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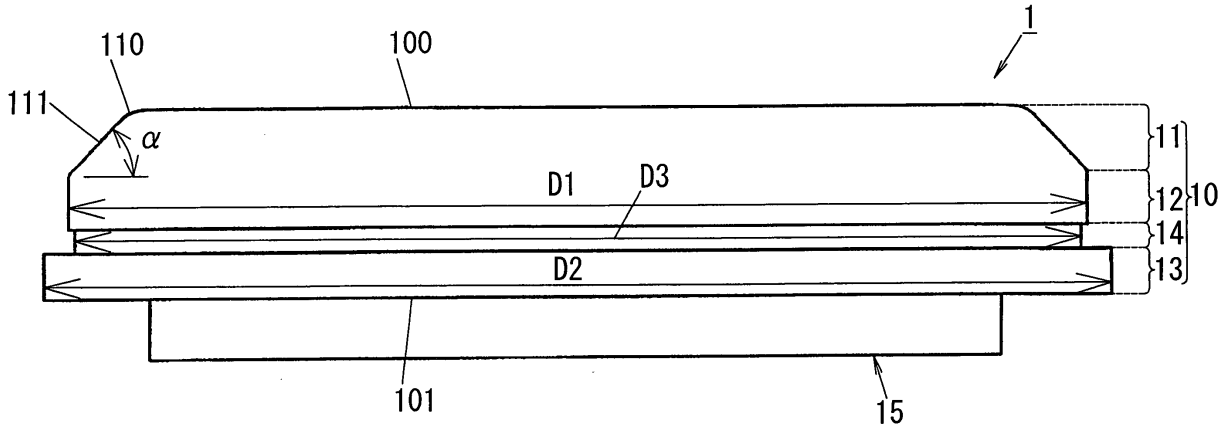
(54) Ultrasonic vibration device and beauty appliance

(57) An ultrasonic vibration device of the invention has an ultrasonic vibrator (15) and a horn (10). The horn has front and rear surfaces and is configured to emit ultrasonic energy from the front surface. The horn integrally may have up to four solids. The first solid (11) has said front surface, and is shaped to become narrower from the rear end to the front end of the first solid. The thickness of the first solid is equal to or thicker than that of the second solid (12). Every width of the second solid is different from any width of the first solid, exclusive of the rear end of the first solid. The diameter of the third solid (13) is different from any diameter of the first and second solids. The fourth solid (14) has a smaller diameter than those of the second and third solids.

FIG. 6



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Description

TECHNICAL FIELD

[0001] The invention relates to ultrasonic vibration devices and beauty appliances.

BACKGROUND ART

[0002] FIG. 1 shows an ultrasonic vibration device (ultrasonic vibration substrate) described in Japanese Patent Application Publication No. 2007-260363 published on October 11, 2007. The ultrasonic vibration device is formed of an ultrasonic vibrator 15 and a horn (substrate) 10. The ultrasonic vibrator 15 is fixed to the horn 10. The horn 10 is made of alumina. The ultrasonic vibration device is installed in an ultrasonic probe, and is used for a beauty appliance.

[0003] FIG. 2 depicts a characteristic curve of ideal impedance versus frequency of vertical vibration in an ultrasonic vibration device under no-load condition. In FIG. 2, "OSCILLATION RANGE" is the frequency range having high ultrasonic generation efficiency, and "fr" and "fa" are the resonance frequency and the antiresonance frequency, respectively. Herein, the impedance range corresponding to the "OSCILLATION RANGE" under load condition is narrower than that under no-load condition. Accordingly, in the impedance characteristic curve, the ultrasonic vibration device under no-load condition can be driven at comparatively low output, and the ultrasonic vibration device under load condition can be driven at comparatively high output.

[0004] In the ultrasonic vibration device of FIG. 1, the horn 10 integrally has a taper shaped solid 11 and a circular cylinder shaped solid 12, and the thickness of the solid 12 is thicker than that of the solid 11. Accordingly, the impedance characteristic curve of the device may include spurious as shown in FIG. 3 by the influence of the lateral vibration (specifically, large resonance) generated at the solid 12 on the vertical vibration generated at the horn 10. In this case, if the device is driven at the frequency "fd1", the impedance difference between no-load and load conditions becomes small, which reduces the output difference between no-load and load conditions.

DISCLOSURE OF THE INVENTION

[0005] It is an object of the present invention to prevent spurious from occurring between the resonance frequency and the antiresonance frequency in a characteristic curve of impedance versus frequency of vertical vibration generated at a horn.

[0006] An ultrasonic vibration device of the present invention comprises an ultrasonic vibrator for generating ultrasonic vibration, and a horn having front and rear surfaces. The horn is configured to emit ultrasonic energy from the front surface. The ultrasonic energy is obtained from the ultrasonic vibrator. The rear surface of the horn is connected with the ultrasonic vibrator. The horn integrally comprises first and second solids. The first solid has said front surface, and is shaped to become narrower from the rear end to the front end of the first solid. Every width of the second solid is different from any width of the first solid, exclusive of the rear end of the first solid. In an aspect of the invention, the thickness of the first solid is equal to or thicker than that of the second solid.

[0007] In this configuration (hereinafter referred to as a "first configuration"), the lateral vibration generated at the first solid has different frequencies among positions in the thickness direction of the first solid, and accordingly the influence of the lateral vibration generated at the first solid can be reduced. Moreover, since the thickness of the first solid is equal to or thicker than that of the second solid, the influence of the lateral vibration generated at the second solid can be also reduced. Therefore, it is possible to prevent spurious from occurring between the resonance frequency and the antiresonance frequency in a characteristic curve of impedance versus frequency of vertical vibration generated at the horn.

[0008] In an embodiment, the first solid has a tapered side. The second solid is in the shape of a circular cylinder having the same diameter as the rear end of the first solid. In this embodiment, since the first solid has a tapered side, the influence of the lateral vibration generated at the first solid can be effectively reduced.

[0009] In an embodiment, the edge of said front surface is a rounded edge. In this embodiment, since the first solid has the rounded edge and the tapered side, it is possible to make the front surface of the horn smoothly touch human skin. Consequently, the resistance to the skin can be reduced.

[0010] In an embodiment, the first solid is in the shape of a truncated cone. This configuration is hereinafter referred to as a "second configuration".

[0011] In the second configuration, the second solid may have said rear surface.

[0012] In the second configuration, the horn may further comprise a third solid. Every diameter of the third solid may be different from any diameter of the first and second solids. The thickness of the third solid may be equal to or thinner than that of the first solid. In this configuration (hereinafter referred to as a "third configuration"), the third solid can be latched to the inner edge side of an opening of a head cover in a beauty appliance, so that the horn can be prevented from coming off the opening. Moreover, since every diameter of the third solid is different from any diameter of the first and second solids, the frequency of the lateral vibration generated at the third solid is different from those of the lateral vibrations generated at the first and second solids. Therefore, even if the thickness of the second and third solids is thicker than that of the first solid, the occurrence of large resonance in a diameter direction of the horn can be avoided.

[0013] In the third configuration, the third solid may be in the shape of a circular cylinder having a larger diameter

than those of the first and second solids. This configuration is hereinafter referred to as a "fourth configuration".

[0014] In the fourth configuration, the third solid may have said rear surface and may be also combined with the rear end of the second solid.

[0015] In the fourth configuration, the horn may further comprise a fourth solid. The fourth solid may be in the shape of a circular cylinder having a smaller diameter than those of the second and third solids. The fourth solid may be combined with the rear end of the second solid. The third solid may have said rear surface and may be also combined with the rear end of the fourth solid. In this configuration, the fourth solid forms a peripheral groove between the second and third solids, and accordingly a gum member such as an O ring or the like can be fit into the peripheral groove. Therefore, it is possible to prevent gel or the like from entering inside a beauty appliance from an opening of its head cover. Moreover, since the fourth solid has a smaller diameter than those of the second and third solids, the frequency of the lateral vibration generated at the fourth solid is different from that of each lateral vibration generated at the second and third solids. Therefore, even if the thickness of the second to fourth solids is thicker than that of the first solid, the occurrence of large resonance in a diameter direction of the horn can be avoided.

[0016] In the first configuration, the second solid may have said rear surface.

The first and second solids may form a truncated cone having a tapered side. In this configuration, the influence of the lateral vibration generated in the horn can be considerably reduced.

[0017] A beauty appliance of the present invention comprises the ultrasonic vibration device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Preferred embodiments of the invention will now be described in further details. Other features and advantages of the present invention will become better understood with regard to the following detailed description and accompanying drawings where:

FIG. 1 is an explanatory diagram of an ultrasonic vibration device described in Japanese Patent Application Publication No. 2007-260363;
FIG. 2 depicts ideal impedance characteristics versus frequency of vertical vibration in an ultrasonic vibration device under no-load condition;
FIG. 3 depicts impedance characteristics including spurious;
FIG. 4 is a schematic diagram of an ultrasonic vibration device in accordance with a first embodiment of the present invention;
FIG. 5 is a schematic diagram of an ultrasonic vibration device in accordance with a second embodiment of the present invention;
FIG. 6 is a schematic diagram of an ultrasonic vibration device in accordance with a third embodiment of the present invention;
FIG. 7 is a schematic diagram of an ultrasonic vibration device in accordance with a fourth embodiment of the present invention;
FIG. 8 is a schematic diagram of an ultrasonic vibration device in accordance with a fifth embodiment of the present invention;
FIG. 9 is a schematic diagram of a beauty appliance in accordance with a sixth embodiment of the present invention;
FIG. 10 is an exploded perspective view of the beauty appliance;
FIG. 11 is a schematic diagram of a head block of the beauty appliance;
FIG. 12 is a sectional view of the head block; and
FIG. 13 is an exploded perspective view of the head block.

BEST MODE FOR CARRYING OUT THE INVENTION

FIRST EMBODIMENT

[0019] FIG. 4 shows an ultrasonic vibration device 1 in accordance with a first embodiment of the present invention. The ultrasonic vibration device 1 has an ultrasonic vibrator (e.g., a piezoelectric vibrator) 15 for generating ultrasonic vibration, and a flat (specifically a disc) shaped horn 10 having front and rear surfaces 100 and 101. In the example of FIG. 4, each of the front and rear surfaces 100 and 101 is a plane. The rear surface 101 is connected with the ultrasonic vibrator 15. That is, the ultrasonic vibrator 15 is mounted on the rear surface 101 of the horn 10. The horn 10 is configured to emit ultrasonic energy from the front surface 100. The ultrasonic energy is obtained from the ultrasonic vibrator 15.

[0020] In the first embodiment, the horn 10 is made of metal such as aluminum or the like, and integrally has solids 11 and 12 (first and second solids). The solid 11 has the front surface 100 is shaped to become narrower from the rear end to the front end of the solid 11.

[0021] In the example of FIG. 4, the solid 11 is in the shape of a truncated cone and has a tapered side 111. The taper angle "α" is preferably equal to or less than 40°, but not limited to, e.g., 38°. The peripheral edge of the front surface 100 is a rounded edge 110 smoothly joined to the tapered side 111. If the ultrasonic vibration device 1 is used for a beauty appliance, the device 1 has the rounded edge 110 and the tapered side 111 and accordingly it is possible to make the front surface 100 of the horn 10 smoothly touch human skin. Consequently, the resistance to the skin can be reduced. As shown in FIG. 1, the lateral vibration waves have anti-nodes at both ends of the horn 10 in a diameter direction, and therefore the lateral vibration generated at the solid 11 of the first embodiment has different frequencies among positions in the thickness direction of the solid 11. Accordingly, the influence of the lateral vibration generated

at the solid 11 can be reduced.

[0022] Every width (diameter) of the solid 12 is different from any width of the solid 11, exclusive of the rear end of the solid 11. In the example of FIG. 4, the solid 12 is in the shape of a circular cylinder having the same diameter "D1" as the rear end of the solid 11, and has the rear surface 101. Specifically, the diameter of the solid 12 is at least 4mm larger than that of the front surface 100. Thus, since the horn 10 has the circular cylinder shaped solid 12, the horn 10 can be fit into an opening of a head cover of a beauty appliance, without a gap.

[0023] In an aspect of the first embodiment, the thickness of the solid 11 is equal to or thicker than that of the solid 12. Since the lateral vibration waves have antinodes at both ends of the horn 10 in a diameter direction, the lateral vibration generated at the solid 12 has a constant frequency in the thickness direction of the solid 12. In the first embodiment, since the thickness of the solid 11 is equal to or thicker than that of the solid 12, the influence of the lateral vibration generated at the solid 12 can be reduced in comparison with the conventional structure of FIG. 1. In the example of FIG. 4, the thickness of the solid 11 is thicker than that of the solid 12, and accordingly the influence of the lateral vibration generated at the solid 12 can be reduced considerably. Therefore, it is possible to prevent spurious from occurring between the resonance frequency and the antiresonance frequency in a characteristic curve of impedance versus frequency of vertical vibration generated at the horn 10.

SECOND EMBODIMENT

[0024] FIG. 5 shows an ultrasonic vibration device 1 in accordance with a second embodiment of the present invention. For the purpose of clarity, like kind elements are assigned the same reference numerals as depicted in the first embodiment.

[0025] A horn 10 of the second embodiment is made of metal such as aluminum or the like, and integrally has solids 11, 12 and 13 (first, second and third solids). That is, the horn 10 further has the solid 13. The solids 11 and 12 of the second embodiment are respectively formed in the same way as those of the first embodiment. However, the solid 13 has the rear surface 101 of the horn 10 and is joined to the rear end of the solid 12.

[0026] Every width (diameter) of the solid 13 is different from any width of the solids 11 and 12. In the example of FIG. 5, the solid 13 is in the shape of a circular cylinder having a larger diameter "D2" than those of the solids 11 and 12. If the ultrasonic vibration device 1 of the second embodiment is used for a beauty appliance, the solid 13 can be latched to the inner edge side of an opening of a head cover in the beauty appliance, so that the horn 10 can be prevented from coming off the opening.

[0027] Also, in the second embodiment, the thickness of the third solid 13 is equal to or thinner than that of the solid 11. In the example of FIG. 5, the thickness of the third solid 13 is thinner than that of the solid 11. Accordingly, the influence of the lateral vibration generated at the solid 13 can be reduced. Moreover, since the solid 13 is in the shape of the circular cylinder having the larger diameter "D2" than those of the solids 11 and 12, the frequency of the lateral vibration generated at the solid 13 is different from that of the lateral vibration generated at the solid 12. Therefore, even if the thickness of the solids 12 and 13 is thicker than that of the solid 11, the occurrence of large resonance in a diameter direction of the horn 10 can be avoided.

THIRD EMBODIMENT

[0028] FIG. 6 shows an ultrasonic vibration device 1 in accordance with a third embodiment of the present invention. For the purpose of clarity, like kind elements are assigned the same reference numerals as depicted in the second embodiment.

[0029] A horn 10 of the third embodiment is made of metal such as aluminum or the like, and integrally has solids 11, 12, 13 and 14 (first, second, third and fourth solids). That is, the horn 10 further has the solid 14. The solids 11, 12 and 13 of the third embodiment are respectively formed in the same way as those of the second embodiment. However, the solid 13 is joined to the rear end of the solid 14.

[0030] Every width (diameter) of the solid 14 is different from any width of the solids 12 and 13. In the example of FIG. 6, the solid 14 is in the shape of a circular cylinder having a smaller diameter "D3" than those of the solids 12 and 13, and is joined to the rear end of the solid 12. That is, the solid 14 forms a peripheral groove between the solids 12 and 13. If the ultrasonic vibration device 1 of the third embodiment is used for a beauty appliance, a gum member such as an O ring or the like can be fit into the peripheral groove. Therefore, it is possible to prevent gel or the like from entering inside the beauty appliance from an opening of its head cover.

[0031] In the third embodiment, the thickness of the third solid 14 is equal to or thinner than that of the solid 11. In the example of FIG. 6, the thickness of the third solid 14 is thinner than that of the solid 11.

Accordingly, the influence of the lateral vibration generated at the solid 14 can be reduced. Moreover, since the solid 14 is in the shape of the circular cylinder having the smaller diameter "D3" than those of the solids 12 and 13, the frequency of the lateral vibration generated at the solid 14 is different from that of each lateral vibration generated at the solids 12 and 13. Therefore, even if the thickness of the solids 12-14 is thicker than that of the solid 11, the occurrence of large resonance in a diameter direction of the horn 10 can be avoided.

FOURTH EMBODIMENT

[0032] FIG. 7 shows an ultrasonic vibration device 1 in accordance with a fourth embodiment of the present invention. For the purpose of clarity, like kind elements

are assigned the same reference numerals as depicted in the firth embodiment.

[0033] A horn 10 of the fourth embodiment is made of metal such as aluminum or the like, and integrally has solids 11 and 12 (first and second solids) like the first embodiment. However, the solid 12 has a concave slope 112.

FIFTH EMBODIMENT

[0034] FIG. 8 shows an ultrasonic vibration device 1 in accordance with a fifth embodiment of the present invention. For the purpose of clarity, like kind elements are assigned the same reference numerals as depicted in the firth embodiment.

[0035] A horn 10 of the fifth embodiment is made of metal such as aluminum or the like, and integrally has first and second solids which form a truncated cone having a taped side 102. In the example of FIG. 8, the upper part of the horn 10 corresponds to the first solid, and the lower part of the horn 10 corresponds to the second solid. The thickness of the first solid is equal to or thicker than that of the second solid. In the fifth embodiment, the influence of the lateral vibration generated in the horn 10 can be considerably reduced.

[0036] In a modified example, a disc shaped ultrasonic vibrator 15 is mounted on the rear surface 101 of the horn 10 so that the axis of the ultrasonic vibrator 15 is off the axis of the disc shaped horn 10. In this example, the occurrence of large resonance in a diameter direction of the horn 10 can be avoided.

SIXTH EMBODIMENT

[0037] FIGS. 9 and 10 show a beauty appliance 2 in accordance with a sixth embodiment of the present invention. The beauty appliance 2 is formed of head blocks 3 and 4, a support block 5 and a grip block 6.

[0038] Each of the head blocks 3 and 4 is equipped with an ultrasonic vibration device 1 of any of the first to fifth embodiments. The head block 3 is equipped with, but not limited to, e.g., the ultrasonic vibration device 1 of FIG. 6.

[0039] As shown in FIGS. 11-13, the head block 3 has the ultrasonic vibration device 1, a head cover 30, O rings 32 and 33, and terminals 34 and 35.

[0040] In the ultrasonic vibration device 1, the ultrasonic vibrator 15 has a front electrode and a rear electrode formed on the front 150 and the rear 151, respectively. The horn 10 has a plurality of (e.g., three) recesses 130 formed on the rear end of the solid 13. In the example of FIG. 13, each of the front 150 and the rear 151 of the ultrasonic vibrator 15 is a plane.

[0041] The head cover 30 is in the shape of a circular cylinder, and has a front opening 300, a rear opening 301, and dents 302 formed on the inner periphery.

[0042] The head base 31 is formed to close the rear opening 301 of the head cover 30, and has a center hole 310, a peripheral groove 311, a plurality of (e.g., three) hooks 312 and a plurality of (e.g., three) lock poles 313. The peripheral groove 311 is formed on the outer peripheral side of the head cover 30. The hooks 312 are engaged with the dents 302 of the head cover 30, respectively, and thereby the head cover 30 is fixed to the head base 31.

[0043] In this case, the solid 13 of the horn 10 is latched to the inner edge side of the front opening 300 of the head cover 30 so that the solid 11 projects outward from the front opening 300. The O ring 32 is fit into the peripheral groove (solid 14) of the horn 10, and seals between the horn 10 and the front opening 300 of the head cover 30. The O ring 33 is fit into the peripheral groove 311 of the head base 31, and seals between the horn 10 and the rear opening 301 of the head cover 30. The lock poles 313 of the head base 31 are fit into the recesses 130 of the horn 10, respectively, and thereby preventing the horn 10 from rotating.

[0044] The terminal 34 is in contact with the rear electrode of the ultrasonic vibrator 15, and is also connected with a lead wire inserted into the center hole 310 of the head base 31. The terminal 35 is in contact with the rear surface 101 of the horn 10 and connected with the front electrode of the ultrasonic vibrator 15 through the horn 10, and is also connected with a lead wire inserted into the center hole 310 of the head base 31. Thereby, electric power can be supplied to the ultrasonic vibrator 15 through the lead wires.

[0045] The head block 4 is formed like the head block 3. However, the ultrasonic vibrator 15 in the head block 4 has a horn 10 for nose care, of which front surface 101 is smaller than that of the ultrasonic vibration device 1 in the head block 3.

[0046] The support block 5 is formed of head links 51 and 52, a head base 53 and a pair of case halves 54. The head links 51 and 52 are fixed to the head base 53. The case halves 54 are fixed to the head base 53, and then cover the head base 53. The head blocks 3 and 4 are supported by the head base 53 through the head links 51 and 52, respectively. The head block 3 is floatable and slidable through the head link 51, while the head block 4 is unslidable.

[0047] The grip block 6 is formed of an access ring 61, a housing 62, a cover 63, a control circuit (printed-circuit assembly) 64, a rechargeable battery (secondary battery) 65 and an operation switch 66. The support block 5 is supported by the grip block 6 through the access ring 61. The housing 62 is in the shape of a circular cylinder, and the bottom opening of the housing 62 is closed with the cover 63. The control circuit 64 and the rechargeable battery 65 are put in the housing 62, and each ultrasonic vibrator 15 of the head blocks 3 and 4 is electrically connected to the control circuit 64 through lead wires. The operation switch 66 is formed of a switch gum 661, a switch presser 662, a switch axis 663 and a switch button 664. The rechargeable battery 65 and the operation switch 66 are electrically connected to the control circuit

64 through lead wires.

[0048] If the beauty appliance 2 is activated through the operation switch 66, the control circuit 64 supplies electric vibration to one or both of the head blocks 3 and 4. Thereby, one or both head blocks convert the electric vibration into mechanical vibration to generate ultrasonic vibration. The mechanical vibration is transmitted to one or both horns 2. Therefore, a user can transmit the ultrasonic vibration to the skin or into the living body by making the front surface 100 of the horn 10 touch the skin while holding the grip block 6. Thereby, a desired beauty effect can be obtained.

[0049] In the sixth embodiment, since the head block 3 includes the ultrasonic vibration device 1 of FIG. 6, the occurrence of large resonance in a diameter direction of the horn 10 can be avoided like the third embodiment. Accordingly, it is possible to prevent spurious from occurring between the resonance frequency and the antiresonance frequency in a characteristic curve of impedance versus frequency of vertical vibration generated at the horns 10.

[0050] Since each horn 10 of the head blocks 3 and 4 is in the shape of a flat, each horn 10 can be easily formed, and miniaturizing and cost reduction can be possible. The horns 10 also have the rounded edge 110 and the tapered side 111 each, and accordingly it is possible to make the front surfaces 100 of the head blocks 3 and 4 smoothly touch human skin. Further, gel or the like can be prevented from entering inside the beauty appliance 2 from the front opening 300 of the head cover 30. The horn 10 can be also prevented from coming off the front opening 300 of the head cover 30.

[0051] However, not limited to the beauty appliance 2, the ultrasonic vibration device of the present invention can be applied to a device for ultrasonic processing such as diagnosis, processing, joint, cleaning, percutaneous permeation accelerator, diffusion, dispersion, emulsification, atomization or the like.

[0052] Although the present invention has been described with reference to certain preferred embodiments, numerous modifications and variations can be made by those skilled in the art without departing from the true spirit and scope of this invention.

Claims

1. An ultrasonic vibration device (1), comprising:

an ultrasonic vibrator (15) for generating ultrasonic vibration; and
a horn (10) having front and rear surfaces (100 and 101), the rear surface (101) being connected with the ultrasonic vibrator (15), the horn (10) being configured to emit ultrasonic energy from the front surface (100), the ultrasonic energy being obtained from the ultrasonic vibrator (15),
wherein the horn (10) integrally comprises first and second solids (11 and 12),
the first solid (11) having said front surface (100),
the first solid (11) being shaped to become narrower from the rear end to the front end of the first solid (11),
every width of the second solid (12) being different from any width of the first solid (11), exclusive of the rear end of the first solid (11),
characterized in that
the thickness of the first solid (11) is equal to or thicker than that of the second solid (12).

2. The ultrasonic vibration device (1) of claim 1, wherein:

the first solid (11) has a tapered side (111 or 112); and
the second solid (12) is in the shape of a circular cylinder having the
same diameter as the rear end of the first solid (11).

3. The ultrasonic vibration device of claim 2, wherein the edge of said front surface (100) is a rounded edge (110).

4. The ultrasonic vibration device of claim 3, wherein the first solid (11) is in the shape of a truncated cone.

5. The ultrasonic vibration device of claim 4, wherein the second solid (12) has said rear surface (101).

6. The ultrasonic vibration device of claim 4, wherein the horn (10) further comprises a third solid (13),
every diameter of the third solid (13) being different from any diameter of the first and second solids (11 and 12),
the thickness of the third solid (13) being equal to or thinner than that of the first solid (11).

7. The ultrasonic vibration device of claim 6, wherein the third solid (13) is in the shape of a circular cylinder having a larger diameter than those of the first and second solids (11 and 12).

8. The ultrasonic vibration device of claim 7, wherein the third solid (13) has said rear surface (101) and is combined with the rear end of the second solid (12).

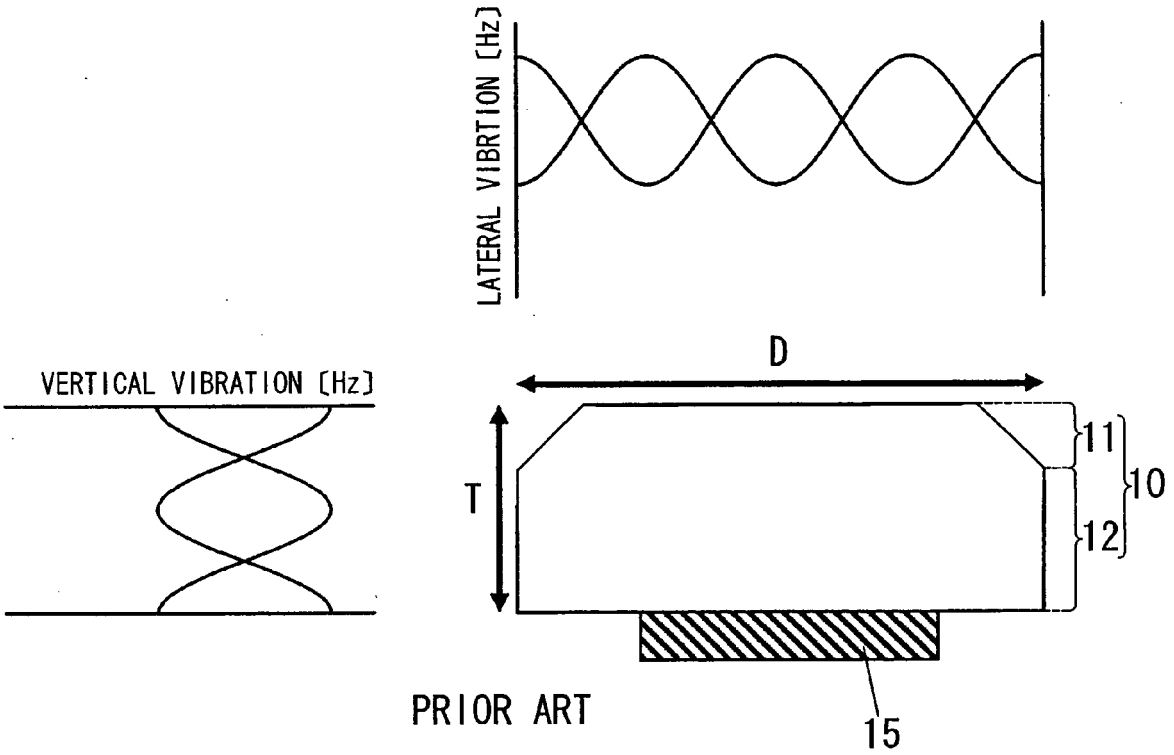
9. The ultrasonic vibration device of claim 7,
wherein the horn (10) further comprises a fourth solid (14),
the fourth solid (14) being in the shape of a circular cylinder having a smaller diameter than those of the second and third solids (12 and 13),
the fourth solid (14) being combined with the rear end of the second solid (12),

wherein the third solid (13) has said rear surface (101) and is
combined with the rear end of the fourth solid (14).

10. The ultrasonic vibration device of claim 1, wherein the second solid has said rear surface (101), wherein the first and second solids form a truncated cone having a
tapered side (102).

11. A beauty appliance (2), comprising the ultrasonic vibration device (I) of any one of the claims 1-9.

FIG. 1



PRIOR ART

FIG. 2

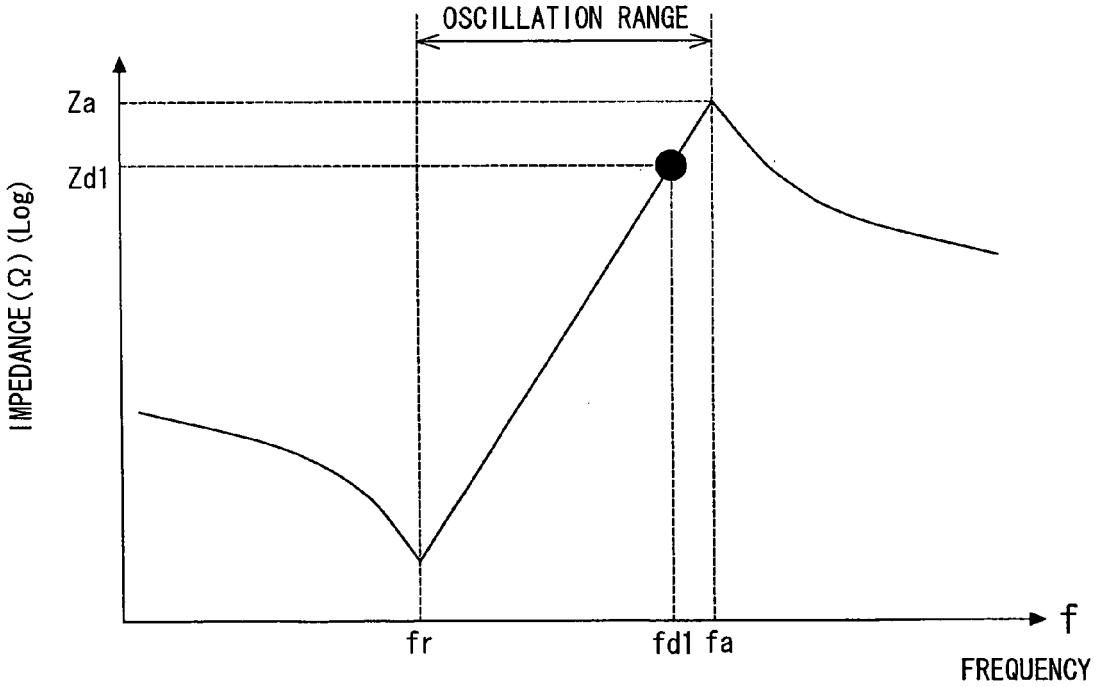
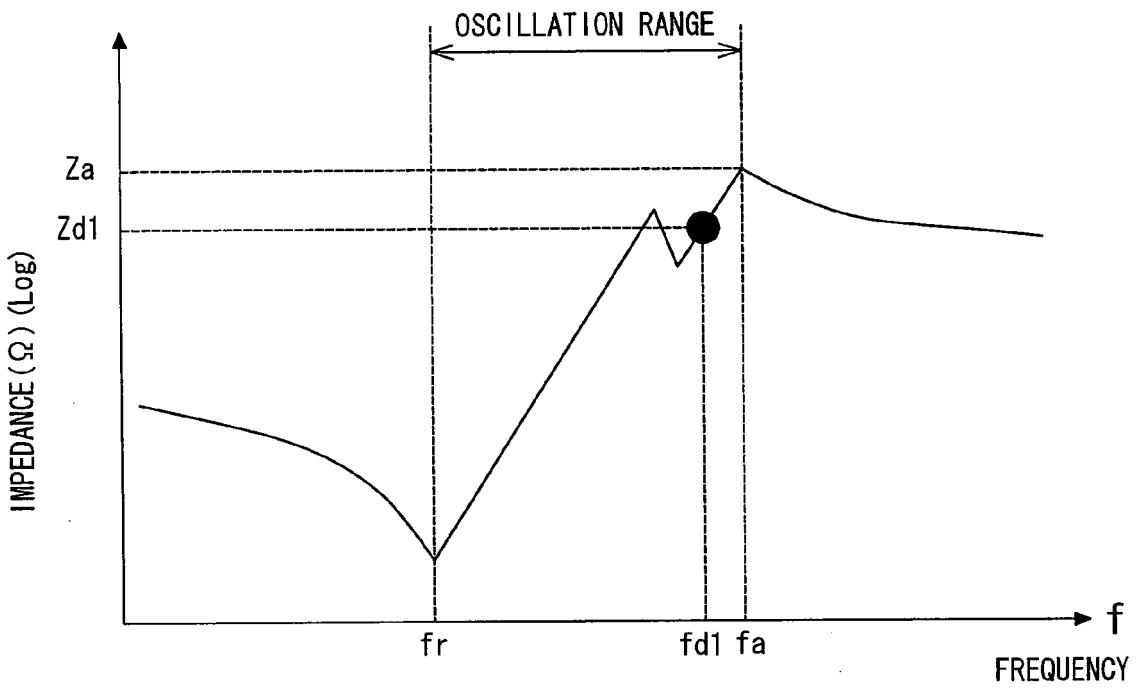


FIG. 3


OSCILLATION RANGE
Za
Zd1
IMPEDANCE(Ω)(Log)
fr
fd1
fa
f
FREQUENCY

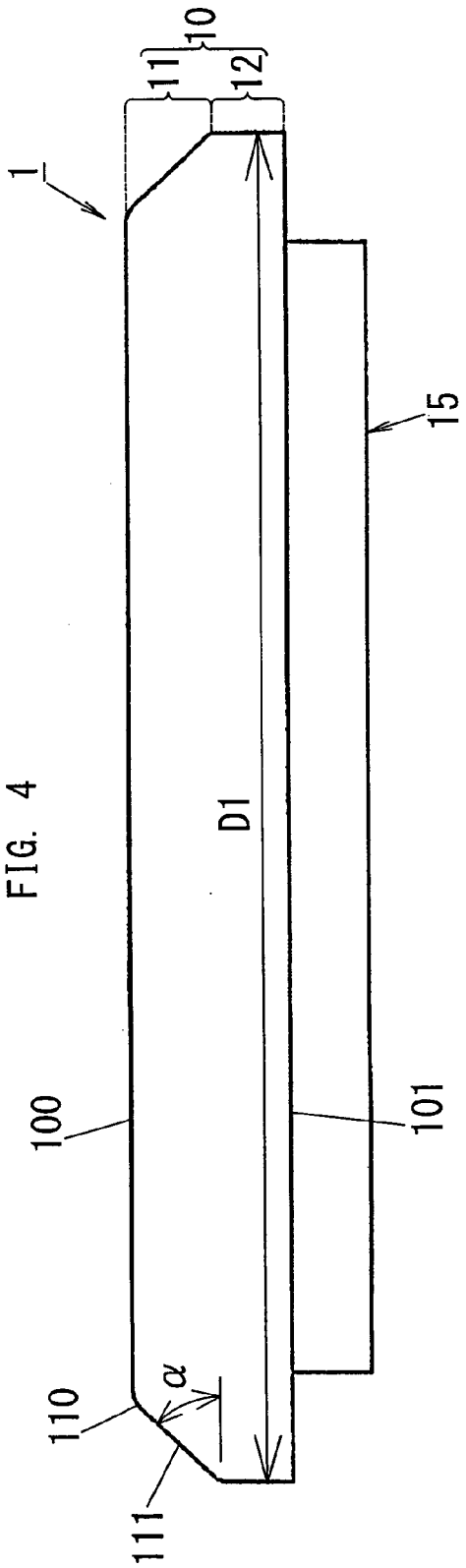
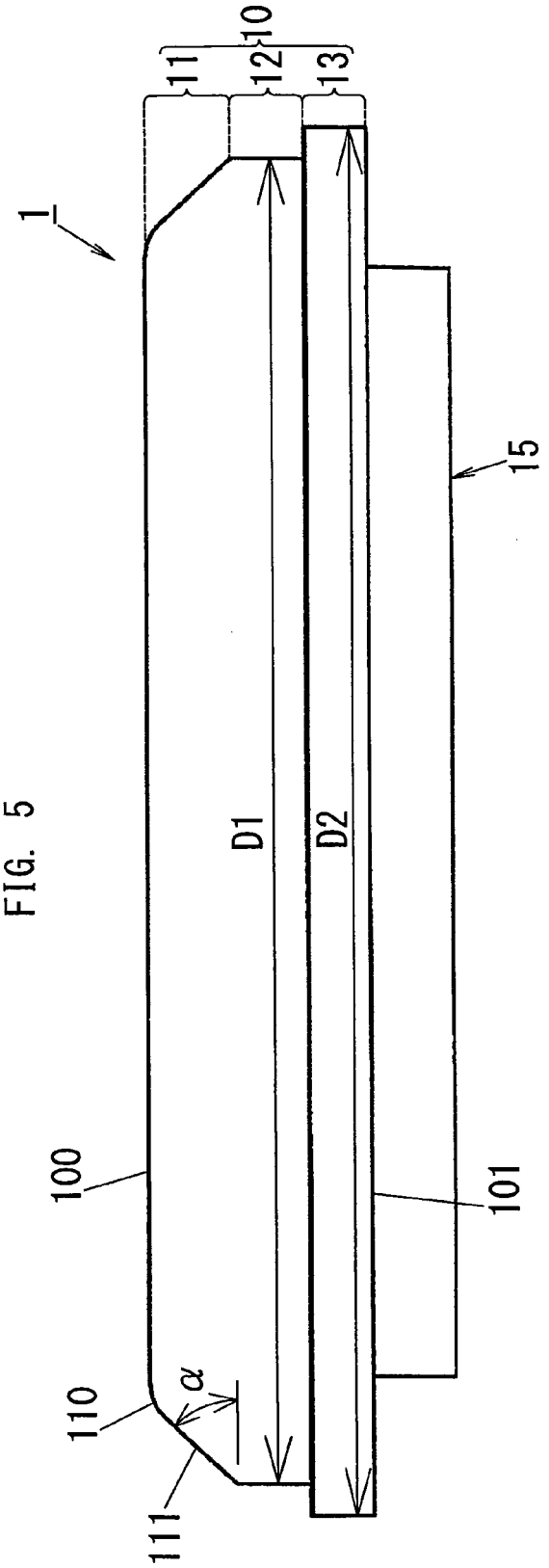

10
11
12
1
15
D1
100
101
110
α
111

FIG. 4


10
11
12
13
1
15
D1
D2
100
101
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α
111

FIG. 5

FIG. 6

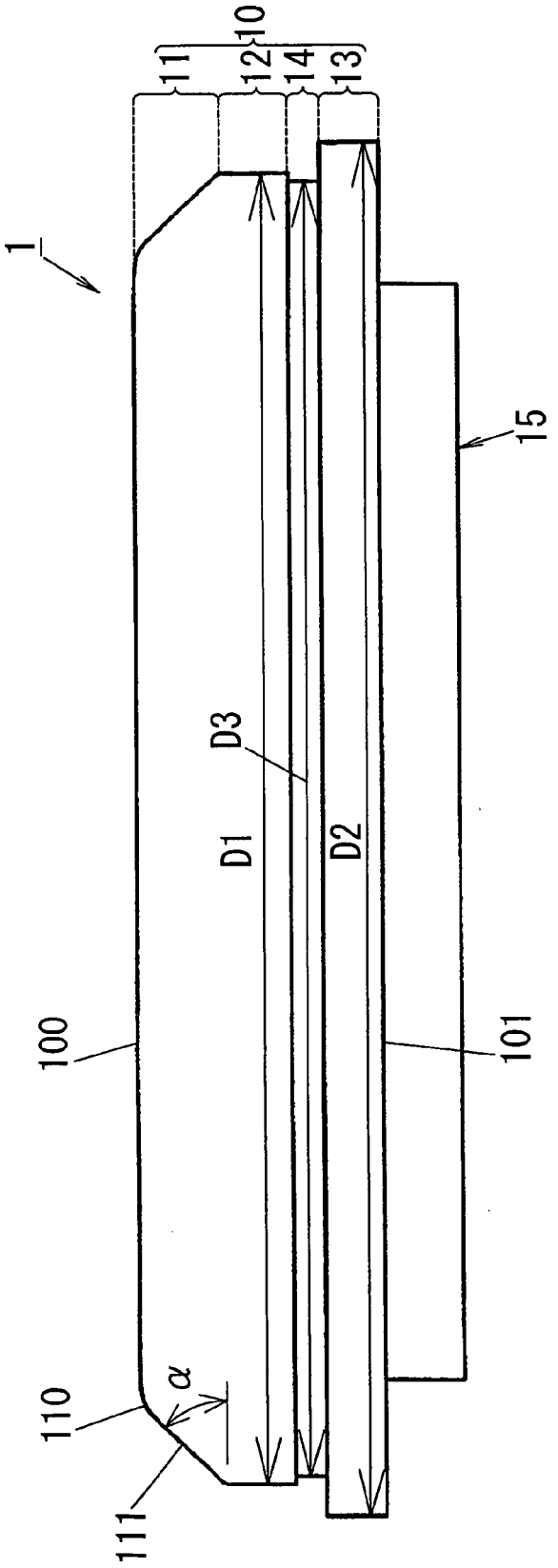


FIG. 7

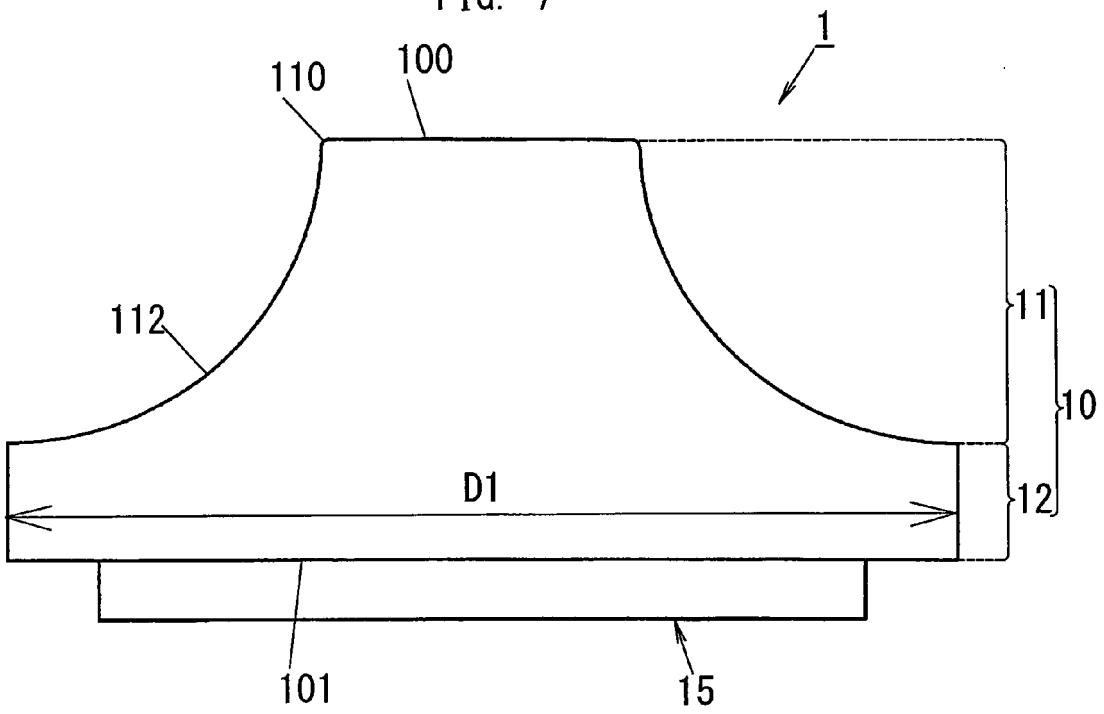


FIG. 8

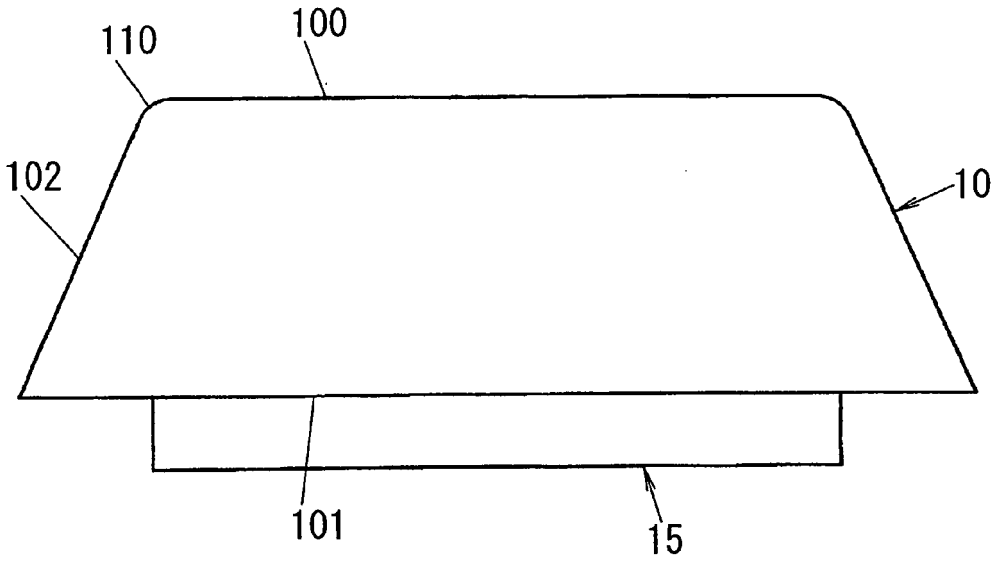


FIG. 9

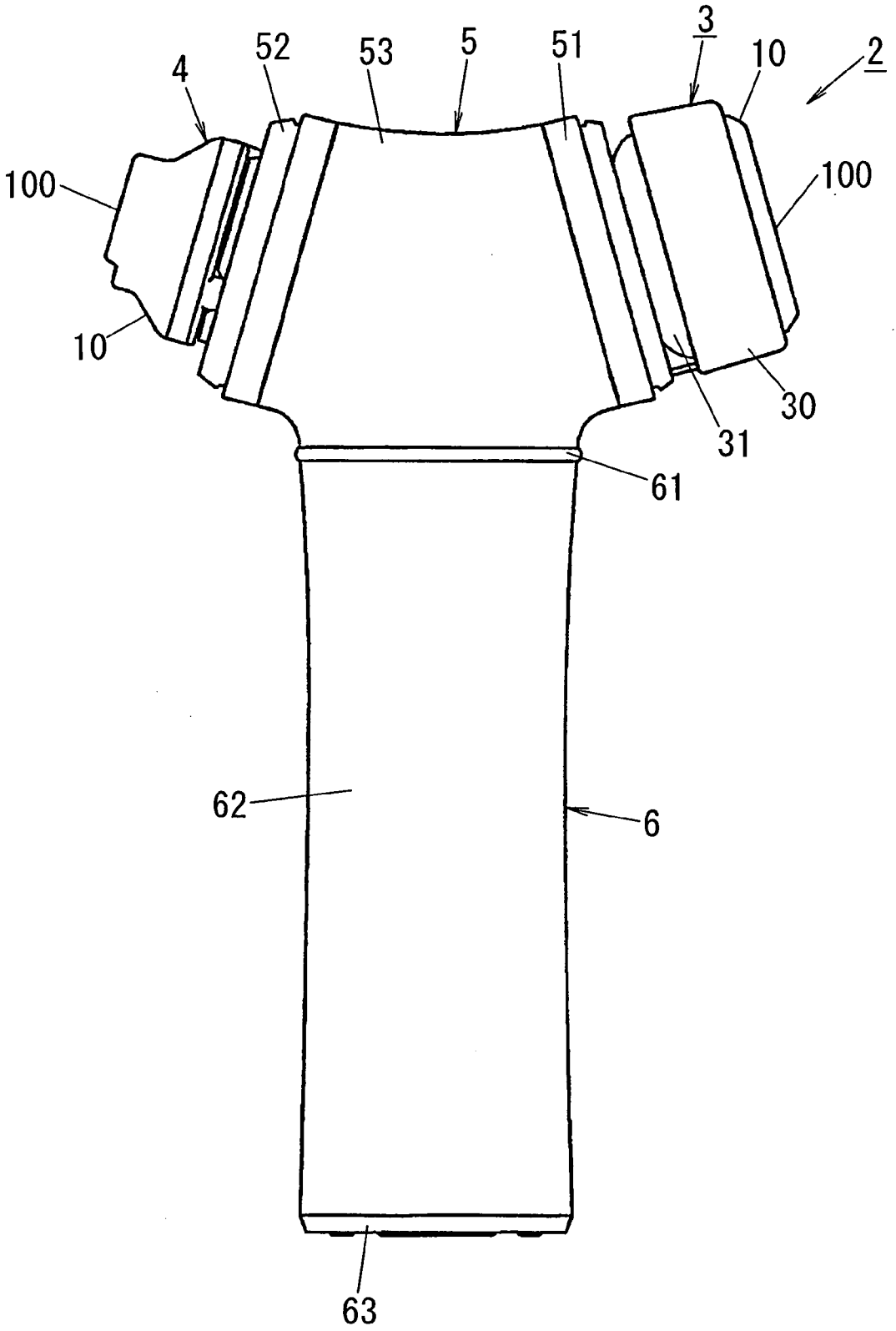


FIG. 10

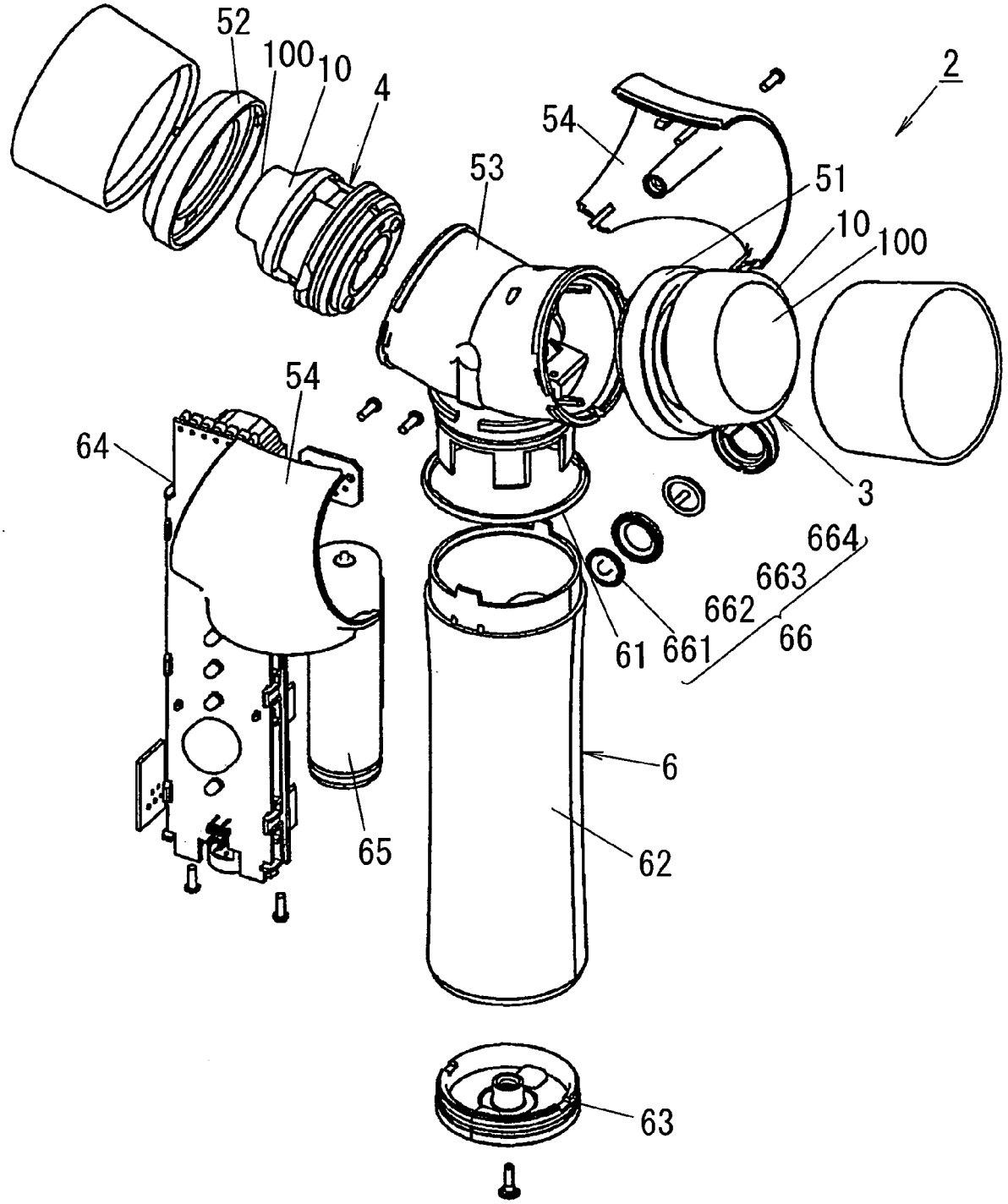
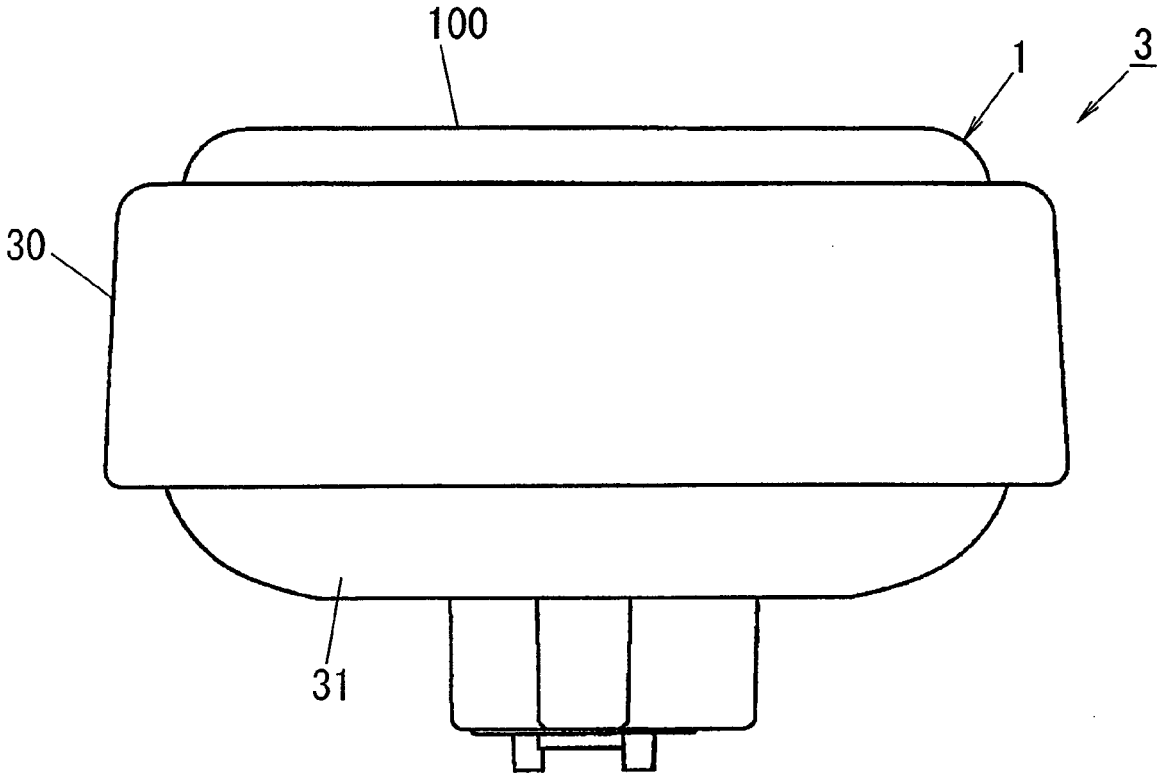


FIG. 11



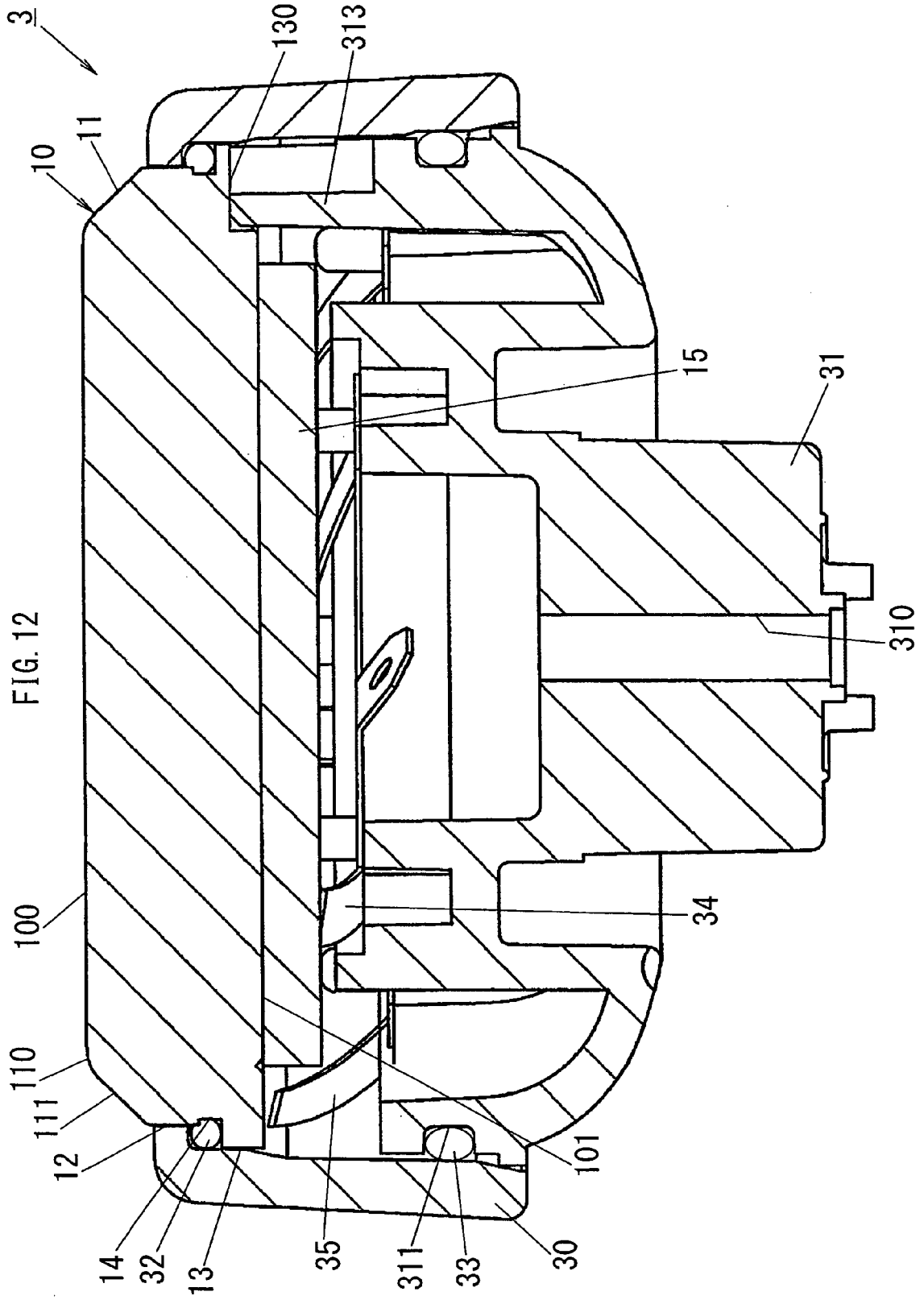
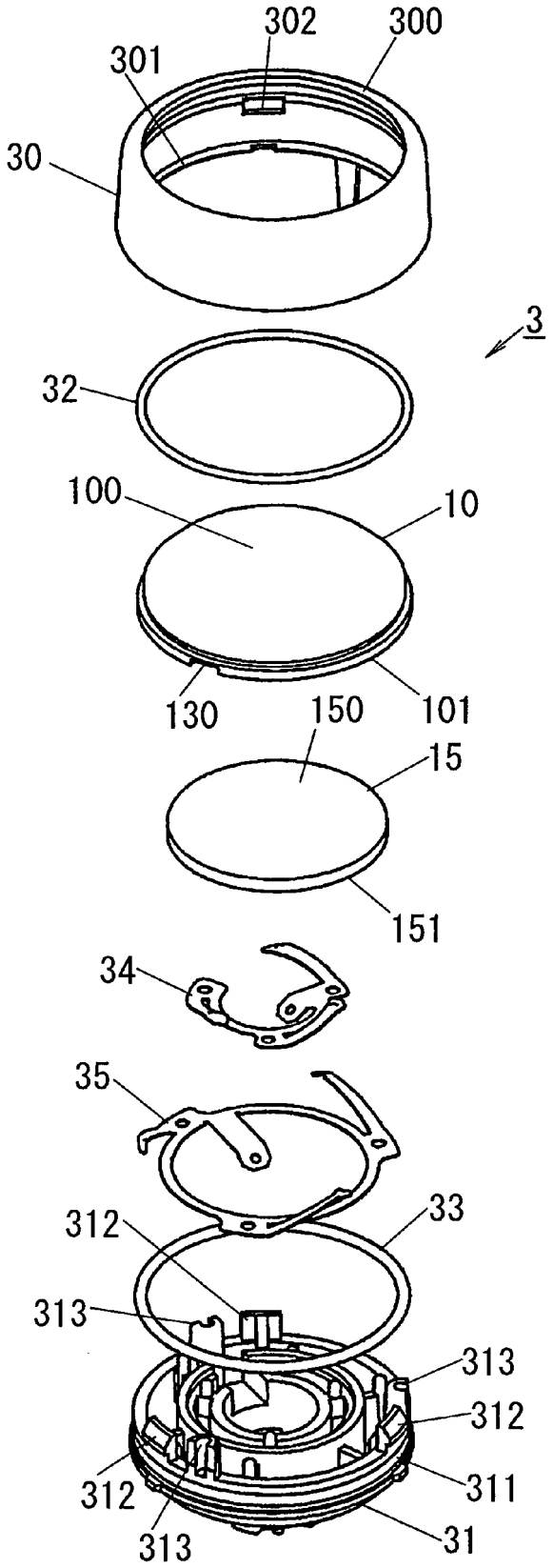


FIG. 12

FIG. 13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