnet **323**. The first main magnet **321** is annular and is fixed to the magnetic yoke **31**. The main pole core **322** is annular and is stacked on and fixed to the first main magnet **321**. The second main magnet **323** is annular and is stacked on and fixed to the main pole core **322**.

The auxiliary magnetic circuit **33** is fixed to the magnetic yoke **31**.

Specifically, the auxiliary magnetic circuit **33** includes an auxiliary magnet **331** and an auxiliary pole core **332**. The auxiliary magnet **331** is annular and is fixed to the magnetic yoke **31**. The auxiliary pole core **332** is annular and is stacked on and fixed to the auxiliary magnet **331**.

The auxiliary magnetic circuit **33** surrounds the main magnetic circuit **32** and is spaced apart from the main magnetic circuit **32** to form the magnetic gap **30**.

The auxiliary pole core **332** and the main pole core **322** are spaced apart to form the magnetic gap **30**. In the embodiment, the magnetic yoke **31**, the main pole core **322**, and the auxiliary pole core **332** are made of strong magnetic conductive materials, which enhance magnetic driving force of the magnetic circuit system **3**.

The top magnet **34** is stacked on and fixed to one side, close to the vibration system **2**, of the main magnetic circuit **32**. The top magnet **34** completely covers the guide space **320**. The main magnetic circuit **32**, the top magnet **34**, and the magnetic yoke **31** enclose to define the mounting groove **301**.

In the embodiment, the vibrating diaphragm **21** is annular. The vibrating diaphragm **21** is disposed around the top magnet **34**. An outer side of the vibrating diaphragm **21** is fixed to the frame **1**. An inner side of the vibrating diaphragm **21** is fixed to the main magnetic circuit **32** and/or the top magnet **34**. The vibrating diaphragm **21** is fixed to the magnetic circuit system **3**, so that the overall thickness of the multifunctional sound device is small, which facilitates light and thin application of the multifunctional sound device **100**.

A first end of the first elastic component **4** is fixed to the frame **1**. A second end of the first elastic component **4** is elastically connected to the magnetic circuit system **3**.

The voice coil **22** is inserted into the magnetic gap **30** to drive the magnetic circuit system **3** to vibrate along the first direction Z, so as to drive the sound unit **300** to vibrate along the first direction Z.

When the sound unit **300** vibrates in the first direction Z, the magnetic circuit system **3** is suspended in the accommodating space **201** through the first elastic component **4**, so that the sound unit **300** is able to vibratee along the first direction Z.

Specifically, the first elastic component **4** includes a first section **41**, a second section **42**, a third section **43**, and elastic arms **44**. The first section **41** is fixed to the frame **1**. The second section **42** is bent and extends from the first section **41** to the magnetic yoke **31**. The third section **43** is fixed to the magnetic yoke **31**. The elastic arms **44** elastically connect the second section **42** to the third section **43**. A first end of each of second elastic components **6** is fixed to the housing **200**. A second end of each of the second elastic components **6** is fixed to the first section **41**. Thus, on one hand, the magnetic circuit system **3** is suspended in the accommodating space **201**, and on the other hand, the overall thickness of the multifunctional sound device **100** is small, which makes the multifunctional sound device **100** light and thin.

The motor assembly **400** includes a stator **5** and the second elastic components **6**. The stator **5** is accommodated in the mounting groove **301**. The second elastic components **6** suspend the sound unit **300** in the accommodating space **201**.

The stator **5** is fixed to one side, away from the vibration system **2**, of the housing **200**. The stator **5** is spaced apart from the magnetic circuit system **3** and drives the magnetic circuit system **3** to vibrate along a second direction Y, so as to drive the sound unit **300** to vibrate along the second direction Y.

The first direction Z and the second direction Y are perpendicular to each other. In the embodiment, the sound unit **300** is rectangular, and the frame **1** is rectangular. The second direction Y is a direction of a long axis of the frame **1**. In addition, a direction of a short axis of the frame **1** is a third direction X. The third direction X, the first direction Z, and the second direction Y are perpendicular to each other.

The stator **5** includes an iron core **51** and a coil **52**. The iron core **51** is fixed to the housing **200**. the coil **52** is wound on the iron core **51**. The iron core **51** is fixed to the housing **200** and is at least partially accommodated in the guide space **320** after passing through the magnetic yoke center hole **310**.

The coil **52** is spaced apart from the main magnetic circuit **32** and the top magnet **34** and drives the magnetic circuit system **3** to vibrate along the second direction Y, so as to drive the sound unit **300** to vibrate along the second direction Y.

In the embodiment, there are two second elastic components **6**. The two second elastic components **6** are respectively located on two opposite short sides of the sound unit **300**.

Principle of the multifunctional sound device **100** of the present invention that achieves vibration in two directions is as follows:

A magnetizing direction of the first main magnet **321**, a magnetizing direction of the second main magnet **323**, a magnetizing direction of the auxiliary magnet **331**, and a magnetizing direction of the top magnet **34** are all along the first direction Z. The magnetizing direction of the first main magnet **321** is opposite to the magnetizing direction of the second main magnet **323** and the magnetizing direction of the auxiliary magnet **331**.

A magnetic pole of one side, close to the main pole core **322**, of the first main magnet **321** is same as a magnetic pole of one side, close to the main pole core **322**, of the second main magnet **323**.

The magnetic pole of the one side, close to the main pole core **322**, of the first main magnet **321** is opposite to a magnetic pole of one side, close to the auxiliary pole core **332**, of the auxiliary magnet **331**.

The top magnet **34** is of a multi-pole magnetizing structure including a plurality of magnetizing directions. One of the plurality of magnetizing directions is opposite to an adjacent magnetizing direction of the plurality of magnetizing directions along the second direction Y.

A magnetic pole of one side, close to the second main magnet **323**, of the top magnet **34** is opposite to a magnetic pole of one side, close to the top magnet **34**, of the second main magnet **323**.

Referring to FIG. **4**, in the embodiment, the magnetic pole of the one side, close to the main pole core **322**, of the first main magnet **321** is an S pole. The magnetic pole of the one side, away from the main pole core **322**, of the first main magnet **321** is an N pole. The magnetic pole of the one side, close to the main pole core **322**, of the second main magnet **323** is the S pole. The magnetic pole of the one side, away from the main pole core **322**, of the second main magnet **323** is the N pole. The magnetic pole of the one side, close to the auxiliary pole core **332**, of the auxiliary magnet **331** is the N pole. A magnetic pole of one side, away from the auxiliary pole core **332**, of the auxiliary magnet **331** is the S pole. The magnetic pole of the one side, close to the second main magnet **323**, of the top magnet **34**, is the S pole.

Magnetic field lines of the first main magnet **321** sequentially pass through the magnetic yoke **31**, the auxiliary magnet **331**, the auxiliary pole core **332**, the main pole core **322**, and the first main magnet **321** to form a magnetic loop. When the voice coil **22** is energized, a driving force F**1** along the first direction Z is formed to reciprocate the magnetic circuit system **3** to vibrate along the first direction Z.

When the coil **52** is energized, the iron core **51** is polarized along the second direction Y to have the N pole and the S pole. The polarized iron core **51** interacts with magnetic poles of two ends of the top magnet **34** adjacent to the iron core **51** in to form a suction force and a repulsive force, and directions of the suction force and the repulsive force are consistent to form a driving force F**2** along the second direction Y. The driving force F**2** along the second direction Y reciprocates the sound unit **300** to vibrate along the second direction Y.

The vibrating diaphragm **21** of the sound unit **300** has a rigidity K**1**. The rigidity K**1** is configured to provide elastic support for the voice coil **22** to form the vibration system **2** for vibrating and generating sound, and the vibration system **2** has a frequency F**01**.

The first elastic component **4** has a rigidity KZ along the first direction Z and provides the elastic support for the magnetic circuit system **3**, so as to form a Z-direction vibration system reciprocating the multifunctional sound device **100** to vibrate along the first direction Z, and the Z-direction vibration system has a frequency F**0**z.

The second elastic components **6** provide a rigidity Ky along the second direction Y, and provides a support for the whole sound unit **300**, resulting in forming a Y-direction vibration system for reciprocating vibration of the multi-

functional sound device **100** along the second direction Y, and the Y-direction vibration system has a frequency F0*y*.

For the magnetic circuit system **3** and the voice coil **22**, the voice coil **22** is energized under a magnetic field of the magnetic circuit system **3** to generate the driving force F**1**. A direction of the driving force F**1** alternatively changes along the first direction Z, but a magnitude of the driving force F**1** is constant.

The driving force F**2** formed by the coil **52** acts on the whole of the sound unit **300**. When a working frequency of the driving force F**2** is close to the frequency F0*y*, the Y-direction system resonates in the second direction Y, resulting in forming a Y-direction vibration system for reciprocating the multifunctional sound device **100** to vibrate along the second direction Y to form a Y-axis motor.

When a working frequency of the driving force F**1** is close to the frequency F**01**, the vibrating diaphragm **21** and the voice coil **22** of the vibration system **2** resonate along the first direction Z. That is, the sound unit **300** vibrates and generate sound to work as a speaker.

When the working frequency of the driving force F**1** is close to the frequency F0*z*, the magnetic circuit system **3** resonates along the first direction Z, reciprocating the multifunctional sound device **100** to vibrate along the first direction Z to form a Z-axis motor.

The working frequency of the sound unit **300** is generally high, and the working frequency of the motor assembly **400** is low, that is, the frequency F**01** is far greater than the frequency F0*z*, so that a risk of mutual interference between the sound unit **300** and the motor assembly **400** is avoided.

Compared with the prior art, the multifunctional sound device includes the mounting groove. The mounting groove is formed in the center position of the magnetic circuit system, and since there are few magnetic field lines in the center position of the magnetic circuit system, after the mounting groove is formed in the center position of the magnetic circuit system, a magnetic energy product utilization rate of the magnetic circuit system is increased, and the acoustic performance of the multifunctional sound device is excellent. The motor assembly is accommodated in the mounting groove, so that the overall thickness of the multifunctional sound device is small, which makes the multifunctional sound device light and thin. The sound unit includes the first elastic component. The first end of the first elastic component is fixed to the frame. The second end of the first elastic component is elastically connected to the magnetic circuit system. The voice coil is inserted into the magnetic gap to drive the magnetic circuit system to vibrate along the first direction, so as to drive the sound unit to vibrate along the first direction. The motor assembly includes the stator and the second elastic components. The stator is accommodated in the mounting groove. The second elastic components suspend the sound unit in the accommodating space. The stator is fixed to the one side, away from the vibration system, of the housing. The stator is spaced apart from the magnetic circuit system and drives the magnetic circuit system to vibrate, so as to drive the sound unit to vibrate along the second direction. The multifunctional sound device is enabled to vibrate along the first direction and vibrate along the second direction. Furthermore, the first direction and the second direction are perpendicular to each other. When the motor assembly drives the sound unit to vibrate along the second direction, the stator of the motor assembly has little influence on the driving force of the magnetic circuit system of the sound unit along the first direction, and mutual interference is small. When the voice coil drives the sound unit to vibrate along the first direction, the magnetic circuit system is reused, so that the multifunctional sound device is small in size, excellent in the acoustic performance, and excellent in vibration performance.

The above are only the embodiments of the present invention. It should be noted that, for the person of ordinary skill in the art, improvements are made without departing from concepts of the present invention, but these are all within the protection scope of the present invention.

What is claimed is:

1. A multifunctional sound device, comprising:

a housing;

a sound unit; and

a motor assembly;

wherein the housing comprises an accommodating space; the sound unit and the motor assembly are fixedly accommodated in the accommodating space; the sound unit comprises a frame, a vibration system, and a magnetic circuit system; the vibration system and the magnetic circuit system are respectively fixed on the frame; the magnetic circuit system defines a magnetic gap; the vibration system comprises a vibrating diaphragm and a voice coil; the vibrating diaphragm is fixed to the frame; the voice coil is configured to drive the vibrating diaphragm to sound; and the voice coil is inserted into the magnetic gap to drive the vibrating diaphragm to vibrate and generate sound along a first direction;

the sound unit further comprises a first elastic component; the first elastic component suspends the magnetic circuit system in the accommodating space; a first end of the first elastic component is fixed to the frame; a second end of the first elastic component is elastically connected to the magnetic circuit system; the voice coil is inserted into the magnetic gap to drive the magnetic circuit system to vibrate along the first direction, so as to drive the sound unit to vibrate along the first direction; and

the magnetic circuit system is recessed along the first direction to from a mounting groove; the motor assembly comprises a stator and second elastic components; the stator is accommodated in the mounting groove; the second elastic components suspend the sound unit in the accommodating space; the stator is fixed to the housing; the stator is spaced apart from the magnetic circuit system and drives the magnetic circuit system to vibrate along a second direction, so as to drive the sound unit to vibrate along the second direction; the first direction and the second direction are perpendicular to each other.

2. The multifunctional sound device according to claim **1**, wherein the magnetic circuit system comprises a magnetic yoke, a main magnetic circuit, an auxiliary magnetic circuit, and a top magnet; the main magnetic circuit is fixed to the magnetic yoke; the auxiliary magnetic circuit surrounds the main magnetic circuit and is spaced apart from the main magnetic circuit to form the magnetic gap, and the top magnet is stacked on and fixed to one side, close to the vibration system, of the main magnetic circuit;

the magnetic yoke is spaced apart from the housing and is located on one side, away from the vibration system, of the magnetic circuit system; the second end of the first elastic component is elastically connected to the magnetic yoke; a magnetic yoke center hole is defined in a center of the magnetic yoke, and the magnetic yoke center hole penetrates the magnetic yoke; and

the main magnetic circuit is annular and defines a guide space; the main magnetic circuit is disposed around the magnetic yoke center hole; the guide space is communicated with the magnetic yoke center hole; the top magnet completely covers the guide space; the main magnetic circuit, the top magnet, and the magnetic yoke enclose to define the mounting groove.

3. The multifunctional sound device according to claim **2**, wherein the vibrating diaphragm is annular; the vibrating diaphragm is disposed around the top magnet; an outer side of the vibrating diaphragm is fixed to the frame, and an inner side of the vibrating diaphragm is fixed to the main magnetic circuit and/or the top magnet.

4. The multifunctional sound device according to claim **2**, wherein the main magnetic circuit comprises a first main magnet, a main pole core, and a second main magnet; the first main magnet is annular and is fixed to the magnetic yoke; the main pole core is annular and is stacked on and fixed to the first main magnet; the second main magnet is annular and is stacked on and fixed to the main pole core; the auxiliary magnetic circuit comprises an auxiliary magnet and an auxiliary pole core; the auxiliary magnet is annular and is fixed to the magnetic yoke; the auxiliary pole core is annular and is stacked on and fixed to the auxiliary magnet; the auxiliary pole core and the main pole core are spaced apart to form the magnetic gap.

5. The multifunctional sound device according to claim **4**, wherein a magnetizing direction of the first main magnet, a magnetizing direction of the second main magnet, a magnetizing direction of the auxiliary magnet, and a magnetizing direction of the top magnet are along the first direction; the magnetizing direction of the first main magnet is opposite to the magnetizing direction of the second main magnet and the magnetizing direction of the auxiliary magnet; a magnetic pole of one side, close to the main pole core, of the first main magnet is same as a magnetic pole of one side, close to the main pole core, of the second main magnet; the magnetic pole of the one side, close to the main pole core, of the first main magnet is opposite to a magnetic pole of one side, close to the auxiliary pole core, of the auxiliary magnet.

6. The multifunctional sound device according to claim **5**, wherein the top magnet is a multi-pole magnetizing structure having a plurality of magnetizing directions; one of the plurality of magnetizing directions is opposite to an adjacent magnetizing direction of the plurality of magnetizing directions along the second direction; a magnetic pole of one side, close to the second main magnet, of the top magnet is opposite to a magnetic pole of one side, close to the top magnet, of the second main magnet.

7. The multifunctional sound device according to claim **2**, wherein the first elastic component comprises a first section, a second section, a third section, and elastic arms; the first section is fixed to the frame; the second section is bent and extends from the first section to the magnetic yoke; the third section is fixed to the magnetic yoke; the elastic arms elastically connect the second section with the third section; a first end of each of the second elastic components is fixed to the housing, and a second end of each of the second elastic components is fixed to the first section.

8. The multifunctional sound device according to claim **1**, wherein the sound unit is rectangular, there are two second elastic components; and the two second elastic components are respectively located on two opposite short sides of the sound unit.

9. The multifunctional sound device according to claim **2**, wherein the stator comprises an iron core and a coil; the iron core is fixed to the housing; the coil is wound on the iron core, the iron core is fixed to the housing and is at least partially accommodated in the guide space after passing through the magnetic yoke center hole; the coil is spaced apart from the main magnetic circuit and the top magnet and drive the magnetic circuit system to vibrate along the second direction, so as to drive the sound unit to vibrate along the second direction.

10. The multifunctional sound device according to claim **1**, wherein the vibration system further comprises a support frame and elastic supporting components; the support frame is fixed to the vibrating diaphragm; the elastic supporting components are spaced apart from the vibrating diaphragm; the voice coil is suspended in the magnetic gap through the support frame; a first end of each of the elastic supporting components is fixed to the frame, and a second end of each of the elastic supporting components is fixed to the support frame.

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