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(71) Applicant

000005832

Panasonic Electric Works Co., Ltd.

1048 Oaza Kadoma, Kadoma City,
Osaka Prefecture

(74) Agent

100087767

Patent Attorney: Keisei Nishikawa

(74) Agent

100085604

Patent Attorney: Atsuo Mori

(72) Inventor

Manabu Nakata

Panasonic Electric Works Co., Ltd.,
1048 Oaza Kadoma, Kadoma City,
Osaka Prefecture

(72) Inventor

Yoshio Mitsutake

Panasonic Electric Works Co., Ltd.,
1048 Oaza Kadoma, Kadoma City,
Osaka Prefecture

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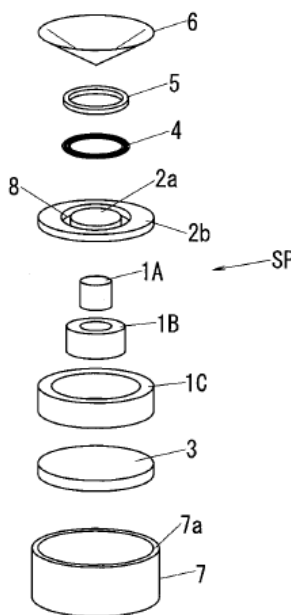
(54) [Title of the Invention] Speaker Device

(57) [Abstract]

[Problem] To provide a small-sized speaker device with a large magnet volume and strong electromagnetic force.

[Solution] A speaker device SP comprising: a cylindrical magnet 1A magnetized along the axial direction; a first annular magnet 1B arranged concentrically with the cylindrical magnet 1A, with its inner circumferential surface tightly attached to the outer circumferential surface of the cylindrical magnet 1A, and magnetized along the radial direction; a second annular magnet 1C arranged concentrically with the cylindrical magnet 1A, with its inner circumferential surface tightly attached to the outer circumferential surface of the first annular magnet 1B, and magnetized along the axial direction; a cylindrical magnetic body 2a and an annular magnetic body 2b made of iron or the like, arranged concentrically with the cylindrical magnet 1A at one end of the cylindrical magnet 1A; a cylindrical magnetic body 3 made of iron or the like, arranged concentrically with the cylindrical magnet 1A at the other end of the cylindrical magnet 1A; a gap 8 formed concentrically with the cylindrical magnet 1A between the cylindrical magnetic body 2a and the annular magnetic body 2b; a voice coil 4 arranged in the gap 8; a diaphragm 6 that vibrates with the displacement of the voice coil 4 via a voice coil bobbin; and a housing 7 made of synthetic resin.

[Abstract Drawing] Figure 1



SP	Speaker Device
1A	Cylindrical Magnet
1B	First Annular Magnet
1C	Second Annular Magnet
2a	Cylindrical Magnetic Body
2b	Annular Magnetic Body
3	Cylindrical Magnetic Body
4	Voice Coil
5	Voice Coil Bobbin
6	Diaphragm
7	Housing
8	Gap

[Claims]

[Claim 1]

A speaker device characterized by comprising: a columnar magnet, and magnetized along the axial direction, with one end in the axial direction as the first pole and the other end as the second pole; a first annular magnet arranged concentrically with the columnar magnet, with its inner circumferential surface tightly attached to the outer circumferential surface of the columnar magnet, and magnetized along the radial direction perpendicular to the axial direction, with the inner circumference as the first pole and the outer circumference as the second pole; a second annular magnet arranged concentrically with the columnar magnet, with its inner circumferential surface tightly attached to the outer circumferential surface of the first annular magnet, and magnetized along the axial direction, with one end in the axial direction as the first pole and the other end as the second pole; magnetic bodies arranged at both ends of the columnar magnet, the first annular magnet, and the second annular magnet; a gap formed concentrically with the columnar magnet in the magnetic bodies arranged at one end of the columnar magnet, the first annular magnet, and the second annular magnet; a voice coil arranged in the gap; and a diaphragm that vibrates with the displacement of the voice coil.

[Claim 2]

The speaker device according to Claim 1, characterized by comprising an insertion hole penetrating from the magnetic body on one side through the columnar magnet to the magnetic body on the other side, wherein the diaphragm is connected to the outside via the insertion hole.

[Claim 3]

The speaker device according to Claim 1 or 2, characterized in that the first and second annular magnets and the magnetic bodies are housed in a non-magnetic housing, and the outer circumferential surfaces of the second annular magnet and the magnetic bodies are tightly attached to the inner surface of the housing, and the outer edge of the diaphragm is supported by the housing.

[Claim 4]

The speaker device according to any one of Claim 1 to 3, characterized in that one end of each of the columnar magnet, the first annular magnet, and the second annular magnet is exposed in the gap, and a recess is provided at a position symmetrical to the voice coil.

[Detailed description of invention]

[Technical field]

[0001]

The present invention relates to a speaker device with a magnet and a voice coil.

[Background art]

[0002]

Conventionally, the magnetic circuit of a speaker, as shown in Figure 8, consists of a cylindrical magnet 101 arranged at the center, an annular magnet 102 arranged around it, a cylindrical magnetic body 103, an annular magnetic body 104, and a resin housing 105. The cylindrical magnet 101 and the annular magnet 102 are magnetized along the axial direction, while their magnetization directions are opposite to each other. Moreover, a voice coil (not shown) is arranged in a gap 106 formed between the cylindrical magnetic body 103 and the annular magnetic body 104. (For example, refer to Patent Document 1)

[Patent Document 1] Patent Publication No. 2002-27590 (Paragraphs [0010] to [0019], Figures 1 and 2)

[Disclosure of invention]

[Topic to be solved by the invention]

[0003]

As shown in Figure 8, in the conventional magnetic circuit, there is a gap 107 between the cylindrical magnet 101 and the annular magnet 102 arranged on the inner and outer circumferences of the voice coil, respectively, which reduces the volume of the magnet and results in low magnetic flux density within the magnet. Therefore, the electromagnetic force in the gap 106 between the 2 magnets where the voice coil is arranged becomes weak, leading to low output efficiency and large size.

[0004]

The present invention is based on the above circumstances, aiming to provide a small-sized speaker device with a large magnet volume and strong electromagnetic force.

[Topic solution]

[0005]

The invention of Claim 1 is characterized by comprising: a columnar magnet magnetized along the axial direction, with one end in the axial direction as the first pole and the other end as the second pole; a first annular magnet arranged concentrically with the columnar magnet, with its inner circumferential surface tightly attached to the outer circumferential surface of the columnar magnet, and magnetized along the radial direction perpendicular to the axial direction, with the inner circumference as the first pole and the outer circumference as the second pole; a second annular magnet arranged concentrically with the columnar magnet, with its inner circumferential surface tightly attached to the outer circumferential surface of the first annular magnet, and magnetized along the axial direction, with one end in the axial direction as the first pole and the other end as the second pole; magnetic bodies arranged at both ends of the columnar magnet, the first annular magnet, and the second annular magnet; a gap formed concentrically with the columnar magnet in the magnetic bodies arranged at one end of the columnar magnet, the first annular magnet, and the second annular magnet; a voice coil arranged in the gap; and a diaphragm that vibrates with the displacement of the voice coil.

10 [0006]

With the present invention, a first annular magnet magnetized along the radial direction is present in the gap between the 2 conventional magnets. Therefore, the volume of the magnet increases, the magnetic energy also increases, and the magnetic flux linked with the voice coil increases. Thus, the electromagnetic force acting on the voice coil increases. As a result, the output efficiency improves, and miniaturization can be achieved.

[0007]

Moreover, in the absence of the first annular magnet magnetized along the radial direction, the magnetic flux forms a ring on the surface of the magnet. Therefore, the magnetic flux not linked with the voice coil increases, and the amount of magnet linked with the voice coil decreases. However, in this speaker device, by using the first annular magnet magnetized along the radial direction, a magnetic flux path is formed widely around the voice coil, as shown by the dotted line X1 in Figure 2. Therefore, the magnetic flux not linked with the voice coil decreases, and the amount of magnet linked with the voice coil increases. Thus, the electromagnetic force acting on the voice coil increases, further improving the output efficiency.

20 [0008]

The invention of Claim 2 is characterized by comprising, in Claim 1, an insertion hole penetrating from the magnetic body on one side through the columnar magnet to the magnetic body on the other side, wherein the diaphragm is connected to the outside via the insertion hole.

[0009]

With the present invention, the airflow generated by the vibration of the diaphragm can be discharged through the insertion hole, reducing the strain on the diaphragm caused by air pressure changes during vibration.

[0010]

30 The invention of Claim 3 is characterized by, in Claim 1 or 2, housing the first and second annular magnets and the magnetic bodies in a non-magnetic housing, with the outer circumferential surfaces of the second annular magnet and the magnetic bodies tightly attached to the inner surface of the housing, and supporting the outer edge of the diaphragm by the housing.

[0011]

With the present invention, the leakage magnetic flux from the outer circumferential surfaces of the second annular magnet and the magnetic bodies can be reduced, while the diameter of the diaphragm can be increased.

[0012]

The invention of Claim 4 is characterized by, in any one of Claim 1 to 3, exposing one end of each of the columnar magnet, the first annular magnet, and the second annular magnet in the gap, and providing a recess at a position symmetrical to the voice coil.

[0013]

With the present invention, the voice coil does not interfere with the magnet when the voice coil is displaced.

40 [Effects of the Invention]

[0014]

As described above, a first annular magnet magnetized along the radial direction is present in the gap between the 2 conventional magnets. Therefore, the volume of the magnet increases, the magnetic energy also increases, and the magnetic flux linked with the voice coil increases. Thus, the electromagnetic force acting on the voice coil increases. As a result, the output efficiency improves, and miniaturization can be achieved.

[0015]

50 Moreover, in the absence of the first annular magnet magnetized along the radial direction, the magnetic flux forms a ring on the surface of the magnet. Therefore, the magnetic flux not linked with the voice coil increases, and the amount of magnet linked with the voice coil decreases. However, in this speaker device, by using the first annular magnet magnetized along the radial direction, a magnetic flux path is formed widely around the voice coil. Therefore, the magnetic flux not linked with the voice coil decreases, and the amount of magnet linked with the voice coil increases. Thus, the electromagnetic force acting on the voice coil increases, further improving the output efficiency.

10 [0016]

That is, it has the effect of providing a small-sized speaker device with a large magnet volume and strong electromagnetic force.

[Best Embodiment of the Invention]

[0017]

Hereinafter, Embodiment of the present invention will be described with reference to the drawings.

[0018]

(Embodiment 1)

20 Figures 1 and 2(a) show the configuration of the speaker device SP of this embodiment, which comprises: a cylindrical magnet 1A; a first annular magnet 1B arranged concentrically with the cylindrical magnet 1A, with its inner circumferential surface tightly attached to the outer circumferential surface of the cylindrical magnet 1A; a second annular magnet 1C arranged concentrically with the cylindrical magnet 1A, with its inner circumferential surface tightly attached to the outer circumferential surface of the first annular magnet 1B; a cylindrical magnetic body 2a and an annular magnetic body 2b made of iron or the like, arranged concentrically with the cylindrical magnet 1A at one end of the cylindrical magnet 1A; a cylindrical magnetic body 3 made of iron or the like, arranged concentrically with the cylindrical magnet 1A at the other end of the cylindrical magnet 1A; a voice coil 4; a voice coil bobbin 5; a dome-shaped diaphragm 6; and a bottomed annular housing 7 with one end open.

[0019]

The cylindrical magnet 1A is magnetized along the axial direction (front-rear direction), as shown in Figure 2(a), with one end magnetized as the S pole and the other end as the N pole.

[0020]

30 The first annular magnet 1B is magnetized along the radial direction perpendicular to the axial direction, as shown in Figure 2(a), with the inner circumference magnetized as the S pole and the outer circumference as the N pole.

[0021]

The second annular magnet 1C is magnetized along the axial direction, as shown in Figure 2(a), with one end magnetized as the S pole and the other end as the N pole.

[0022]

Moreover, at one end of the cylindrical magnet 1A, the first annular magnet 1B, and the second annular magnet 1C, a cylindrical magnetic body 2a is arranged concentrically with the cylindrical magnet 1A, and an annular magnetic body 2B is arranged outside the cylindrical magnetic body 2a, with the inner circumference of the annular magnetic body 2b symmetrical to the outer circumference of the cylindrical magnetic body 2a.

[0023]

40 A gap 8 is formed concentrically with the cylindrical magnet 1A between the outer circumference of the cylindrical magnetic body 2a and the inner circumference of the annular magnetic body 2b, and one end of the first annular magnet 1B is exposed in the gap 8.

[0024]

A voice coil is arranged in the gap 8, freely movable along the front-rear direction. The voice coil 4 is connected to the back of the diaphragm 6 via an annular voice coil bobbin 5. When a sound signal is input to the voice coil 4, an electromagnetic force is generated in the voice coil 4 by the current input to the voice coil 4 and the magnetic fields of the cylindrical magnet 1A, the first annular magnet 1B, and the second annular magnet 1C. Therefore, the voice coil bobbin 5 vibrates along the front-rear direction with the diaphragm 6. At this time, the diaphragm 6 emits sound corresponding to the sound signal. That is, the above-mentioned cylindrical magnet 1A, first annular magnet 1B, second annular magnet 1C, cylindrical magnetic body 2a, annular magnetic body 2b, cylindrical magnetic body 3, voice coil 4, voice coil bobbin 5, and diaphragm 6, which constitute the electrodynamic speaker device SP, are housed in a housing 7 made of synthetic resin such as acetal resin, and the outer circumferential surfaces of the second annular magnet 1C, annular magnetic body 2b, and cylindrical magnetic body 3 are tightly attached to the inner side of the housing 7. The housing is made of non-magnetic material such as synthetic resin, which can reduce the leakage magnetic flux from the outer circumferential surfaces of the second annular magnet 1C, annular magnetic body 2b, and cylindrical magnetic body 3 compared to a housing made of magnetic material.

50 [0025]

Moreover, the outer edge of the diaphragm 6 is supported by the open edge 7a at one end of the housing 7, allowing the diameter of the diaphragm 6 to be maximized relative to the housing 7.

[0026]

In this speaker device SP, a first annular magnet 1B magnetized along the radial direction is provided between the cylindrical magnet 1A and the second annular magnet 1C, and the first annular magnet 1B is present in the gap between the two conventional magnets. Therefore, the volume of the magnet increases, the magnetic energy also increases, and the magnetic flux linked with the voice coil increases. Thus, the electromagnetic force acting on the voice coil 4 increases. As a result, the output power improves, and miniaturization can be achieved under the same output conditions compared to the conventional method.

[0027]

Moreover, in the absence of the first annular magnet 1B magnetized along the radial direction, the magnetic flux forms a ring on the surface of the magnet. Therefore, the magnetic flux not linked with the voice coil 4 increases, and the amount of magnet linked with the voice coil 4 decreases. However, in this speaker device SP, by using the first annular magnet 1B magnetized along the radial direction, as shown by the dotted line X1 in Figure 2, a magnetic flux path is formed widely around the voice coil 4. Therefore, the magnetic flux not linked with the voice coil 4 decreases, and the amount of magnet linked with the voice coil 4 increases. Thus, the electromagnetic force acting on the voice coil 4 increases, further improving the output efficiency.

[0028]

Furthermore, the simulation results of the electromagnetic force generated in the gap 8 when 0.4W is input to the voice coil 4 are shown in Figure 8. Compared to the conventional magnetic circuit speaker, the electromagnetic force increases by about 5-10%. #####

[0029]

Moreover, as shown in Figure 2(b), the cylindrical magnet 1 can be magnetized with one end as the N pole and the other end as the S pole, the first annular magnet 1B can be magnetized with the inner circumference as the N pole and the outer circumference as the S pole, and the second annular magnet 1C can also be magnetized with the other end as the N pole and one end as the S pole. (That is, the magnetization direction of each magnet in Figure 2(b) is opposite to that in Figure 2(a).)

(Embodiment 2)

Figures 3 and 4(a) show the configuration of the speaker device SP of this embodiment. Holes 9b, 9a, 9c, and 9d are provided at the radial centers of the cylindrical magnet 1A, cylindrical magnetic body 2a, cylindrical magnetic body 3, and housing 7 of Embodiment 1, respectively, forming an insertion hole 9 at the radial center of this speaker device SP.

[0030]

The back of the diaphragm 6 is connected to the outside via the insertion hole 9, allowing the airflow generated by the vibration of the diaphragm 6 to be discharged through the insertion hole 9, reducing the strain on the diaphragm caused by air pressure changes during vibration.

[0031]

Moreover, the magnetization directions of the cylindrical magnet 1A, the first annular magnet 1B, and the second annular magnet 1C can be opposite to those in Figure 4(a), as shown in Figure 4(b).

[0032]

Furthermore, the same components as in Embodiment 1 are denoted by the same reference numerals, and their descriptions are omitted.

[0033]

(Embodiment 3)

Figure 5(a) shows the configuration of the speaker device SP of this embodiment. A recess 1a is provided at one end of the first annular magnet 1B of Embodiment 1, at a position symmetrical to the voice coil 4 in the gap, concentrically with the cylindrical magnet 1A, to prevent the voice coil 4 from interfering with the first annular magnet 1B when the voice coil 4 is displaced. Furthermore, the same components as in Embodiment 1 are denoted by the same reference numerals, and their descriptions are omitted.

[0034]

Moreover, the magnetization directions of the cylindrical magnet 1A, the first annular magnet 1B, and the second annular magnet 1C can be opposite to those in Figure 5(a), as shown in Figure 5(b).

10 [0035]

Furthermore, Embodiment 2 also includes the recess 1a as described above, achieving the same effects.

[0036]

(Embodiment 4)

As shown in Figure 6, one or more switch boxes 22 are embedded at suitable positions in a building. Each switch box 22 is connected to wires L1 and signal lines L2 pre-installed in the walls, and the wires L1 are connected to the initial switch box 22 via the main breaker MB and sub-breaker BB in the distribution board 21, while the signal lines L2 are connected to the external internet NT via a gateway GW (with built-in router and hub). Various functional modules such as basic function modules 25 with call functions, socket functions, wall switch functions, etc., and expansion function modules 26 are connected to the wiring system of wires L1 and signal lines L2. Here, the switch boxes 22 can be divided into the following types: those installed at a high position (HP) on the indoor ceiling, those installed at a recommended height (MP) through wall switches, and those installed near the floor (LP).

20 [0037]

In each switch box 22, a door device 23 connecting the basic function module 25 is installed. The door device 23 has a modular interface 24, including a circuit interface 24A connected to the wires via contact parts and an information interface 24B connected to the signal lines L2.

[0038]

The intervals between these interfaces 24A and 24B, the arrangement of internal contact parts, and the shape of the opening parts are standardized. The front part of the door device 23 body is covered, and the back part of the basic function module 25 installed at the front opening of the switch box 22 is provided with a connector (not shown) that can be freely connected and disconnected to each interface 24A and 24B.

[0039]

30 Moreover, the two sides of the basic function module 25 are configured to connect to the expansion function module 26 via connectors, and the two sides of the expansion function module 26 are also configured to connect to the basic function module 25 and expansion function module 26 via connectors. Furthermore, each basic function module 25 and expansion function module 26 are connected to the wires L1 and signal lines L2 via the door device 23, providing power and easily performing linked control between other basic function modules 25 and expansion function modules 26, with excellent construction and expandability.

[0040]

In the above wiring system, for example, a basic function module 25 with a pendant plug connection part 30 is connected to the door device 23 of the switch box 22 installed at a high position (HP) such as the indoor ceiling. This basic function module 25 is connected to an expansion function module 26 with a human sensor 31. Alternatively, a basic function module 25 with only a speaker device SP is connected to the door device 23.

40 [0041]

In the door device 23 of the switch box 22 installed at a recommended height (MP) on the indoor wall through wall switches, a basic function module with a wall switch 32 for controlling lighting fixtures is connected to an expansion function module 26 with a clock 32 and an expansion function module 26 with a speaker device SP. Alternatively, a basic function module 25 with a monitor device 34 is connected to the door device 23 of the switch box 22 at the middle position (MP).

[0042]

Moreover, in the door device 23 of the switch box 22 installed near the floor (LP), a basic function module 25 with a power socket 35 is connected to an expansion function module 26 with a foot-light 36. Alternatively, a basic function module 25 with only a speaker device SP is connected to the door device 23.

[0043]

Figure 7 shows the installation state of the expansion function module 26 with the above-mentioned speaker device SP. This expansion function module 26 comprises a speaker device SP, a microphone M1, a call switch SW1, and an alarm release switch SW2, forming a call device with an intercom function for communication between rooms in the house. Moreover, multiple sound holes 26b are provided on the front of the module body 26a, symmetrical to the speaker device SP and microphone M1.

[0044]

One side of the module body 26a is provided with a male power connector 26A and a signal connector 26b, connected to the male power connector 26A' and signal connector 26B' on the other side of the expansion function module 26 (or basic function module 25).

[0045]

Moreover, the speaker device SP described in any of Embodiment 1 to 3 has high output efficiency, and under the same output conditions, it can be miniaturized compared to the conventional method. Therefore, if the speaker device SP described in any of Embodiment 1 to 3 is mounted on the above-mentioned expansion function module 26, the module body 26a can be made thinner, making it easier to install on the indoor ceiling, walls, floor, etc. Furthermore, the same effects can be achieved by mounting the speaker device SP described in any of Embodiment 1 to 3 on the basic function module 25.

[Simple description of figures]

[0046]

[Figure 1] Exploded perspective view of the speaker device of Embodiment 1.

[Figure 2] (a)(b) Side cross-sectional view of the same.

[Figure 3] Exploded perspective view of the speaker device of Embodiment 2.

[Figure 4] (a)(b) Side cross-sectional view of the same.

[Figure 5] (a)(b) Side cross-sectional view of the speaker device of Embodiment 3.

[Figure 6] Configuration diagram of the wiring system of Embodiment 4.

[Figure 7] Installation state diagram of the expansion function module of the same.

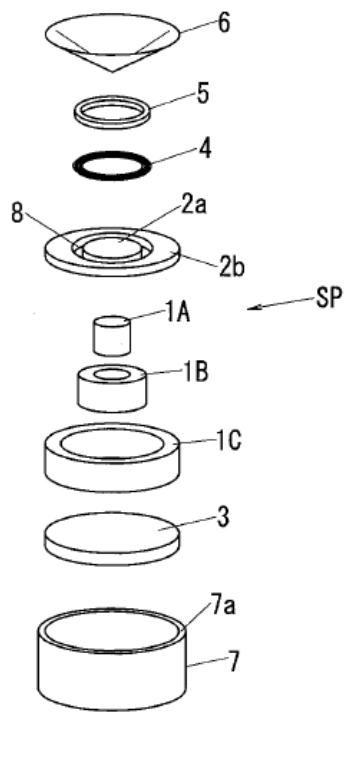
[Figure 8] Side cross-sectional view of the conventional speaker device.

[Description of symbols]

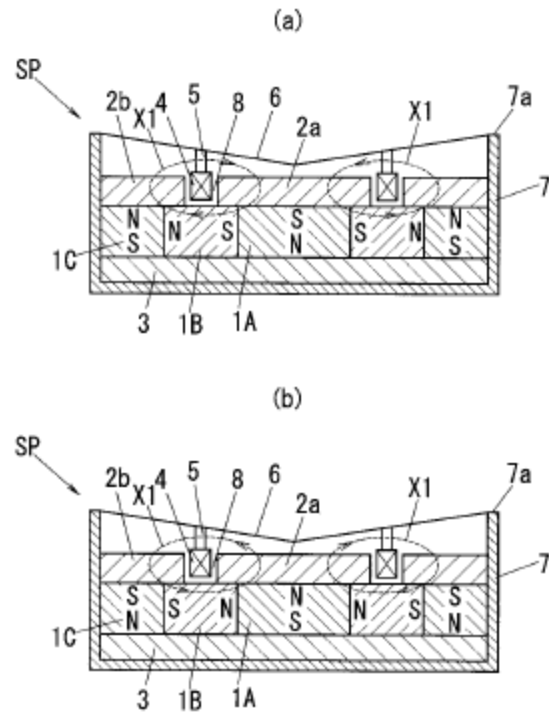
[0047]

SP	Speaker Device
1A	Cylindrical Magnet
1B	First Annular Magnet
1C	Second Annular Magnet
2a	Cylindrical Magnetic Body
2b	Annular Magnetic Body
3	Cylindrical Magnetic Body
4	Voice Coil
5	Voice Coil Bobbin
6	Diaphragm
7	Housing
8	Gap

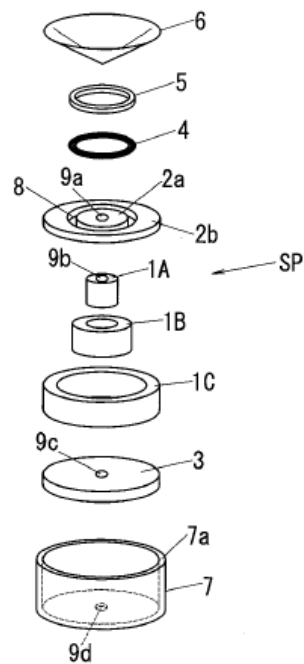
[Figure 1]



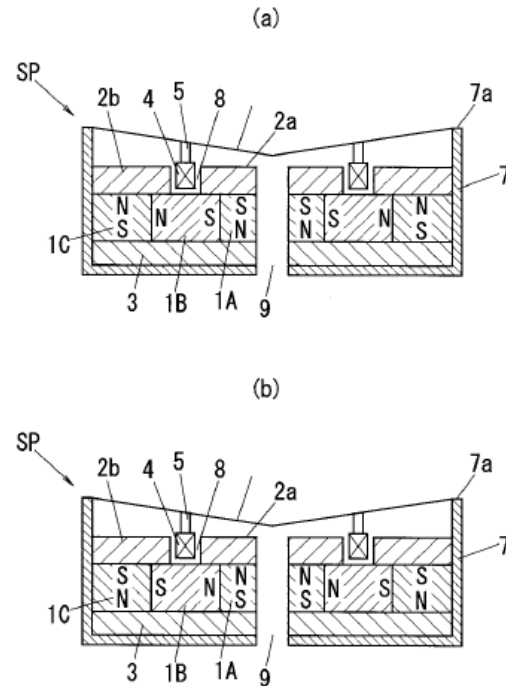
[Figure 2]



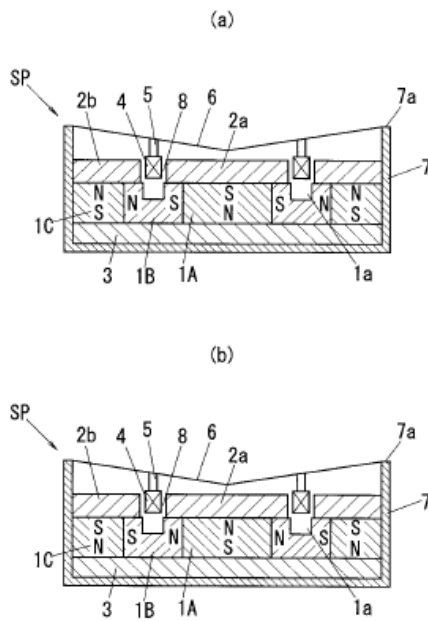
[Figure 3]



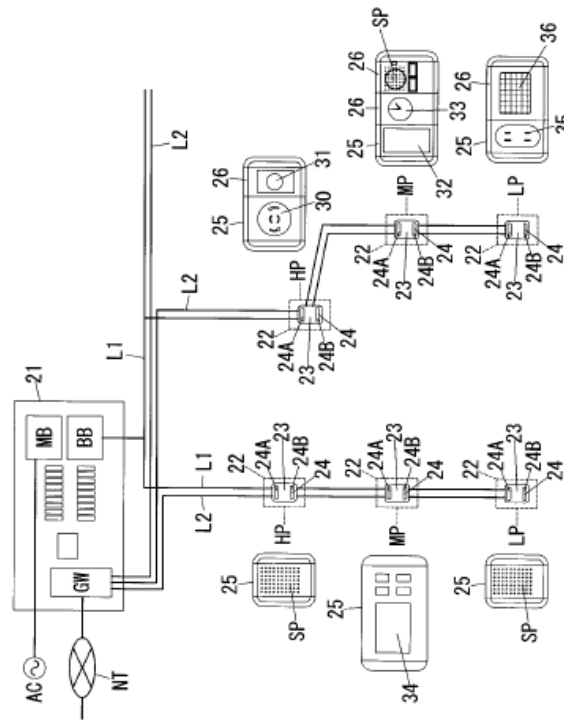
[Figure 4]



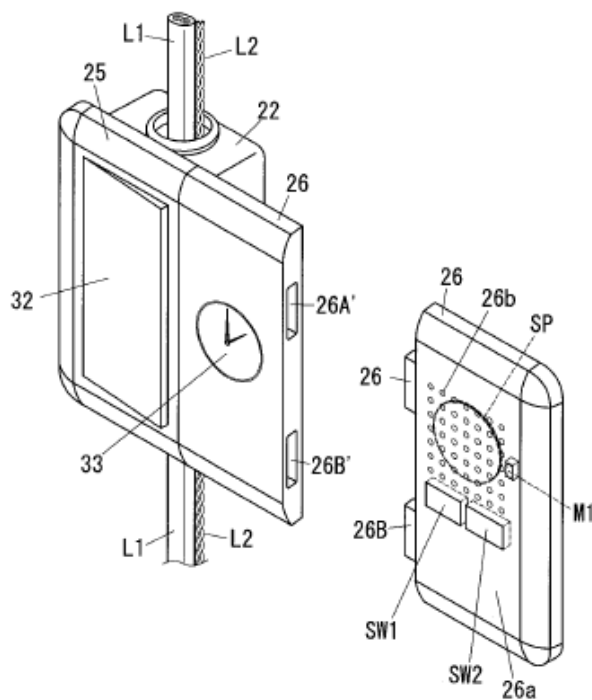
[Figure 5]



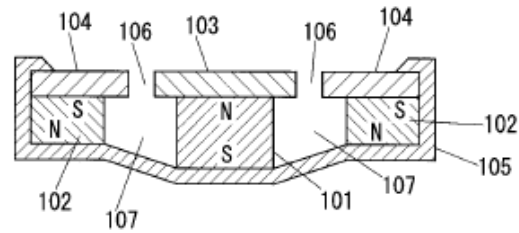
[Figure 6]



[Figure 7]



[Figure 8]



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(72) Inventor	Tomohiro Ota 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.
(72) Inventor	Yuya Hasegawa 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.
(72) Inventor	Kosaku Kitada 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.
(72) Inventor	Keiichi ▲Yoshida ▼ 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.
(72) Inventor	Yasushi Arikawa 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.
(72) Inventor	Hiroaki Takeyama 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.
(72) Inventor	Hiroshi Kawata 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.
(72) Inventor	Shinya Kimoto 1048 Oaza Kadoma, Kadoma City, Osaka Prefecture	Panasonic Electric Works Co., Ltd.

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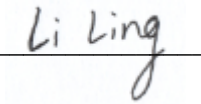
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