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(54) **Vibration plate, speaker, acoustic system and method of manufacturing vibration plate**

Schwingungsplatte, Lautsprecher, akustisches System und Verfahren zur Herstellung einer Schwingungsplatte

Plaque vibrante, haut-parleur, système acoustique et procédé permettant de fabriquer une plaque vibrante

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Description

TECHNICAL FIELD

[0001] The present invention relates to a speaker and an audio system.

BACKGROUND ART

[0002] Materials such as paper, plastics and metal are relatively inexpensive and easy to process, and accordingly, have been widely used as materials of a diaphragm of audio equipment. However, in each of these materials, propagation speeds of vibrations and sounds are equal in every direction, and accordingly, in the case of manufacturing the diaphragm, a standing wave is prone to occur therein, and there is a case where the standing wave adversely affects acoustic characteristics of the diaphragm in various ways.

[0003] As a diaphragm that suppresses an occurrence of the standing wave, there is known a diaphragm of a wood cone type, which uses, as a diaphragm material, a wood material having propagation speeds different between a fiber direction and a non-fiber direction. There is also known a diaphragm of an oblique cone type, in which a cross-sectional shape is made asymmetric by shifting a position of a voice coil from a center of the diaphragm.

[0004] There is also known a diaphragm formed of paper, plastics, metal or the like, in which anisotropy is imparted to the propagation speed in such a manner that a laser beam is irradiated onto a surface of the diaphragm, and that a part of the raw material of the diaphragm is thereby modified (for example, refer to JP 2001-258 091 A).

[0005] However, there is a case where, in the diaphragm of the wood cone type, manufacturing cost thereof is increased since a manufacturing method thereof is complicated. Since the diaphragm of the oblique cone type has a bias in directivity, it is rather difficult for a sound to be emitted forward therefrom, and depending on a case, a sound field expression with a high density cannot sometimes be enjoyed.

[0006] In the method of irradiating the laser beam onto the surface of the diaphragm, the material of the modified portion is damaged, and accordingly, the modified portion becomes fragile as compared with peripheries thereof, and a product malfunction is prone to be brought about. US 2005/078850 A1 discloses the incorporation of surface irregularities into a loudspeaker diaphragm to control the resonances of diaphragm. Through the use of the described resonance control techniques, a single loudspeaker driver is able to offer excellent performance over a wide range of the audio spectrum. The randomness of the selected features is constrained within a set of boundary conditions to accomplish a balance of achieving the desired performance, as well as ensure that the device is practical to manufacture.

US 2007/263888 A1 discloses a method and system for surround sound beamforming using vertically displaced drivers. A pair of vertically displaced speaker drivers is supplied with surround and main channel information in a controlled phase relationship with respect to each driver such that the surround channel information is propagated in a directivity pattern substantially differing from that of the main channel information. The main channel information is generally directed at a listening area, while the surround channel information is directed away from the listening area and is substantially attenuated in the direction of the listening area, so that the surround channel information is heard as a diffuse reflected field. An electronic network provides for control of the surround channel phase relationship and combining of main and surround signals for providing inputs to individual power amplifiers for each driver.

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007] In consideration of the foregoing problems, the present invention provides a speaker and an audio system, which use a diaphragm, which is easy to manufacture, has a high product yield, is capable of suppressing the occurrence of the standing wave, and is excellent in sound field expression

MEANS FOR SOLVING THE PROBLEMS

[0008] In order to solve the foregoing problems, the present invention provides a speaker as set forth in claim 1 and an audio system as set forth in claims 4 or 5.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

[FIG. 1] FIG. 1 is a cross-sectional view showing a speaker unit according to an example.

[FIG. 2] FIG. 2 (a) is a plain view showing a diaphragm according to the example, and FIG. 2(b) is a cross-sectional view in a case where the diaphragm is viewed in an A-A direction of FIG. 2(a).

[FIG. 3] FIG. 3 is a graph showing propagation speeds of a reinforcement portion and a standard portion according to the example.

[FIG. 4] FIG. 4 is a graph showing internal losses of the reinforcement portion and the standard portion according to the example.

[FIG. 5] FIGS. 5(a) to 5(d) are plan views showing arrangement examples of the reinforcement portions according to the example.

[FIG. 6] FIGS. 6(a) to 6(f) are plan views showing shape examples of the reinforcement portions according to the example.

[FIG. 7] FIG. 7 is an explanatory view explaining

characteristics of vibration members according to the example.

[FIG. 8] FIG. 8 (a) is a graph representing measurement results of 8 kHz directivity characteristics, and FIG. 8 (b) is a graph representing measurement results of 12 kHz directivity characteristics.

[FIG. 9] FIG. 9 (a) is a graph showing frequency characteristics of a comparative example, and FIG. 9(b) is a graph showing frequency characteristics of a speaker according to the example.

[FIG. 10] FIGS. 10(a) to 10(g) are process cross-sectional and plan views showing a manufacturing method of the diaphragm according to the example.

[FIG. 11] FIG. 11 is a plan view showing a diaphragm according to a first modification example of the present invention.

[FIG. 12] FIGS. 12(a) to 12(c) are plan views showing shape examples of a reinforcement region of a cap.

[FIG. 13] FIG. 13 is an explanatory view of speakers according to a second modification example of the present invention.

[FIG. 14] FIG. 14 is a view showing an audio system according to a third modification example of the present invention.

[FIG. 15] FIGS. 15(a) to 15(e) are views showing other arrangement examples of speaker units in speakers shown in FIG. 14. Fig. 15 (c) represents an embodiment of the invention.

[FIG. 16] FIG. 16 is a cross-sectional view showing a speaker unit according to a fourth modification example of the present invention.

[FIG. 17] FIG. 17 (a) is a plan view of a diaphragm according to the fourth modification example, and FIG. 17(b) is a cross-sectional view in a case where the diaphragm is viewed in a B-B direction of FIG. 17(a).

BEST MODE FOR CARRYING OUT THE INVENTION

[0010] A description is made below of an example with reference to the drawings. In the following description referring to the drawings, the same or similar reference numerals are assigned to the same or similar portions. The example to be described below illustrates devices and methods for embodying the technical idea of this invention, and the technical idea of this invention does not specify structures, arrangements and the like of constituent components to those to be described below.

[0011] As shown in FIG. 1, a speaker unit (electroacoustic transducer) 3 according to the example includes: a magnetic circuit 34; a frame 33 arranged on the magnetic circuit 34; and a diaphragm 1 fixed to the frame 33. The magnetic circuit 34 includes: a doughnut-like plate 35; and a doughnut-like magnet 36 and a pole piece 30, which are provided under the plate 35.

[0012] A voice coil 31a is loosely inserted into a magnetic gap 37 between the plate 35 and the pole piece 30. A damper 32 is adhered to a voice coil bobbin 31b and

the frame 33.

[0013] The diaphragm 1 has: a vibration member 10 in which a cross section has a conical shape; and a rubber edge 14 attached entirely on an outer circumferential portion (edge) of the vibration member 10. The rubber edge 14 is fixed to the frame 33 while interposing a gasket 39 therebetween.

[0014] As shown in FIG. 2(a), the diaphragm 1 has an opening portion 11 on a center thereof. On the opening portion 11, a cap 38 (refer to FIG. 1) for preventing entrance of a foreign object into the voice coil 31a is attached.

[0015] The vibration member 10 is formed of an isotropic material (uniform material). Here, the "isotropic material (uniform material)" refers to a material in which a sound propagation speed is substantially equal (isotropic) in every direction in the diaphragm unlike a wood material or the like in which the sound propagation speed is different between a fiber direction and a non-fiber direction. For example, the "isotropic material" in this example includes paper such as pulp, plastics such as polypropylene, metal such as aluminum, and the like; however, is not limited to these.

[0016] As shown in FIG. 2 (a) and FIG. 2 (b), the vibration member 10 has: a standard portion 12; and band-like reinforcement portions 13a to 13d, which are integrated with the standard portion 12, and are radially arranged from the opening portion 11 toward an outer circumference side.

[0017] The reinforcement portions 13a to 13d are regions (first-region portions) pressed more strongly than the standard portion 12 (second-region portion) in a manufacturing process of the vibration member 10, which is to be described later. Therefore, a material density of the reinforcement portions 13a to 13d is higher by approximately 10 to 100% as compared with that of the standard portion 12. The material density differs depending on the materials for use. For example, in the case of using paper as the vibration member 10, the material density of the standard portion 12 is approximately 0.4 to 0.7 g/cm³, and the material density of the reinforcement portions 13a to 13d is approximately 0.5 to 1.0 g/cm³.

[0018] The reinforcement portions 13a to 13d are regions formed so that rigidity thereof can be higher as compared with that of the standard portion 12 by being pressed more strongly than the standard portion 12 in the manufacturing process of the vibration member 10. The reinforcement portions 13a to 13d are controlled so that a Young's modulus thereof can be higher by approximately 5 to 15% as compared with that of the standard portion 12. The Young's modulus differs depending on the materials for use; however, for example, in the case of using paper as the vibration member 10, the Young's modulus of the standard portion 12 is approximately 1.2 to 2.0 Pa, and the Young's modulus of the reinforcement portions 13a to 13d is approximately 1.3 to 2.5 Pa.

[0019] A thickness of the reinforcement portions 13a to 13d is different by approximately 10 to 75% from that

of the standard portion 12 by being pressed more strongly than the standard portion 12 in the manufacturing process of the vibration member 10. The thickness differs depending on the materials for use. For example, in the vibration member 10 shown in FIG. 2(b), the thickness T1 of the standard portion 12 is approximately 0.3 mm to 0.35 mm, and the thickness T2 of the reinforcement portions 13a to 13d is approximately 0.2 mm to 0.25 mm.

[0020] FIG. 3 shows comparison in propagation speed between the standard portion 12 and the reinforcement portions 13a to 13d in the case of using paper as the material of the vibration member 10. The vibration member 10 is formed so that the propagation speed (m/s) of the reinforcement portions 13a to 13d can be higher by approximately 5 to 10% as compared with the propagation speed of the standard portion 12.

[0021] FIG. 4 shows internal losses of the standard portion 12 and the reinforcement portions 13a to 13d in the case of using paper as the material of the vibration member 10. The vibration member 10 is formed so that the internal loss ($\tan\delta$) of the reinforcement portions 13a to 13d can be higher by 3 to 10% as compared with the propagation speed of the standard portion 12.

[0022] As shown in FIG. 2(a), the reinforcement portions (first-direction reinforcement portions) 13a and 13b are arranged side by side in a first direction (up-and-down direction of FIG. 2(a)) passing through a center of the vibration member 10. The reinforcement portions (second-direction reinforcement portions) 13c and 13d are arranged side by side in a second direction (right-and-left direction of FIG. 2(a)) passing through the center of the vibration member 10 and different from the first direction. In FIG. 2(a), the first direction and the second direction are set so as to intersect each other substantially orthogonally at the center of the vibration member 10; however, the directions are not limited to intersect orthogonally.

[0023] The number of the reinforcement portions 13a to 13d is variously changeable in response to characteristics of a speaker system that mounts the vibration member 10 thereon. For example, as shown in FIG. 5(a), two reinforcement portions 13a and 13b may only be arranged in an up-and-down direction of FIG. 5(a), or as shown in FIG. 5(b), four reinforcement portions 13a to 13d may be arranged along oblique directions of FIG. 5(b). As shown in FIG. 5(c), half moon-like reinforcement portions 13a to 13d may be arranged, or as shown in FIG. 5(d), three reinforcement portions 13a to 13c extended radially from the opening portion 11 toward the outer circumference may be arranged.

[0024] As a shape of the reinforcement portions 13a and 13b, shapes as shown in FIG. 6(a) to FIG. 6(d) are adoptable. For example, as shown in FIG. 6(a) to FIG. 6(c), shapes in each of which a width in a longitudinal direction is gradually thinned from the opening portion 11 side to the outer circumference side (not shown) are adopted, whereby a change is added to the propagation speed of the vibrations (sounds) transmitting through the

reinforcement portions 13a and 13b. As a result, in terms of audibility, expansion comes to be felt more in a reproduction sound.

[0025] As described above, in accordance with the diaphragm 1 according to the example, on the vibration member 10, the reinforcement portions 13a to 13d are arranged, in each of which the Young's modulus and the internal loss are higher and the propagation speed is faster as compared with those of the standard portion 12. Specifically, as illustrated in FIG. 7, regions in which sound speeds are faster than in the standard portion 12 are formed, and accordingly, in terms of the hearing sense, an impression that the sound comes more forward is obtained, and a sound field expression can be enriched.

[0026] Moreover, the reinforcement portions 13a to 13d are formed integrally and together with the standard portion 12 in press molding to be described later. Therefore, the reinforcement portions 13a to 13d do not peel off from the vibration member 10, and unlike the case of performing a surface process for the vibration member 10 by a laser beam, a part of the vibration member 10 is not damaged, either. Furthermore, the isotropic material such as paper, plastics and metal is used as the material of the vibration member 10, whereby a diaphragm that is inexpensive and easy to manufacture can be provided, and in addition, a loss of output energy owing to an occurrence of a standing wave generated in the case of using the isotropic material can be suppressed.

[0027] Sizes (areas) of all of the reinforcement portions 13a to 13d do not have to be the same. For example, in the case of defining a lower side of FIG. 7 as a mounting surface, the reinforcement portions 13a to 13d are formed so that surface areas of the reinforcement portions 13a and 13b can be larger than surface areas of the reinforcement portions 13c and 13d, whereby the sound speed in the vertical direction with respect to the mounting surface becomes fast. Accordingly, audibility that the sound comes more forward is obtained. Meanwhile, in the case of reducing the areas of the reinforcement portions 13a and 13b than the areas of the reinforcement portions 13c and 13d, audibility that the sound expands in a horizontal direction with respect to the mounting surface is obtained.

[0028] FIG. 8(a) and FIG. 8(b) represent evaluation results of directional sensitivity characteristic tests of a speaker using the diaphragm according to this example. In the directional sensitivity characteristic tests, a speaker using a diaphragm that does not have the reinforcement portions is used as a "comparative example". The speakers according to the comparative example and this example are individually mounted on a turntable, and a microphone is placed at a place radically apart from a center of the turn table by 1 m. While defining a front surface of each of the speakers as zero degree, the directional sensitivity characteristics are evaluated by rotating the turntable clockwise by 360 degrees.

[0029] As shown in FIG. 8(a), it is understood that, in

the case of setting a measurement frequency at 8 kHz, a sound pressure level rises over the entire directions in the speaker according to this example as compared with the comparative example. As shown in FIG. 8(b), in the case of setting the measurement frequency at 10 kHz, the sound pressure level of the sound outputted from a front side of the speaker using the diaphragm according to this example largely rises as compared with the comparative example.

[0030] FIG. 9(a) shows frequency characteristics of the diaphragm that does not have the reinforcement portions 13a to 13d (comparative example), and FIG. 9(b) shows an example of frequency characteristics of the diaphragm according to this example. In the case where sound pressures of these diaphragms are compared with each other at portions shown by dotted lines, that is, at a frequency band of 300 to 1000 kHz, it is understood that the sound pressure of the speaker (refer to FIG. 9(b)) according to this example is higher by approximately 1 dB as compared with that of the comparative example (refer to FIG. 9(b)). When curves representing the frequency characteristics are observed, a dip is formed in a band of 2 to 3 kHz of FIG. 9(a) as the comparative example. Meanwhile, in the case shown in FIG. 9(b) as this embodiment, it is understood that the curve is flatter as compared with that of FIG. 9(a) and an occurrence of a peak (dip) is suppressed.

[0031] As described above, in accordance with the diaphragm 1 according to this example, the reinforcement portions 13a to 13d are arranged, thus making it possible to raise an output level of a midrange in which many vocal components are contained. Moreover, the occurrence of the peak (dip) can be suppressed, and accordingly, in accordance with the diaphragm 1 according to this example, a speaker that is excellent particularly in midrange sound quality can be provided.

[0032] Next, a description is made of a manufacturing method of the diaphragm 1 according to this example by using FIG. 10(a) to FIG. 10(g). Note that the manufacturing method to be described below is merely an example, and it is a matter of course that it is possible to manufacture the diaphragm 1 by various methods other than the method to be described below.

[0033] First, as shown in FIG. 10(a), a paper making apparatus 21 is put into a pulp-dissolved solution 20. A net 22 in which a center portion is formed into a conical shape (conical frustum shape) in advance is mounted on an upper surface of the paper making apparatus 21. The net 22 can be formed of metal such as brass; however, without being limited to this, any raw material can be used as long as it is robust and has heat resistance.

[0034] As the pulp-dissolved solution 20, for example, a pulp-dissolved solution is usable, which is obtained by dispersing, into water, a mixed fiber product of 10 wt% of linters (cotton fiber) and 90 wt% of NBKP pulp (one formed by turning conifer fiber into pulp by a kraft process and bleaching the fiber thus turned into the pulp). In the paper making apparatus 21, an opening portion 23 is

provided for draining extra liquid from a lower side of the net 22 at the time of paper making.

[0035] Next, as shown in FIG. 10(b), the paper making apparatus 21 is gradually lifted toward the above of the pulp-dissolved solution 20, thereby depositing a paper material 24 on the net 22. Thereafter, hot air may be blown onto the paper material 24 on the net 22 in order to remove moisture from the paper material 24. After the paper material 24 is dried, the paper material 24 is detached from the net 22.

[0036] As shown in FIG. 10(c) and FIG. 10(d), the paper material 24 detached from the net 22 is sandwiched between a male die 27 and a female die 26, which compose a heated press machine 28, and is pressed with a predetermined pressure from an upper portion of the male die 27. At this time, since protruding portions 27a and 27b are selectively and partially formed on the male die 27, partial regions of the paper material 24, which are brought into contact with the protruding portions 27a and 27b, are pressed more strongly as compared with peripheral regions other than these. When the pressing pressure is raised too much, the paper material 24 is sometimes broken, and a variety of physical properties such as a sound propagation speed, which are inherent in the paper material 24, are sometimes affected. In this case of this embodiment, for example, it is preferable to set the pressing pressure at 3 to 5 kPa.

[0037] As shown in FIG. 10(e), an outer circumferential portion 25a of a work 25 molded into a predetermined shape is cut out by a cutting process. Subsequently, as shown in FIG. 10(f), the rubber edge 14 is attached entirely on the outer circumferential portion of the work 25, and an inner circumferential portion 15 is punched out. As shown in FIG. 10(g), the diaphragm 1 is fabricated, in which the opening portion 11 is provided on the center of the vibration member 10, and the rubber edge 14 is attached onto the outer circumferential portion.

[0038] In accordance with the diaphragm 1 according to this example, by the press molding step shown in FIG. 10(c) and FIG. 10(d), the paper material 24 is pressed in a lump so that a pressing pressure for a specific portion thereof can be stronger, and the vibration member 10 having the standard portion 12 and the reinforcement portions 13a to 13d is manufactured. Therefore, as compared with the case of processing the diaphragm by the laser beam, the diaphragm can be manufactured, which is easy to manufacture, and also has a high product yield.

(First Modification Example)

[0039] As shown in FIG. 11, a diaphragm 100 according to a first modification example is different from the diaphragm 1 shown in FIG. 2(a) and FIG. 2(b) in that the cap 38 is attached onto the opening portion 11. Others are substantially similar to those of the diaphragm 1 shown in FIG. 2(a) and FIG. 2(b), and accordingly, a description thereof is omitted.

[0040] The cap 38 is composed of: a band-like rein-

forcement region (cap reinforcement portion) 38a having a longitudinal direction thereof in the same direction as that of the reinforcement portions 13a and 13b; and a standard region 38b as a periphery of the reinforcement region 38a. As a material of the cap 38, the isotropic material such as paper, plastics and metal is suitable. The reinforcement region 38a and the standard region 38b are formed so as to be integrated with each other by the press molding.

[0041] The reinforcement region 38a is a region (first-cap-region portion) pressed more strongly than the standard region 38b, and a material density thereof is higher by approximately 10 to 100% as compared with that of the standard region 38b (second-cap-region portion). In the case of using paper as the material of the cap 38, the material density of the standard region 38b is approximately 0.4 to 0.7 g/cm³, and the material density of the reinforcement region 38a is approximately 0.5 to 1.0 g/cm³. A Young's modulus of the reinforcement region 38a is higher by approximately 5 to 15% as compared with that of the standard region 38b. In the case of using paper as the material of the cap 38, the Young's modulus of the standard region 38b is approximately 1.2 to 2.0 Pa, and the Young's modulus of the reinforcement region 38a is approximately 1.3 to 2.5 Pa.

[0042] Moreover, the reinforcement region 38a is pressed more strongly than the standard region 38b in the pressing process at the time of manufacturing the cap 38, and is thereby different in thickness from the standard region 38b. In the vibration member 10 shown in FIG. 11, a thickness of the standard region 38b is approximately 0.3 mm to 0.35 mm, and a thickness of the reinforcement region 38a is approximately 0.2 mm to 0.25 mm.

[0043] A shape of the reinforcement region 38a is not particularly limited. For example, as shown in FIG. 12(a), the reinforcement region 38a may be formed into a band shape extending in the first direction passing through a center of the cap 38. As shown in FIG. 12(b), a V-shaped reinforcement region 38a may be formed, or alternatively, as shown in FIG. 12(c), a cross-shaped reinforcement region 38a may be formed.

[0044] In accordance with the diaphragm 1 according to the first modification example, the reinforcement region 38a and the standard region 38b are arranged also for the cap 38 in addition to the vibration member 10. In such a way, a sound speed of a sound transmitting through the cap 38 can be changed, and accordingly, the occurrence of the standing wave, which is observed in the case of adopting the isotropic member, can be suppressed, and a richer sound field expression becomes realizable.

(Second Modification Example)

[0045] FIG. 13 shows an example of speakers 4a and 4b, in each of which two diaphragms shown in FIG. 11 are arrayed one above the other. The reinforcement por-

tions 13a and 13b are arranged side by side in the substantially vertical direction with respect to the mounting surface. The reinforcement portions 13c and 13d are arranged side by side in the substantially horizontal direction with respect to the mounting surface. The reinforcement region 38a provided on the cap 38 is arranged along the same direction as that of the reinforcement portions 13a and 13b.

[0046] In accordance with each of the speakers shown in FIG. 13, the speaker has the reinforcement portions 13a and 13b and the reinforcement region 38a, whereby the standing wave is prevented, and in addition, the output of the midrange is strengthened more, and audibility that the sound comes out forward can be thereby given to a user. Moreover, the reinforcement portions 13c and 13d are arranged, whereby the expansion feeling of the sound is also obtained in the horizontal direction with respect to the mounting surface, and accordingly, a speaker capable of realizing a denser sound field expression can be provided.

(Third Modification Example)

[0047] FIG. 14 shows an example of an audio system including: the speakers 4a and 4b shown in FIG. 13; and an amplifier 6 connected to the speakers 4a and 4b. On a front surface of a cabinet of the speakers 4a on a left side of FIG. 14, two speaker units 41 and 42 are arranged. On a front surface of a cabinet of the speaker 4b on a right side of FIG. 14, two speaker units 43 and 44 are arranged.

[0048] Each of the speaker units 41 to 44 has: the diaphragm 10 having the standard portion 12 and the reinforcement portions (first-direction reinforcement portions 13a and 13b and second-direction reinforcement portions 13c and 13d); and the cap 38 arranged on the opening portion of the diaphragm 10.

[0049] The first-direction reinforcement portions 13a and 13b are arranged in the substantially vertical direction with respect to the mounting surface. In such a way, the standing wave is suppressed, and in addition, the output of the midrange is strengthened more, and audibility that sound expansion is provided in the vertical direction and that the sound comes more forward can be given to the user. The second-direction reinforcement portions 13c and 13d are arranged in the substantially horizontal direction with respect to the mounting surface. By the second-direction reinforcement portions 13c and 13d, the expansion feeling of the sound is also obtained in the horizontal direction.

[0050] A lateral width of the first-direction reinforcement portions 13a and 13b is made larger than a lateral width of the second-direction reinforcement portions 13c and 13d, whereby the expansion feeling of the sound in the vertical direction is strengthened, and accordingly, this configuration is suitable for a speaker for music appreciation. On the contrary, the lateral width of the second-direction reinforcement portions 13c and 13d is

made larger than the lateral width of the first-direction reinforcement portions 13a and 13b, whereby the expansion feeling of the sound in the horizontal direction is strengthened, and accordingly, this configuration is suitable for use in a home theater speaker for which a feeling of presence is required. Note that the speakers 4a and 4b shown in FIG. 14 are formed so that the lateral width of the first-direction reinforcement portions 13a and 13b can be larger by approximately 5 to 20% as compared with the lateral width of the second-direction reinforcement portions 13c and 13d. In such a way, high-quality speakers can be provided as the speakers for the music appreciation, and the speakers can also be sufficiently utilized as the home theater speakers offering the feeling of presence.

[0051] On each of the caps 38, the reinforcement region 38a having the longitudinal direction thereof in the substantially vertical direction with respect to the mounting surface is arranged. An orientation of the reinforcement region 38a is aligned with the same direction as that of the first-direction reinforcement portions 13a and 13b, whereby the expansion feeling of the sound can be provided in the vertical direction. For example, in the case of using the cap 38 of FIG. 12 (a) for the speaker mainly aimed at the music appreciation, it is preferable to arrange the reinforcement region 38a so that the orientation thereof can be in the same direction (that is, the vertical direction with respect to the mounting surface) as that of the first-direction reinforcement portions 13a and 13b.

[0052] In the case of using the cap of FIG. 12 (b), for the upper speaker unit 41, the reinforcement region 38a is arranged so that a shape thereof can be "V-shaped" by rotating FIG. 12 (b) counterclockwise by 90°. For the lower speaker unit 42, the reinforcement region 38a can also be arranged so that a shape thereof can be "mount-shaped (inverse V-shaped)" by rotating the cap of FIG. 12 (b) clockwise by 90°. In such a way, a feeling of togetherness is created in the sounds emitted from the upper and lower speaker units 41 and 42.

[0053] The caps of FIG. 12 (b) are mounted on the speaker units 43 and 44, and the caps of FIG. 12 (b), which are inverted right and left, are mounted on the speaker units 41 and 42, whereby the expansion feeling of the sound is obtained in the horizontal direction, and accordingly, for example, even in the case of arranging the speakers 4a and 4b closely to each other, the expansion feeling of the sound is obtained as compared with the conventional apparatus.

[0054] In the case of using the cap of FIG. 12 (c), orientations of the cross of the reinforcement region 38a are aligned with the orientations of the first-direction reinforcement portions 13a and 13b and the orientations of the second-direction reinforcement portions 13c and 13d, whereby it becomes possible to reproduce a sound having the feeling of presence.

[0055] As shown in FIG. 14, the speaker unit 41 is connected to the amplifier 6 through a line L1. The speaker unit 42 is connected to the amplifier 6 through a line L2.

The speaker unit 43 is connected to the amplifier 6 through a line L3. The speaker unit 44 is connected to the amplifier 6 through a line L4.

[0056] Note that, in the case of utilizing the audio system shown in FIG. 14 as a two-channel stereo reproduction system, left-channel audio signals (Lch) mutually identical to each other are inputted to the speaker units 41 and 42 from the amplifier 6 through the lines L1 and L2. Right-channel audio signals (Rch) mutually identical to each other are inputted to the speakers 43 and 44 from the amplifier 6 through the lines L3 and L4. At this time, in order to reproduce the sounds from the upper and lower speaker units 41 and 42 while giving the feeling of togetherness thereto, it is preferable to arrange the first-direction reinforcement portions 13a and 13b and the reinforcement region 38a so that the orientations thereof can be aligned with the vertical direction with respect to the mounting surface.

[0057] Moreover, in order to reproduce the sounds from the upper and lower speaker units 41 and 42 while giving the feeling of togetherness thereto in the case of utilizing the speaker units 41 and 42 for the two-channel stereo reproduction system, it is desirable to align the orientations of the first-direction reinforcement portions 13a and 13b between the speaker units 41 and 42, and to align the orientations of the second-direction reinforcement portions 13c and 13d between the speaker units 42 and 42.

[0058] In the case of utilizing the audio system shown in FIG. 14 as a reproduction system of five-channel surround signals, a surround signal for the left channel (surround L ch) and a center-channel signal (center ch) are inputted to the speaker unit 41 from the amplifier 6 to the line L1. A front signal for the left channel (front L ch) is inputted to the speaker unit 42 from the amplifier 6 through the line L2. A surround signal for the right channel (surround R ch) and a center-channel signal (center ch) are inputted to the speaker unit 43 from the amplifier 6 through the line L3. A front signal for the right channel (front R ch) is inputted to the speaker unit 42 from the amplifier 6 through the line L4.

[0059] At this time, in order to reproduce the sounds from the upper and lower speaker units 41 and 42 while giving the feeling of togetherness thereto, it is desirable to arrange the first-direction reinforcement portions 13a and 13b and the reinforcement region 38a so that the orientations thereof can be aligned with the vertical direction with respect to the mounting surface. Note that, for the speaker units 41 and 43 attached on the upper portions of the speakers 4a and 4b, the spots (reinforcement portions) in which the sound speeds are fast in the vertical direction with respect to the mounting surface are positively arranged in order to generate a sound effect, whereby a sound that expands in the vertical direction and has the feeling of presence like looming forward of the speakers 4a and 4b can be reproduced.

[0060] Note that, though an example of arranging the two speakers 4a and 4b has been illustrated in the ex-

ample shown in FIG. 14, a plurality of speakers equivalent to the speakers 4a and 4b may be connected to the amplifier 6, or alternatively, woofers and tweeters may be added, and so on, whereby it is also possible to construct 5.1-channel and 7.1-channel audio systems. Moreover, with regard to the number of mounted speaker units 41 to 44, for example, three or more speaker units may be arranged in line for the one speaker 4a.

[0061] FIG. 15(a) to FIG. 15(e) show another arrangement example of the speakers 4a and 4b shown in FIG. 14. Fig. 15(c) represents an embodiment of this invention

[0062] As shown in FIG. 15(a), the first-direction reinforcement portions 13a and 13b and reinforcement regions 38a of the upper and lower speaker units 41 and 42 are arranged so that the longitudinal orientations thereof can be substantially horizontal with respect to the mounting surface of the speaker 4a, whereby the sound speeds in the horizontal direction become faster as compared with those of the other regions. As a result, a sound field in which the sound expansion in the horizontal direction is made much of can be created. If the same audio signal is inputted to the speaker units 41 and 42 of FIG. 15(a), then the feeling of togetherness can also be given to the sounds emitted from the speaker 4a.

[0063] As shown in FIG. 15(b), the first-direction reinforcement portions 13a and 13b and reinforcement regions 38a of the upper and lower speaker units 41 and 42 are arranged so that the orientations thereof can be substantially vertical with respect to the mounting surface of the speaker 4a, whereby the sound speeds in the vertical direction become faster as compared with those of the other regions. As a result, for example, in the case where the surround signal for the left channel in the reproduction system of the five-channel surround signal is inputted to the speaker unit 41 of FIG. 15(b), audibility that the sound looms forward of the speaker 4a can be given to the user. Meanwhile, in the case of utilizing the speaker 4a of FIG. 15(b) as the speaker for the two-channel stereo reproduction, the same signal is inputted to the speaker units 41 and 42, whereby the feeling of togetherness can be given to the reproduction sounds emitted from the respective speaker units 41 and 42.

[0064] As shown in FIG. 15(c), configurations of the lower speaker units 42 and 44 are set similar to those of FIG. 14, and the first-direction reinforcement portions 13a and 13b and reinforcement regions 38a of the upper speaker units 41 and 43 are arranged so that the orientations thereof can be inclined obliquely with respect to the mounting surface. In such a way, a sound field in which the sounds are diffused in the horizontal direction and the oblique directions can be created.

[0065] As shown in FIG. 15(d), the configuration of the lower speaker unit 42 is set similar to the configuration of FIG. 14, and the orientations of the first-direction reinforcement portions 13a and 13b and reinforcement region 38a of the upper speaker unit 41 are directed in the horizontal direction with respect to the mounting surface, whereby a sound field can be created, in which the sound

expansion in the horizontal direction is emphasized.

[0066] As shown in FIG. 15(e), the configuration of the lower speaker unit 42 is set similar to the configuration of FIG. 14, and the orientations of the first-direction reinforcement portions 13a and 13b and reinforcement region 38a of the upper speaker unit 41 are directed in the vertical direction with respect to the mounting surface, whereby a sound field can be created, in which the sound expansion in the vertical direction is emphasized.

(Fourth Modification Example)

[0067] As mentioned above, in FIG. 1 to FIG. 15, the descriptions have been made by taking as an example the conical vibration member 10; however, as shown in FIG. 16 and FIG. 17, a vibration member 50 in which a cross section has a dome shape can also be used. A speaker unit 9 shown in FIG. 16 includes: a magnetic circuit 91; a housing portion 92 that houses the magnetic circuit 91; a diaphragm 5 arranged on the magnetic circuit 91; and a frame 93 that fixes the diaphragm 5.

[0068] Note that Fig. 16 is a cross-sectional view showing the speaker unit according to the fourth modification example, FIG. 17(a) is a plan view of the diaphragm according to the fourth modification example, and FIG. 17(b) is a cross-sectional view in the case of viewing FIG. 17(a) in a B-B direction.

[0069] The diaphragm 5 has: the vibration member 50 in which the cross section has the dome shape; and an edge 54 formed entirely on an outer circumferential portion of the vibration member 50. As the vibration member 50, there can be used the above-mentioned isotropic materials, silk, cotton, hemp, chemical fiber, a resin film, and the like.

[0070] The vibration member 50 has: a standard portion 50b; and a reinforcement portion 50a provided into a band shape on a center portion of the vibration member 50. The reinforcement portion 50a is a region pressed more strongly than the standard portion 50b in a manufacturing process of the vibration member 50, and a material density of the reinforcement portion 50a is higher as compared with that of the standard portion 50b. In the case of using paper as a material of the vibration member 50, the material density of the standard portion 50b is approximately 0.4 to 0.7 g/cm³, and the material density of the reinforcement portion 50a is approximately 0.5 to 1.0 g/cm³. A Young's modulus of the reinforcement portion 50a is higher by approximately 5 to 15% as compared with that of the standard portion 50b. The Young's modulus of the standard portion 50b is approximately 1.2 to 2.0 Pa, and the Young's modulus of the reinforcement portion 50a is approximately 1.3 to 2.5 Pa. Moreover, a thickness of the standard portion 50b is approximately 0.04 mm to 0.3 mm, and a thickness of the reinforcement portion 50a is approximately 0.020 mm to 0.25 mm.

[0071] A shape of the reinforcement portion 50a is not particularly limited. For example, substantially similar shapes to those of the reinforcement regions 38a shown

in FIG. 12(a) to FIG. 12(c) can be adopted.

[0072] A curvature of a dome portion of the vibration member 50 is relatively large. Accordingly, for example, in the case of pasting a raw material in which a sound speed is faster than in a material of a general diaphragm onto a surface of the diaphragm, the raw material is prone to peel off from the diaphragm. In accordance with the diaphragm according to the third modification example, the reinforcement portion 50a and the standard portion 50b are integrated with each other by the press molding, and accordingly, the reinforcement portion 50a does not peel off from a surface of the vibration member 50. Moreover, the vibration member 50 is formed by being pressed, whereby the vibration member 50 is not damaged as compared with the case of processing the surface of the vibration member 50 by a chemical solution, a laser and the like. Hence, the diaphragm 5 is obtained, in which stable quality is maintained for a long period of time.

Claims

1. A speaker (4a, 4b) that includes first and second speaker units (41, 42; 43, 44) arranged on a front surface of a cabinet thereof, wherein the cabinet has a mounting surface at a lower side thereof, wherein the first speaker unit (41; 43) includes a first vibration member including first-region and second-region portions formed integrally with each other by using an isotropic material in which a sound propagation speed is substantially equal in every direction, the first vibration member having, in the first-region portion, a first reinforcement portion (13a, 13b, 13c, 13d) in which a Young's modulus is higher than in the second-region portion, the second speaker unit (42, 44) includes a second vibration member including third-region and fourth-region portions formed integrally with each other by using an isotropic material in which a sound propagation speed is substantially equal in every direction, the second vibration member having, in the third-region portion, a second reinforcement portion (13a, 13b, 13c, 13d) in which a Young's modulus is higher than in the fourth-region portion, wherein the first reinforcement portion (13a, 13b, 13c, 13d) of the first speaker unit (41; 43) includes:

a first-direction reinforcement portion (13a, 13b) arranged in a first direction passing through a center of the vibration member; and
a second-direction reinforcement portion (13c, 13d) arranged in a second direction passing through the center of the vibration member, the second direction being different from the first direction,

wherein the second reinforcement portion (13a, 13b,

13c, 13d) of the second speaker unit (42, 44) includes:

a third-direction reinforcement portion (13a, 13b) arranged in a third direction passing through a center of the vibration member; and
a fourth-direction reinforcement portion (13c, 13d) arranged in a fourth direction passing through the center of the vibration member, the fourth direction being different from the third direction,

wherein the speaker (4a, 4b) is composed by arranging the first and second speaker units (41, 42; 43, 44) so that the first direction of the first-direction reinforcement portion (13a, 13b) of the first speaker unit (41; 43) is oriented obliquely with respect to the mounting surface of the speaker and the third direction of the third-direction reinforcement portion (13a, 13b) of the second speaker unit (42; 44) is vertical with respect to the mounting surface of the speaker, and

wherein the speaker (4a, 4b) is composed by arranging the first and second speaker units (41, 42; 43, 44) so that the second direction of the second-direction reinforcement portion (13c, 13d) of the first speaker unit (41; 43) and the fourth direction of the fourth-direction reinforcement portion (13c, 13d) of the second speaker unit (42; 44) are horizontal with respect to the mounting surface of the speaker.

2. The speaker according to claim 1, wherein the first and second vibration members have a substantially conical shape, and each of the first and second reinforcement portions (13a, 13b, 13c, 13d) is a plurality of reinforcement portions provided in a band shape radially from a small-diameter side of each of the vibration members toward a large-diameter side of each thereof.
3. The speaker according to claim 1 or 2, wherein the first and second vibration members further include caps (38) which cover opening portions thereof, and
each of the caps (38) includes first-cap-region and second-cap-region portions formed integrally with each other by using an isotropic material in which a sound propagation speed is substantially equal in every direction, and has, in the first-cap-region portion, a cap reinforcement portion (38a) in which a Young's modulus is higher than in the second-cap-region portion.
4. An audio system comprising:

amplifying means (6) for amplifying audio signals including a front signal for a left channel, a surround signal for the left channel, a center-

channel signal, a surround signal for a right channel, and a front signal for the right channel; and

first and second speakers (4a, 4b) according to any one of claims 1 to 4, to which the audio signals are supplied from the amplifying means (6), wherein the surround signal for the left channel and the center-channel signal are supplied to the first speaker unit (41) of the first speaker (4a) from the amplifying means (6), and the front signal for the left channel is supplied to the second speaker unit (42) of the first speaker (4a) from the amplifying means (6), and the surround signal for the right channel and the center-channel signal are supplied to the first speaker unit (43) of the second speaker (4b) from the amplifying means (6), and the front signal for the right channel is supplied to the second speaker unit (44) of the second speaker (4b) from the amplifying means (6).

5. An audio system comprising:

amplifying means (6) for amplifying audio signals including a signal for a left channel and a signal for a right channel; and first and second speakers (4a, 4b) according to any one of claims 1 to 4, to which the audio signals are supplied from the amplifying means, wherein the identical signal for the left channel is supplied to the first and second speaker units (41, 42) of the first speaker (4a) from the amplifying means (6), and the identical signal for the right channel is supplied to the first and second speaker units (43, 44) of the second speaker (4b) from the amplifying means (6).

Patentansprüche

1. Lautsprecher (4a, 4b), der erste und zweite Lautsprechereinheiten (41, 42; 43, 44) umfasst, die auf einer vorderen Oberfläche eines Gehäuses von diesem angeordnet sind, wobei das Gehäuse eine Anbringungsfläche an seiner unteren Seite besitzt, wobei die erste Lautsprechereinheit (41; 43) ein erstes Vibrationsglied umfasst, das Teile eines ersten Bereichs und eines zweiten Bereichs umfasst, die integral miteinander durch Verwenden eines isotropischen Materials gebildet sind, in dem eine Schallausbreitungsgeschwindigkeit in jeder Richtung im Wesentlichen gleich ist, wobei das erste Vibrationsglied in dem Teil des ersten Bereichs einen ersten Aussteifungs- bzw. Verstärkungsteil (13a, 13b, 13c, 13d) besitzt, in dem ein Youngscher- bzw. Elastizitätsmodul höher als in dem Teil des zweiten Bereichs ist,

die zweite Lautsprechereinheit (42, 44) umfasst ein zweites Vibrationsglied, das Teile eines dritten Bereichs und eines vierten Bereichs umfasst, die integral miteinander durch Verwenden eines isotropischen Materials gebildet sind, in dem eine Schallausbreitungsgeschwindigkeit in jeder Richtung im Wesentlichen gleich ist, wobei das zweite Vibrationsglied in dem Teil des dritten Bereichs einen zweiten Verstärkungsteil (13a, 13b, 13c, 13d) besitzt, in dem ein Elastizitätsmodul höher als in dem Teil des vierten Bereichs ist, wobei der erste Verstärkungsteil (13a, 13b, 13c, 13d) der ersten Lautsprechereinheit (41; 43) Folgendes umfasst:

einen Verstärkungsteil (13a, 13b) einer ersten Richtung, der in einer ersten Richtung angeordnet ist, die durch eine Mitte des Vibrationsglieds hindurch geht; und

einen Verstärkungsteil (13c, 13d) einer zweiten Richtung, der in einer zweiten Richtung angeordnet ist, die durch die Mitte des Vibrationsglieds hindurch geht, wobei sich die zweite Richtung von der ersten Richtung unterscheidet, wobei der zweite Verstärkungsteil (13a, 13b, 13c, 13d) der zweiten Lautsprechereinheit (42, 44) Folgendes umfasst:

einen Verstärkungsteil (13a, 13b) einer dritten Richtung, der in einer dritten Richtung angeordnet ist, die durch eine Mitte des Vibrationsglieds hindurch geht; und

einen Verstärkungsteil (13c, 13d) einer vierten Richtung, der in einer vierten Richtung angeordnet ist, die durch die Mitte des Vibrationsglieds hindurch geht, wobei sich die vierte Richtung von der dritten Richtung unterscheidet, wobei der Lautsprecher (4a, 4b) durch Anordnen der ersten und zweiten Lautsprechereinheiten (41, 42; 43, 44) zusammengesetzt wird, so dass die erste Richtung des Verstärkungsteils (13a, 13b) der ersten Richtung der ersten Lautsprechereinheit (41; 43) schräg in Bezug auf die Anbringungsfläche des Lautsprechers ausgerichtet ist und die dritte Richtung des Verstärkungsteils (13a, 13b) des Verstärkungsteils der dritten Richtung der zweiten Lautsprechereinheit (42; 44) vertikal in Bezug auf die Anbringungsfläche des Lautsprechers ist, und

wobei der Lautsprecher (4a, 4b) durch Anordnen der ersten und zweiten Lautsprechereinheiten (41, 42; 43, 44) zusammengesetzt wird, so dass die zweite Richtung des Verstärkungsteils (13c, 13d) der zweiten Richtung der ersten Lautsprechereinheit (41; 43) und die vierte Richtung des Verstärkungsteils (13c, 13d) der vierten Richtung der zweiten Lautsprechereinheit (42; 44) horizontal in Bezug auf die Anbringungsfläche des Lautsprechers ist.

2. Lautsprecher gemäß Anspruch 1, wobei die ersten und zweiten Vibrationsglieder eine im Wesentlichen konische Form besitzen und jeder der ersten und zweiten Verstärkungsteile (13a, 13b, 13c, 13d) aus einer Vielzahl von Verstärkungsteilen besteht, die in einer Bandform radial von einer Seite mit kleinem Durchmesser von jedem der Vibrationsglieder zu einer Seite mit großem Durchmesser von diesen vorgesehen sind.
3. Lautsprecher gemäß Anspruch 1 oder 2, wobei die ersten und zweiten Vibrationsglieder ferner Kappen (38) umfassen, die Öffnungsteile von diesen abdecken, und jede der Kappen (38) umfasst Teile eines ersten Kappenbereichs und eines zweiten Kappenbereichs, die integral miteinander durch Verwenden eines isotropischen Materials gebildet sind, in dem eine Schallausbreitungsgeschwindigkeit in sämtliche Richtungen im Wesentlichen gleich ist, und besitzt in dem Teil des ersten Kappenbereichs einen Kappenverstärkungsteil (38a), in dem ein Elastizitätsmodul höher als in dem Teil des zweiten Kappenbereichs ist.
4. Audiosystem, das Folgendes aufweist:
- ein Verstärkungsmittel (6) zum Verstärken von Audiosignalen, die ein vorderes Signal eines linken Kanals, ein Raumklang- bzw. Surround-Signal für den linken Kanal, ein Mittelkanalsignal, ein Surround-Signal für einen rechten Kanal und ein Front- bzw. - vorderes Signal für den rechten Kanal umfassen; und
- erste und zweite Lautsprecher (4a, 4b) gemäß einem der Ansprüche 1 bis 4, an die die Audiosignale von dem Verstärkungsmittel (6) geliefert werden, wobei das Surround-Signal für den linken Kanal und das Mittelkanalsignal an die erste Lautsprechereinheit (41) des ersten Lautsprechers (4a) von dem Verstärkungsmittel (6) geliefert wird, und das vordere Signal für den linken Kanal an die zweite Lautsprechereinheit (42) des ersten Lautsprechers (4a) von dem Verstärkungsmittel (6) geliefert wird, und das Surround-Signal für den rechten Kanal und das Mittelkanalsignal an die erste Lautsprechereinheit (43) des zweiten Lautsprechers (4b) von dem Verstärkungsmittel (6) geliefert wird, und das vordere Signal für den rechten Kanal an die zweite Lautsprechereinheit (44) des zweiten Lautsprechers (4b) von dem Verstärkungsmittel (6) geliefert wird.
5. Audiosystem, das Folgendes aufweist:
- Verstärkungsmittel (6) zum Verstärken der Audiosignale, die ein Signal für einen linken Kanal

und ein Signal für einen rechten Kanal umfassen; und

erste und zweite Lautsprecher (4a, 4b) gemäß irgendeinem der Ansprüche 1 bis 4, an die die Audiosignale von dem Verstärkungsmittel geliefert werden,

wobei die identischen Signale für den linken Kanal an die ersten und zweiten Lautsprechereinheiten (41, 42) des ersten Lautsprechers (4a) von dem Verstärkungsmittel (6) geliefert werden, und

die identischen Signale für den rechten Kanal an die ersten und zweiten Lautsprechereinheiten (43, 44) des zweiten Lautsprechers (4b) von dem Verstärkungsmittel (6) geliefert werden.

Revendications

1. Haut-parleur (4a, 4b) comprenant des première et deuxième unités de haut-parleur (41, 42 ; 43, 44) agencées sur une surface avant d'une enceinte acoustique, l'enceinte acoustique comportant une surface de montage sur un côté inférieur,

dans lequel la première unité de haut-parleur (41 ; 43) comprend un premier élément de vibration comprenant des portions de première région et de deuxième région formées d'une seule pièce en utilisant un matériau isotrope dans lequel la vitesse de propagation du son est sensiblement égale dans toutes les directions, le premier élément de vibration comportant, dans la portion de première région, une première portion de renfort (13a, 13b, 13c, 13d) dans laquelle le module de Young est supérieur à celui de la portion de deuxième région,

la deuxième unité de haut-parleur (42 ; 44) comprend un deuxième élément de vibration comprenant des portions de troisième région et de quatrième région formées d'une seule pièce en utilisant un matériau isotrope dans lequel la vitesse de propagation du son est sensiblement égale dans toutes les directions, le deuxième élément de vibration comportant, dans la portion de troisième région, une deuxième portion de renfort (13a, 13b, 13c, 13d) dans laquelle le module de Young est supérieur à celui de la portion de quatrième région,

dans lequel la première portion de renfort (13a, 13b, 13c, 13d) de la première unité de haut-parleur (41 ; 43) comprend :

une portion de renfort de première direction (13a, 13b) agencée dans une première direction passant à travers un centre de l'élément de vibration ; et

une portion de renfort de deuxième direc-

tion (13c, 13d) agencée dans une deuxième direction passant à travers le centre de l'élément de vibration, la deuxième direction étant différente de la première direction,

dans lequel la deuxième portion de renfort (13a, 13b, 13c, 13d) de la deuxième unité de haut-parleur (42 ; 44) comprend :

une portion de renfort de troisième direction (13a, 13b) agencée dans une troisième direction passant à travers un centre de l'élément de vibration ; et

une portion de renfort de quatrième direction (13c, 13d) agencée dans une quatrième direction passant à travers le centre de l'élément de vibration, la quatrième direction étant différente de la troisième direction,

dans lequel le haut-parleur (4a, 4b) est composé en agençant des première et deuxième unités de haut-parleur (41, 42 ; 43, 44) de telle sorte que la première direction de la portion de renfort de première direction (13a, 13b) de la première unité de haut-parleur (41 ; 43) soit orientée de façon oblique par rapport à la surface de montage du haut-parleur et la troisième direction de la portion de renfort de troisième direction (13a, 13b) de la deuxième unité de haut-parleur (42 ; 44) soit verticale par rapport à la surface de montage du haut-parleur, et

dans lequel le haut-parleur (4a, 4b) est composé en agençant les première et deuxième unités de haut-parleur (41, 42 ; 43, 44) de telle sorte que la deuxième direction de la portion de renfort de deuxième direction (13c, 13d) de la première unité de haut-parleur (41 ; 43) et la quatrième direction de la portion de renfort de quatrième direction (13c, 13d) de la deuxième unité de haut-parleur (42 ; 44) soient horizontales par rapport à la surface du haut-parleur.

2. Haut-parleur selon la revendication 1, dans lequel les premier et deuxième éléments de vibration ont une forme sensiblement conique, et chacune des première et deuxième portions de renfort (13a, 13b, 13c, 13d) est une pluralité de portions de renfort prévue sous la forme de bandes s'étendant radialement à partir d'un côté de petit diamètre de chacun des éléments de vibration vers un côté de grand diamètre de chacun d'eux.

3. Haut-parleur selon la revendication 1 ou 2, dans lequel les premier et deuxième éléments de vibration comprennent en outre des capuchons (38) qui couvrent des portions ouvertes de ceux-ci, et chacun des capuchons (38) comprend une première région de capuchon et une deuxième région de capuchon, formées d'une seule pièce en utilisant un

matériau isotrope dans lequel la vitesse de propagation du son est sensiblement égale dans toutes les directions, et comporte, dans la portion de première région de capuchon, une portion de renfort de capuchon (38a) dans laquelle le module de Young est supérieur à celui de la portion de deuxième région de capuchon.

4. Système audio comprenant :

des moyens d'amplification (6) pour amplifier des signaux audio comprenant un signal avant pour un canal gauche, un signal ambiophonique pour le canal gauche, un signal de canal central, un signal ambiophonique pour un canal droit, et un signal avant pour le canal droit ; et des premier et deuxième haut-parleurs (4a, 4b) selon l'une quelconque des revendications 1 à 4, auxquels les signaux audio sont fournis à partir des moyens d'amplification (6), dans lequel le signal ambiophonique pour le canal gauche et le signal de canal central sont fournis à la première unité de haut-parleur (41) du premier haut-parleur (4a) à partir des moyens d'amplification (6), et le signal avant pour le canal gauche est fourni à la deuxième unité de haut-parleur (42) du premier haut-parleur (4a) à partir des moyens d'amplification (6), et le signal ambiophonique pour le canal droit et le signal de canal central sont fournis à la première unité de haut-parleur (43) du deuxième haut-parleur (4b) à partir des moyens d'amplification (6), et le signal avant pour le canal droit est fourni à la deuxième unité de haut-parleur (44) du deuxième haut-parleur (4b) à partir des moyens d'amplification (6).

5. Système audio comprenant :

des moyens d'amplification (6) pour amplifier des signaux audio comprenant un signal pour un canal gauche et un signal pour un canal droit ; et des premier et deuxième haut-parleurs (4a, 4b) selon l'une quelconque des revendications 1 à 4, auxquels les signaux audio sont fournis à partir des moyens d'amplification, dans lequel le signal identique pour le canal gauche est fourni aux première et deuxième unités de haut-parleur (41, 42) du premier haut-parleur (4a) à partir des moyens d'amplification (6), et le signal identique pour le canal droit est fourni aux première et deuxième unités de haut-parleur (43, 44) du deuxième haut-parleur (4b) à partir des moyens d'amplification (6).

FIG. 1

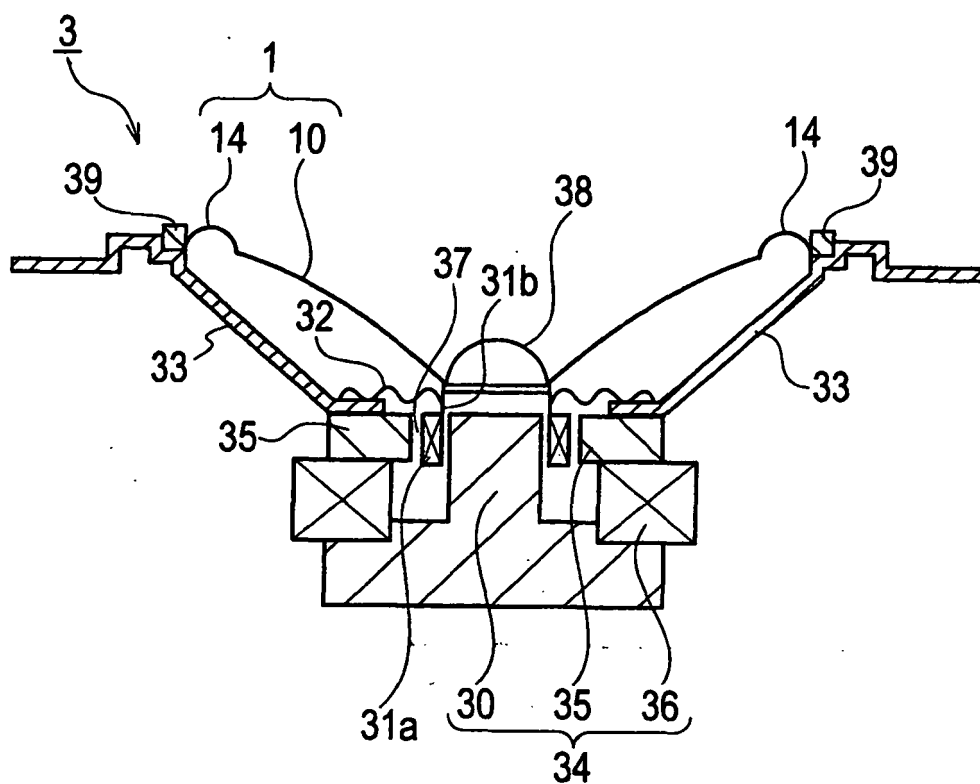


FIG. 2

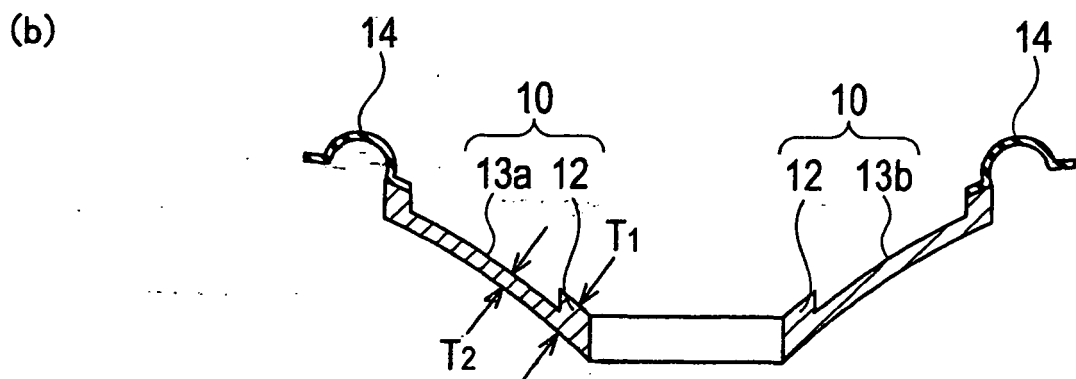
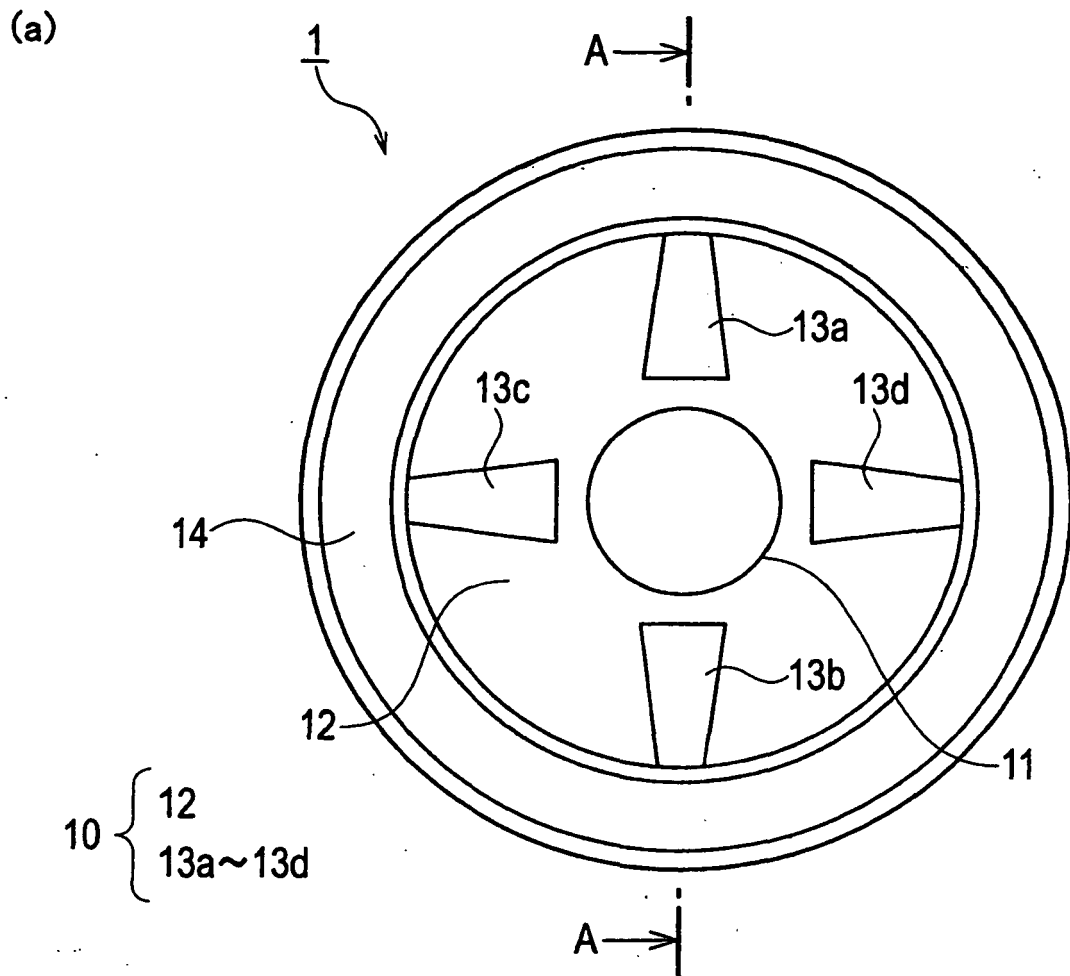


FIG. 3

PROPAGATION SPEED

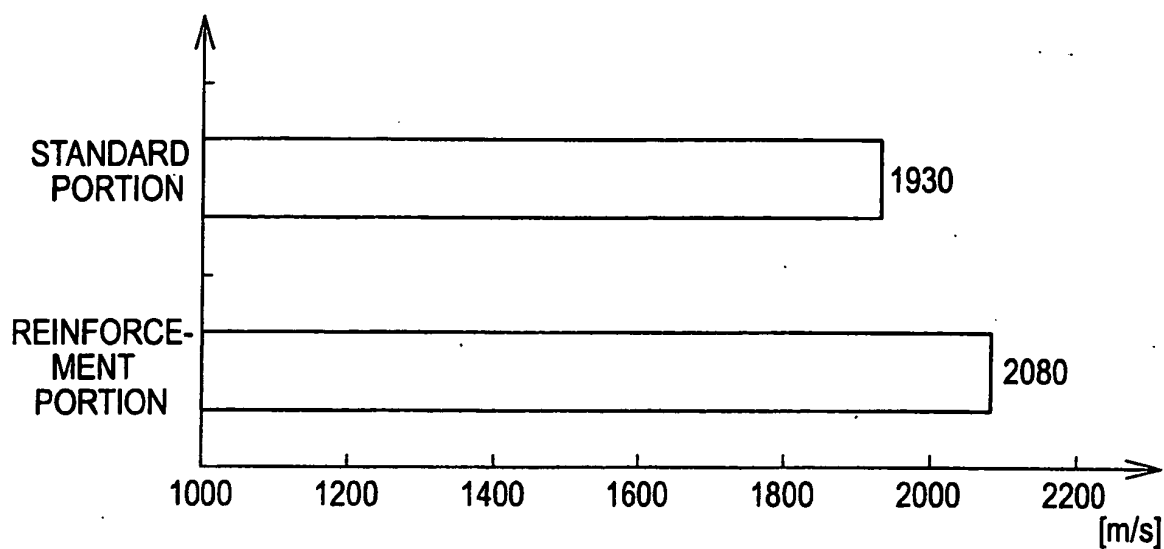


FIG. 4

INTERNAL LOSS

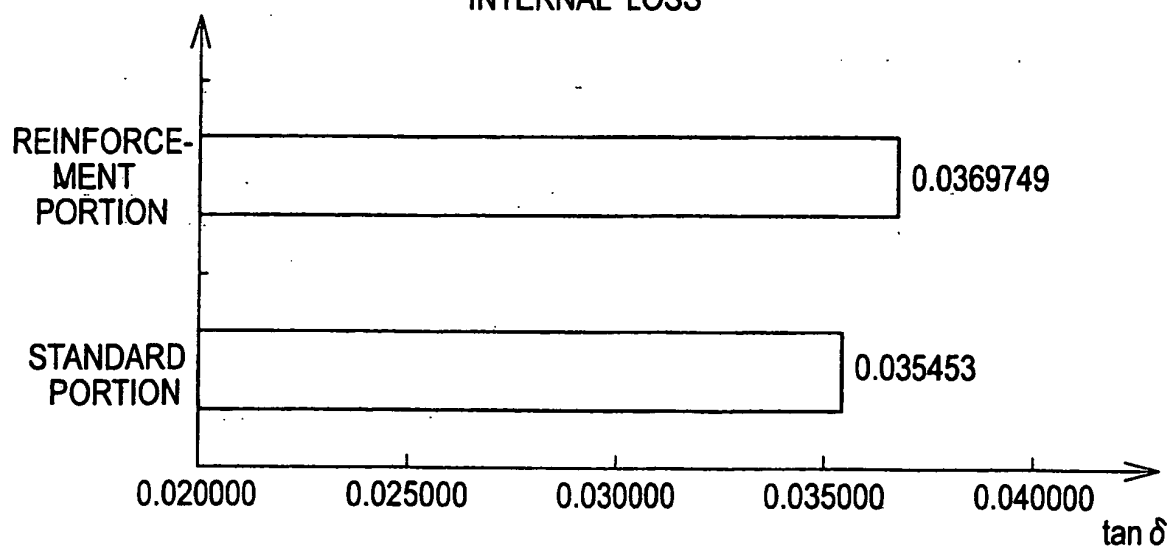


FIG. 5

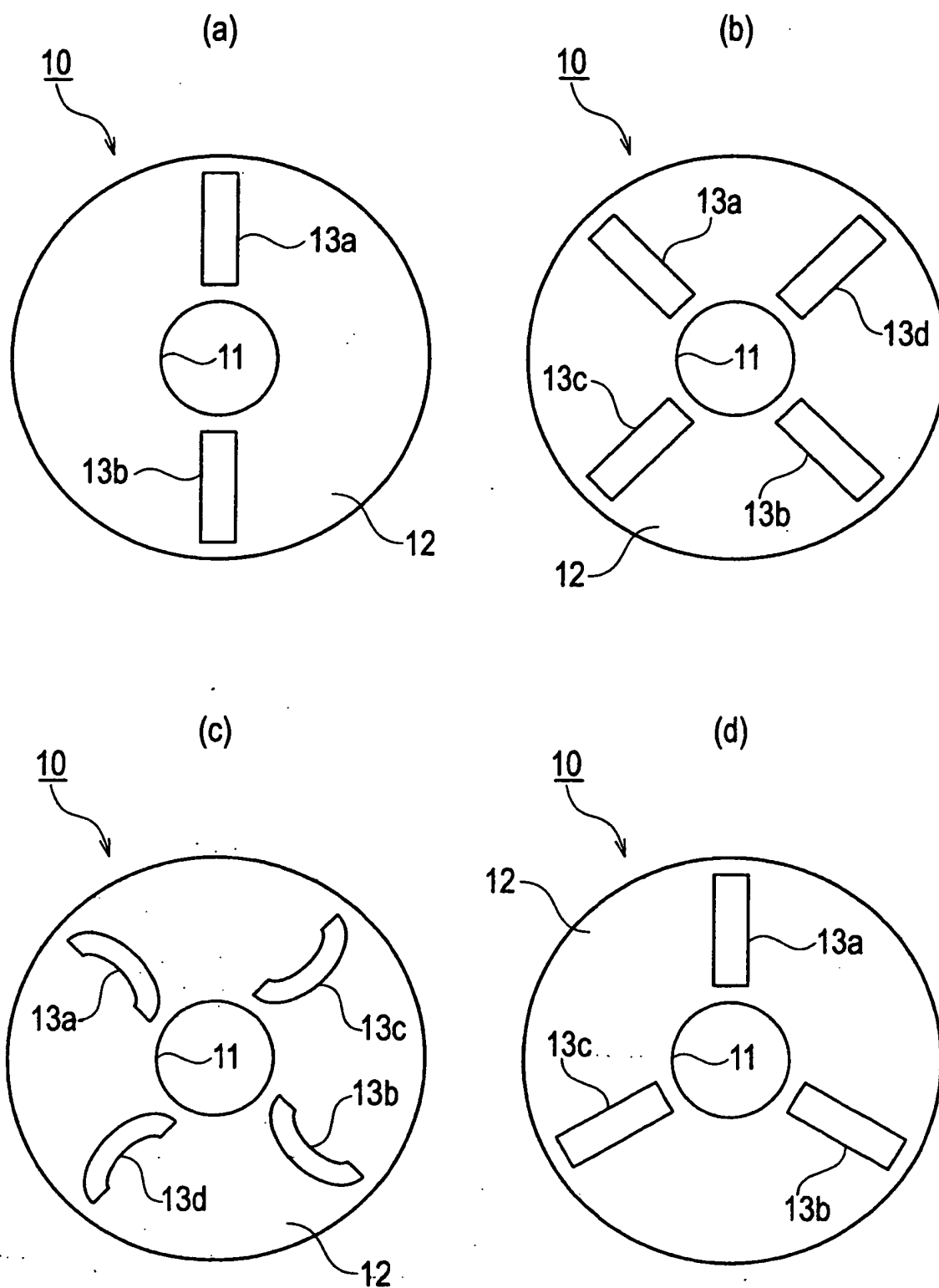


FIG. 6

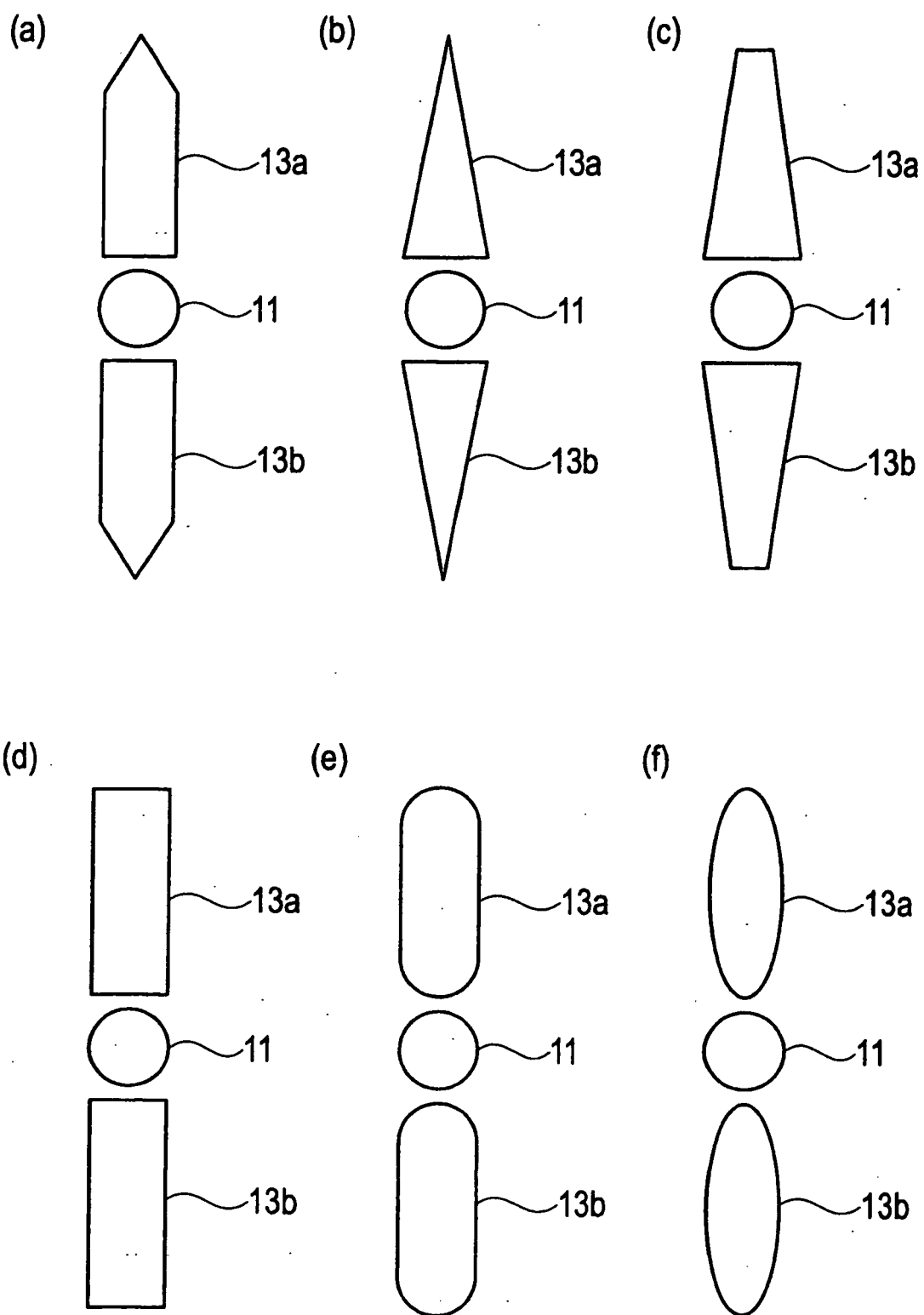


FIG. 7

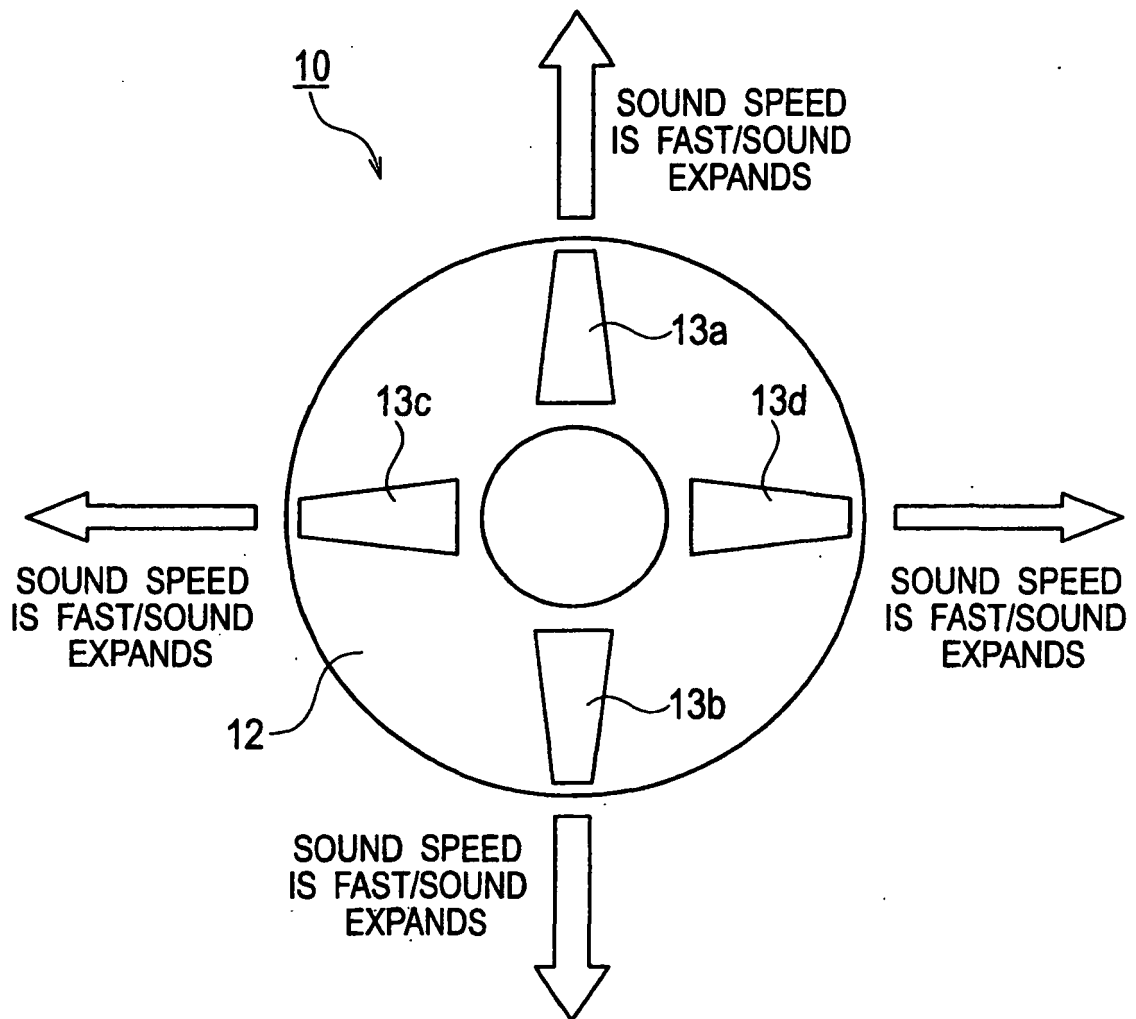


FIG. 8

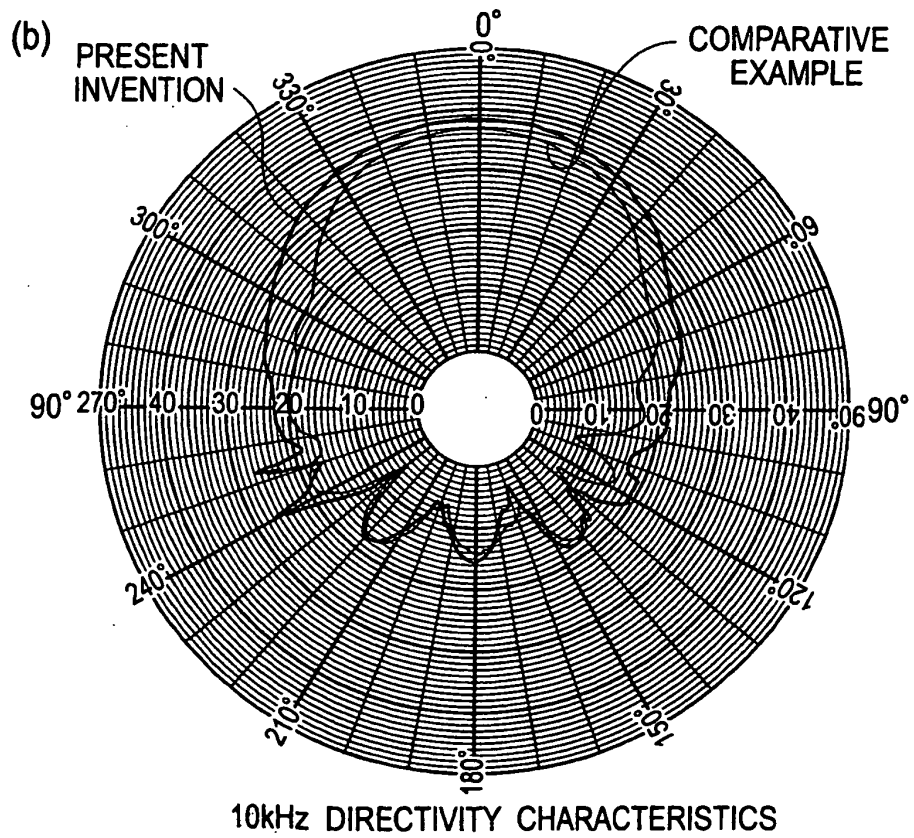
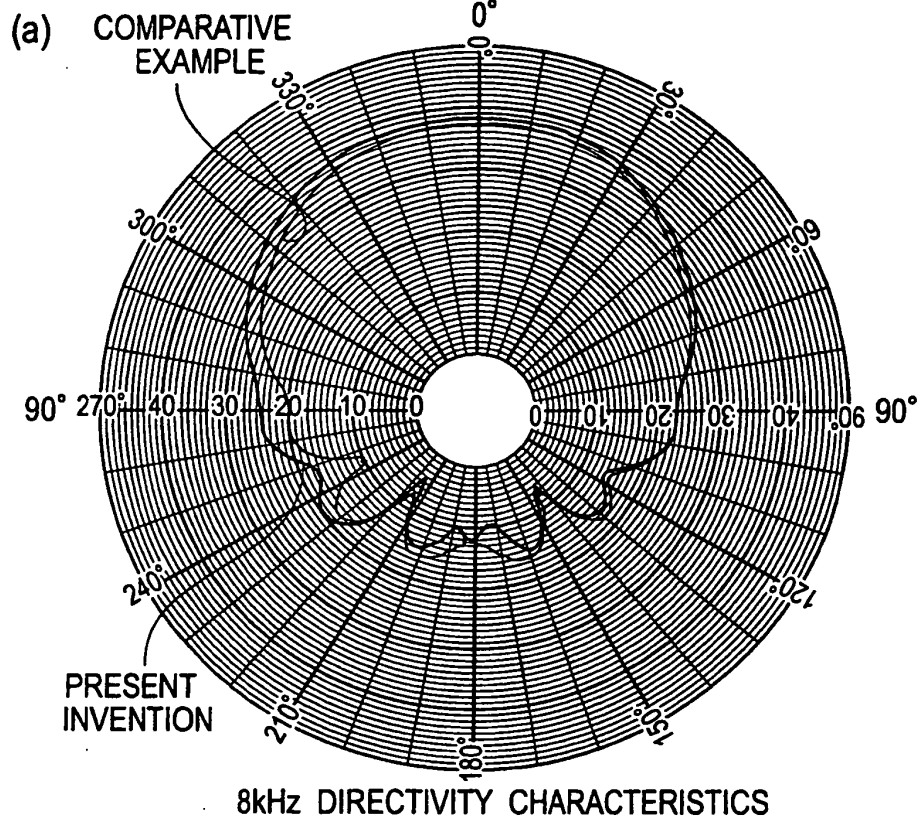


FIG. 9

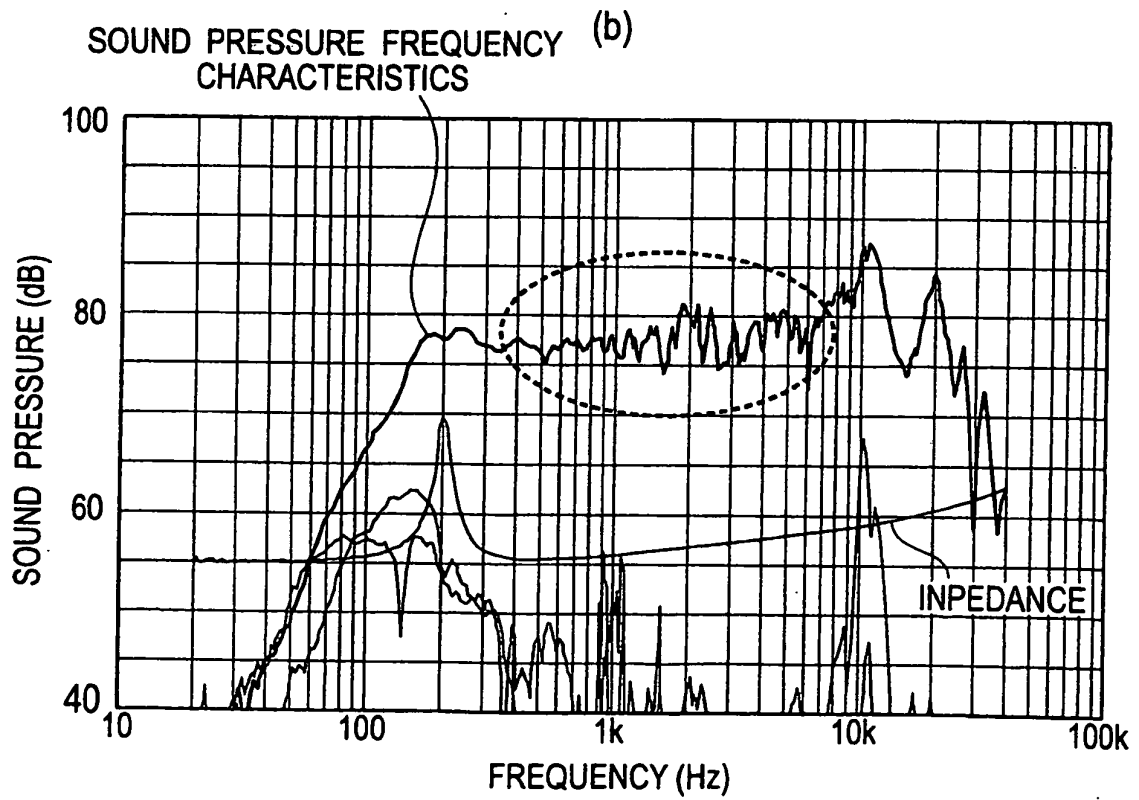
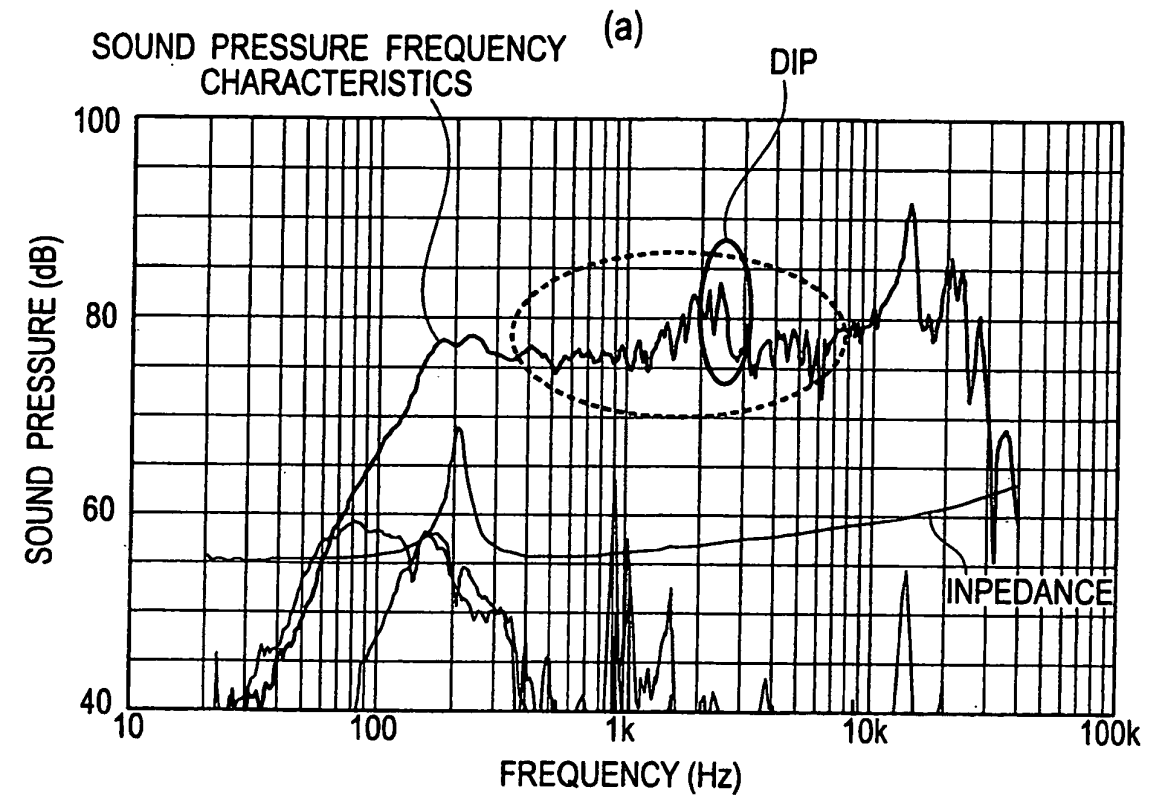


FIG. 10

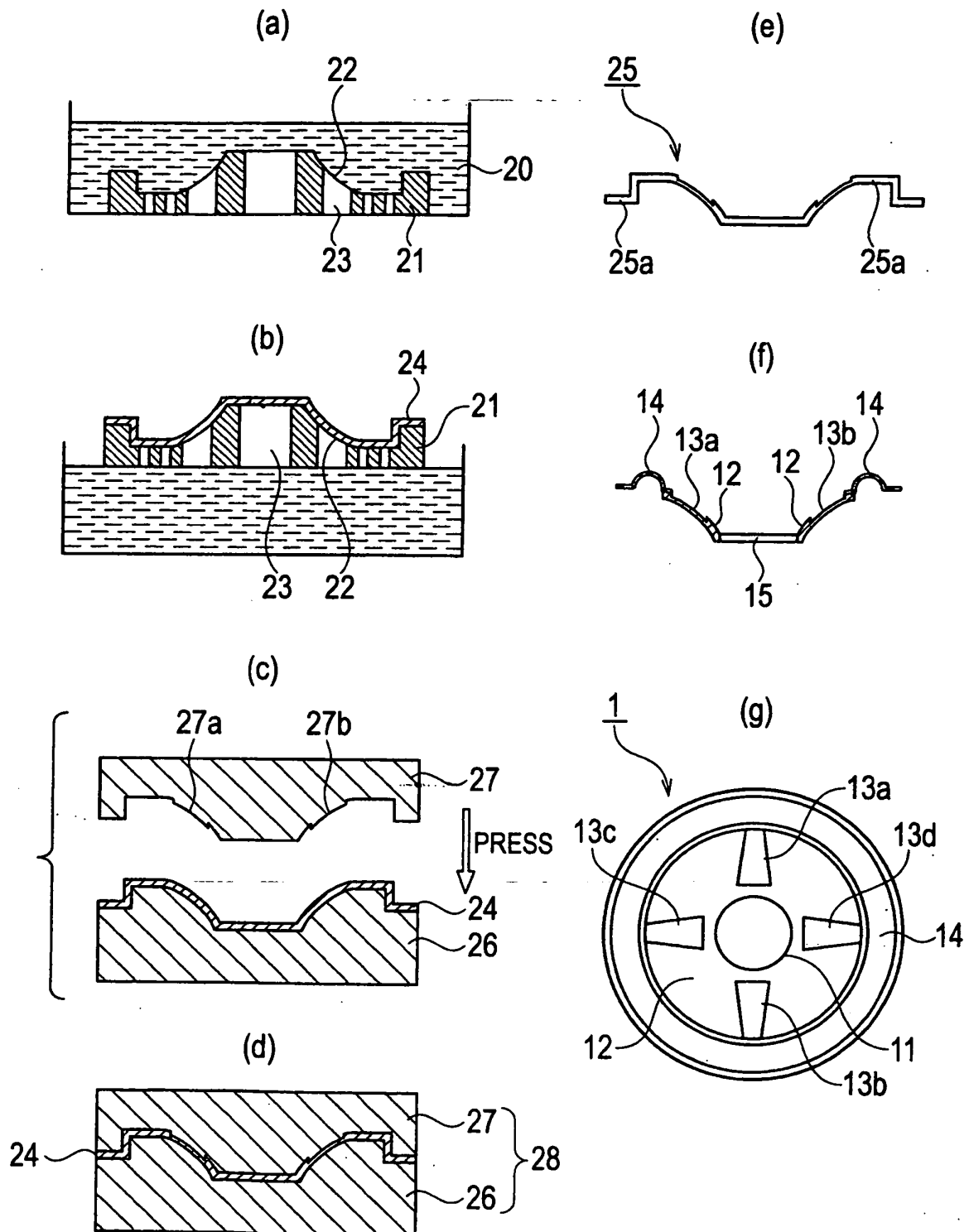


FIG. 11

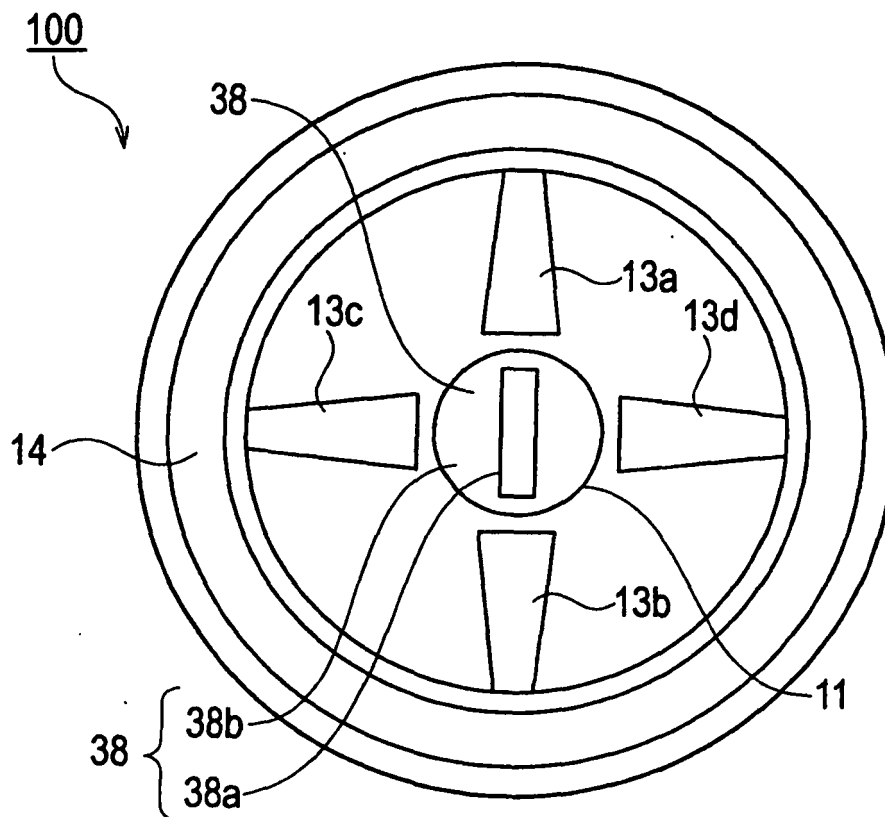


FIG. 12

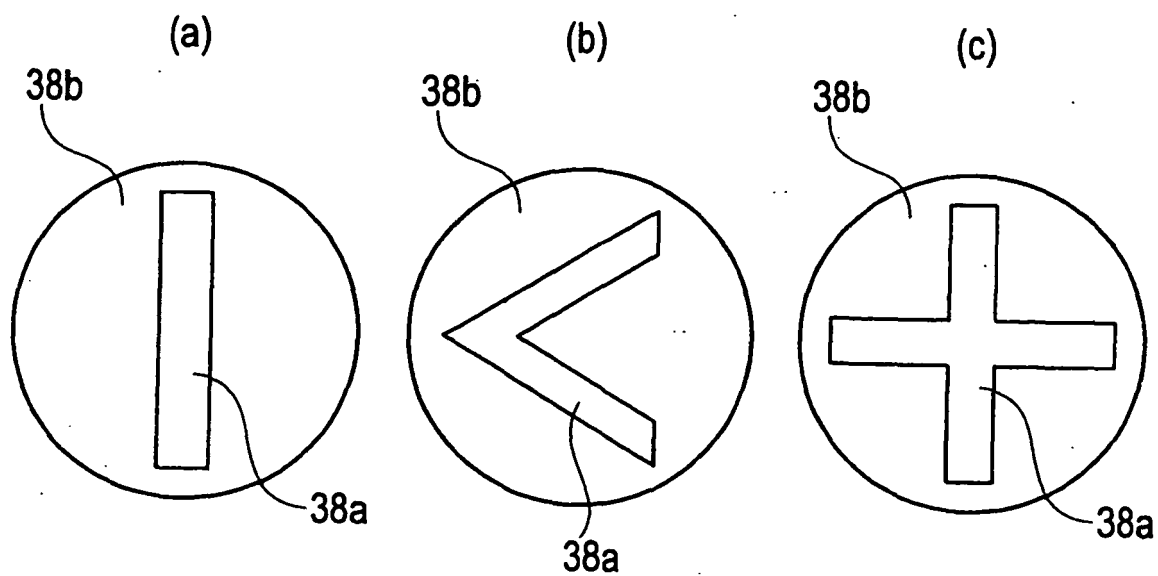


FIG. 13

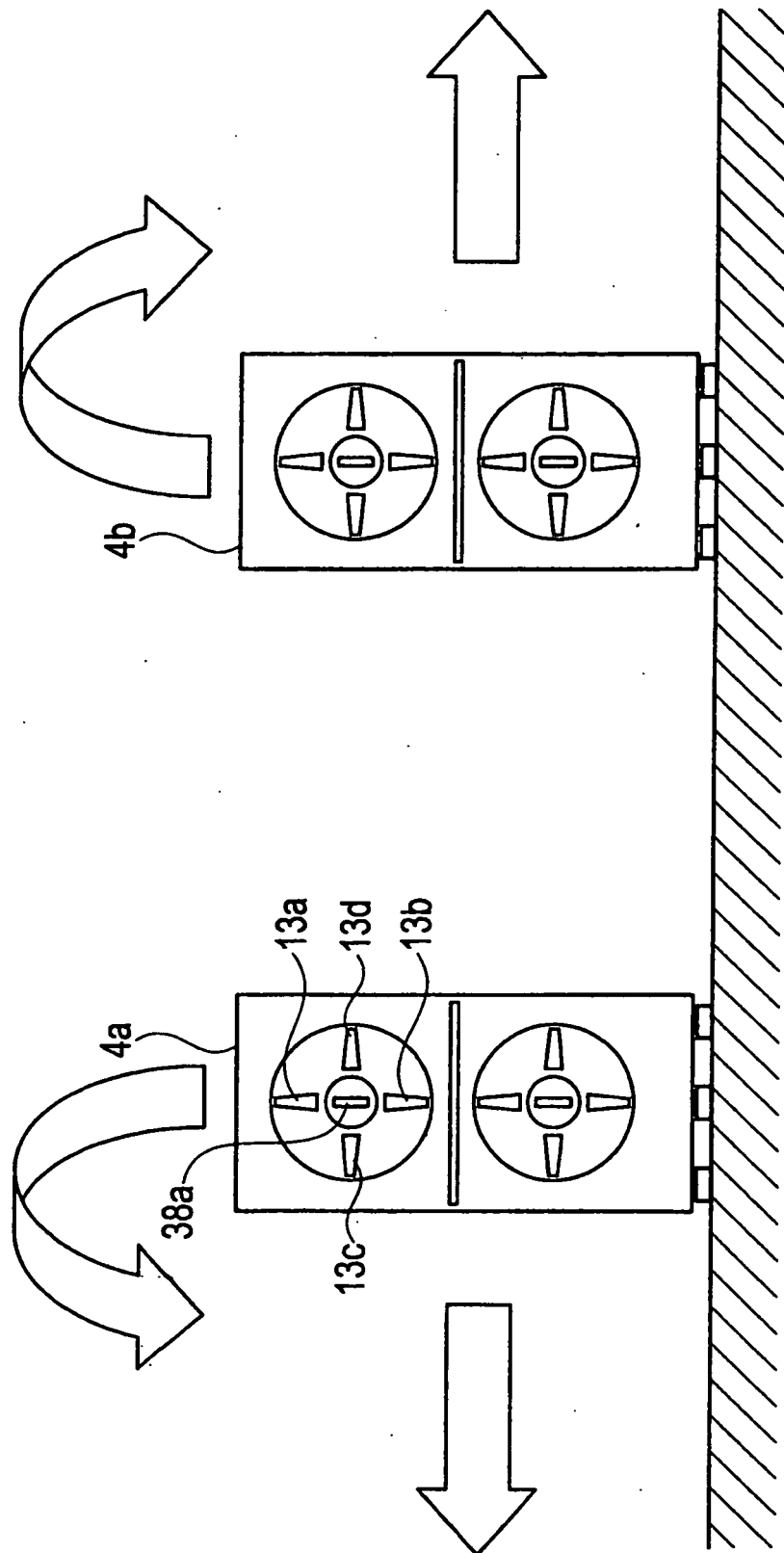


FIG. 14

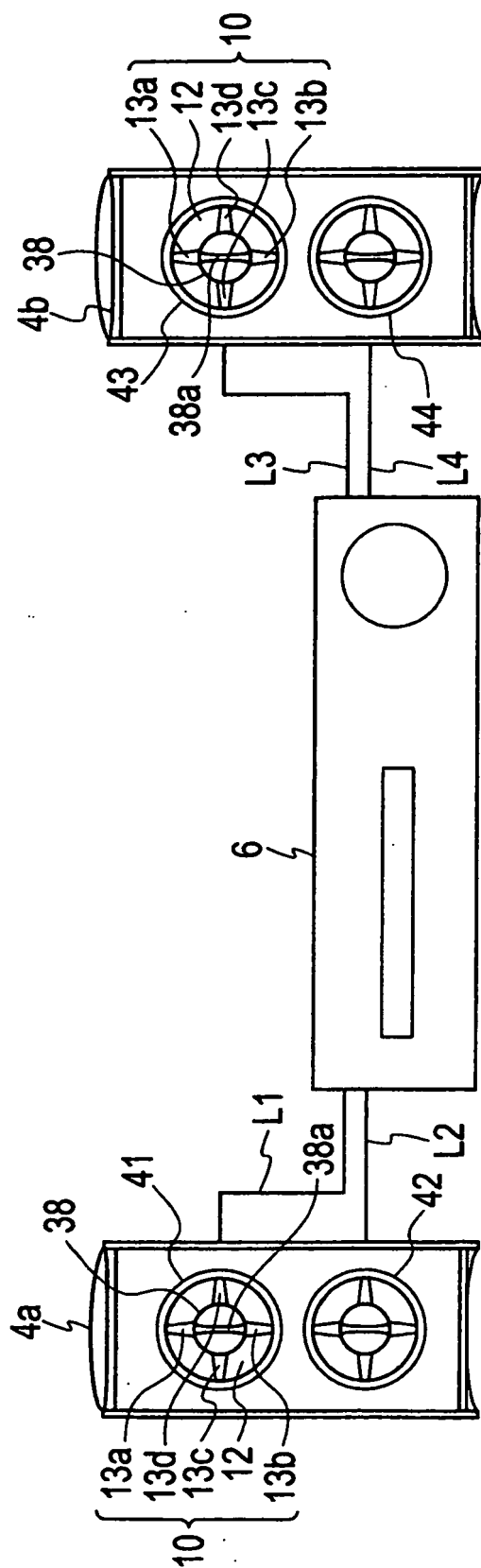


FIG. 15

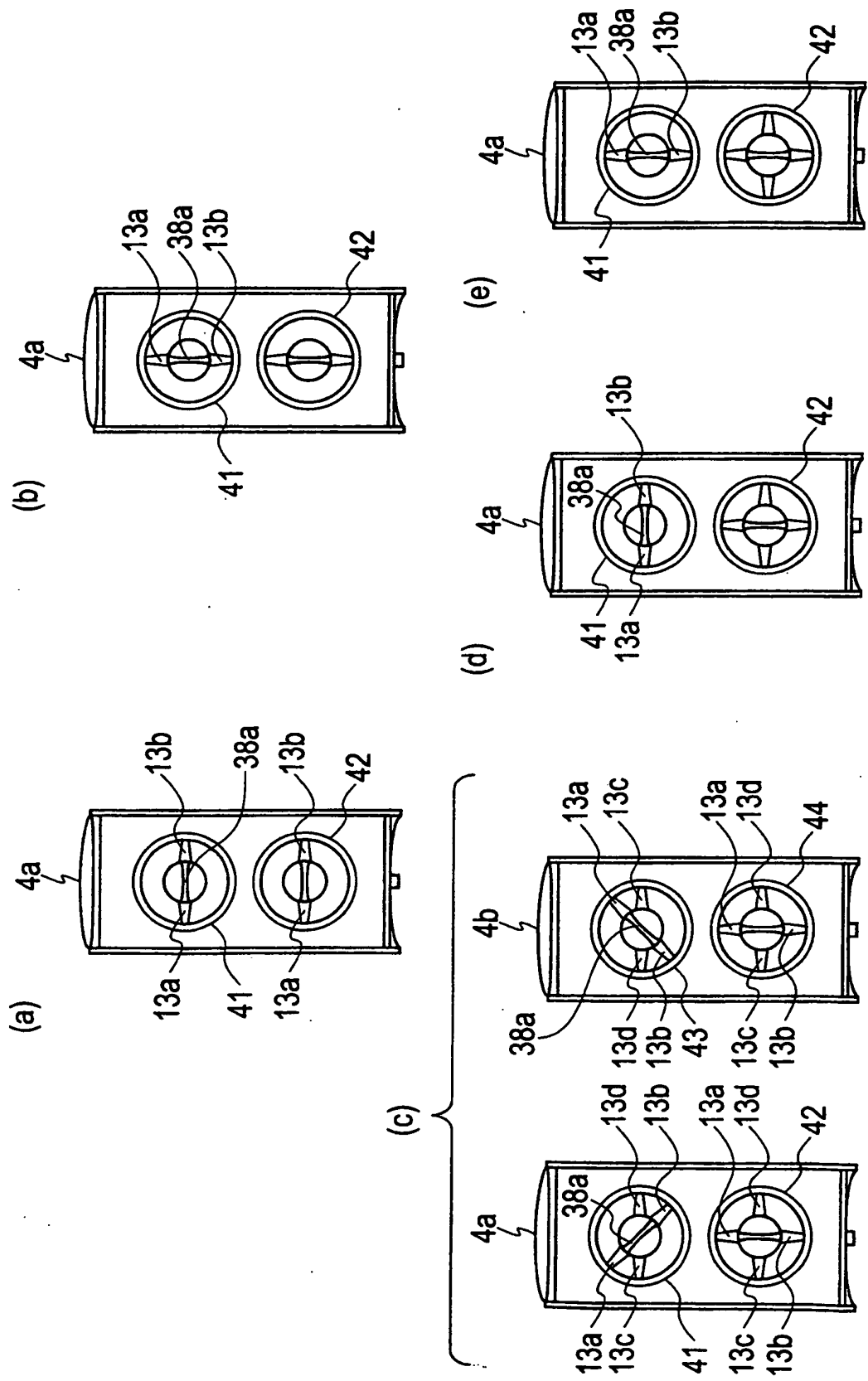


FIG. 16

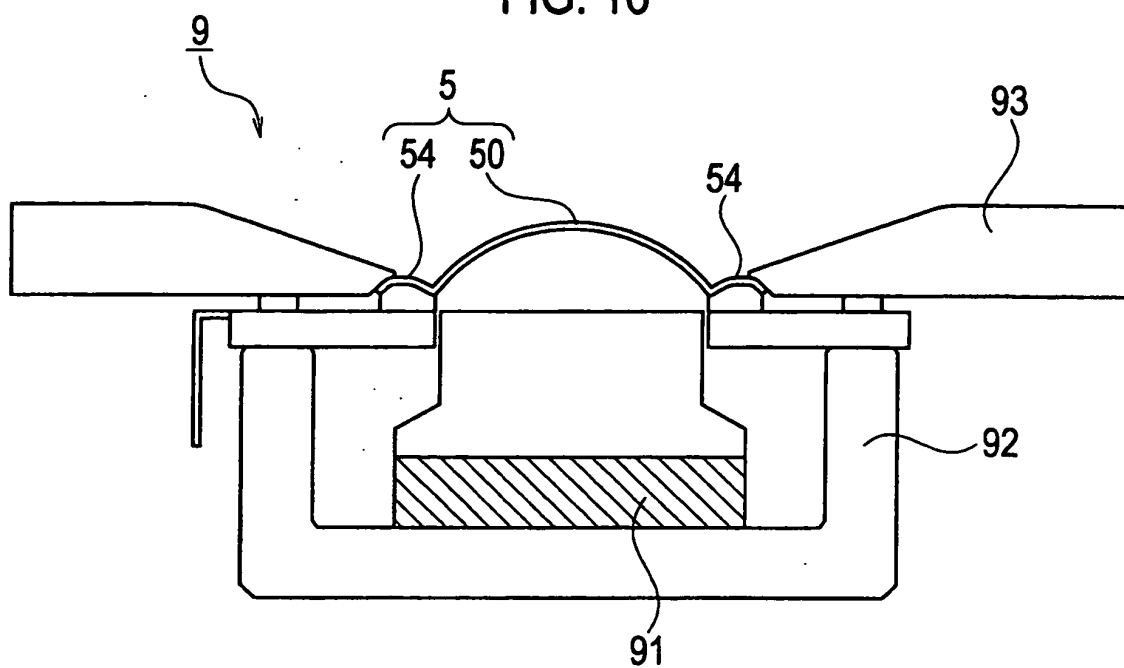
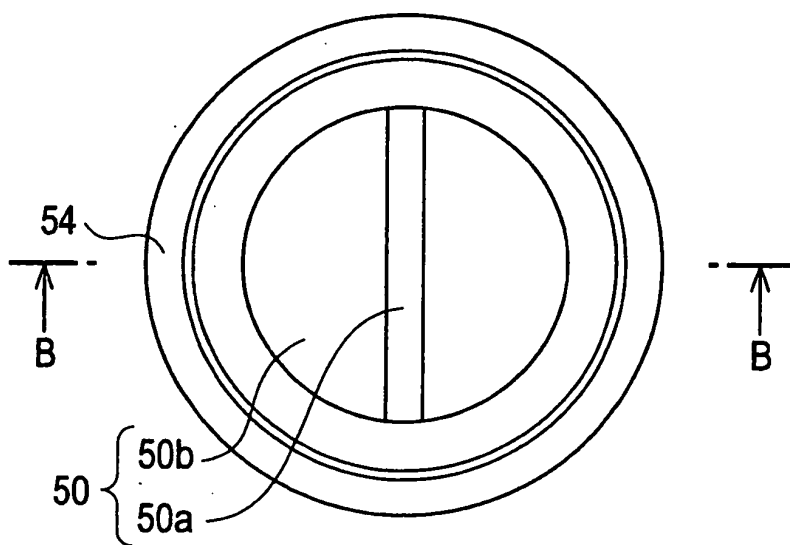
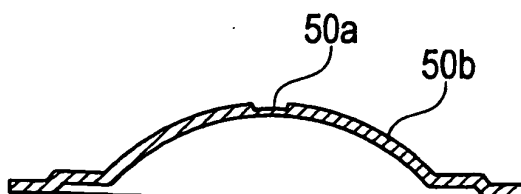


FIG. 17

(a)



(b)



REFERENCES CITED IN THE DESCRIPTION

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