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(54) SOUND DRIVING CIRCUIT, SOUND APPARATUS INCLUDING THE SAME, AND VEHICULAR APPARATUS INCLUDING THE SOUND APPARATUS

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(57) **ABSTRACT**

The present disclosure provides a sound driving circuit, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus. The sound driving circuit includes an audio processor generating an input audio signal based on a sound source, a signal conversion circuit converting the input audio signal into a piezoelectric audio signal and an amplifier circuit amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

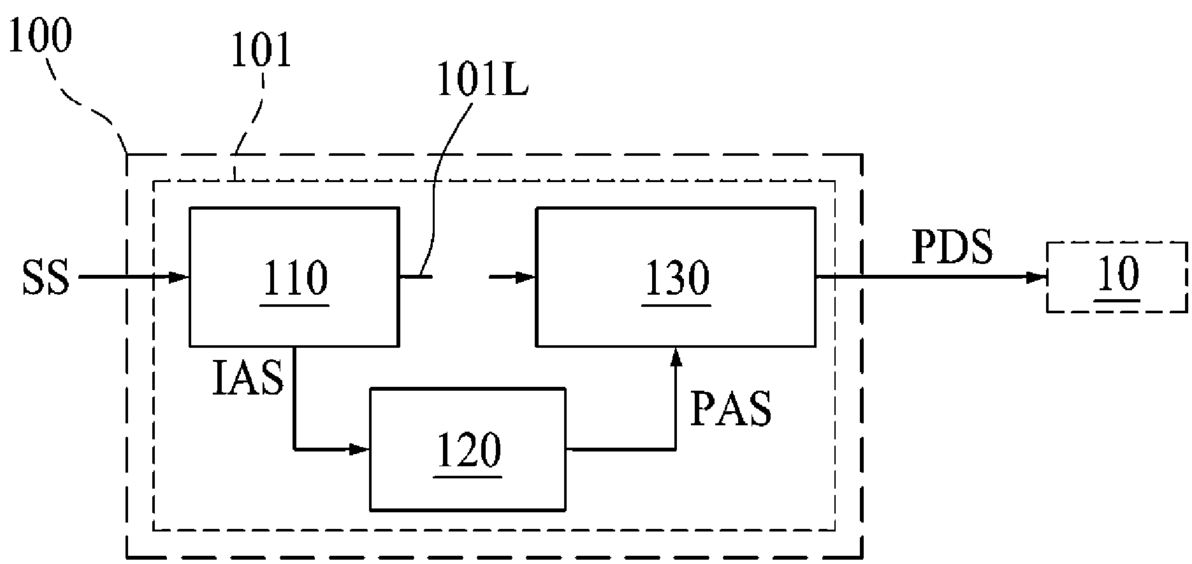


FIG. 1

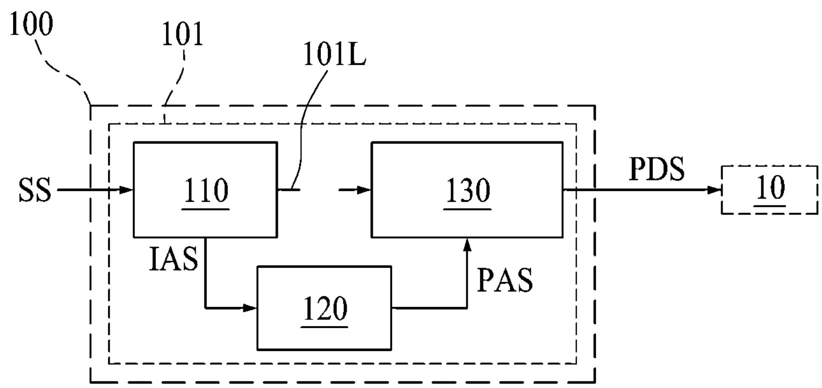


FIG. 2

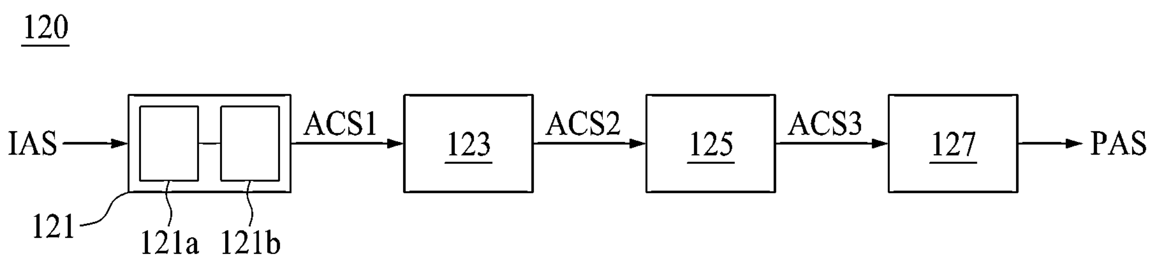


FIG. 3

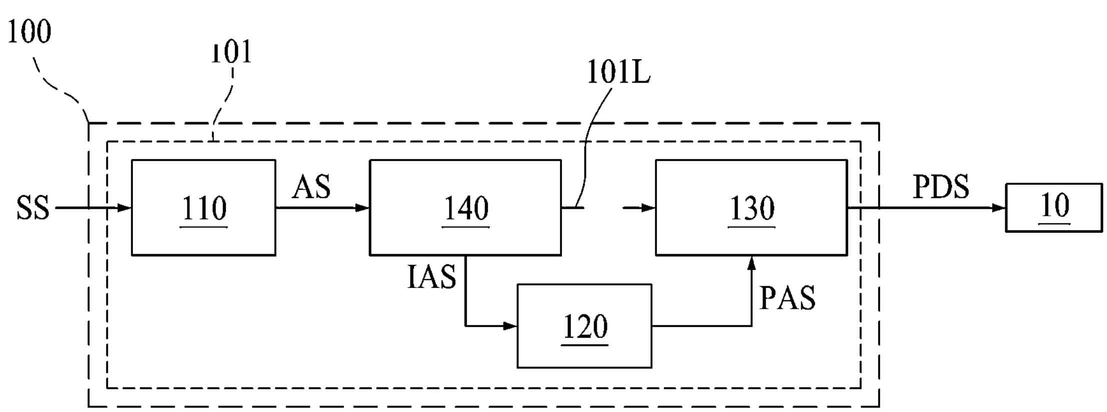


FIG. 4

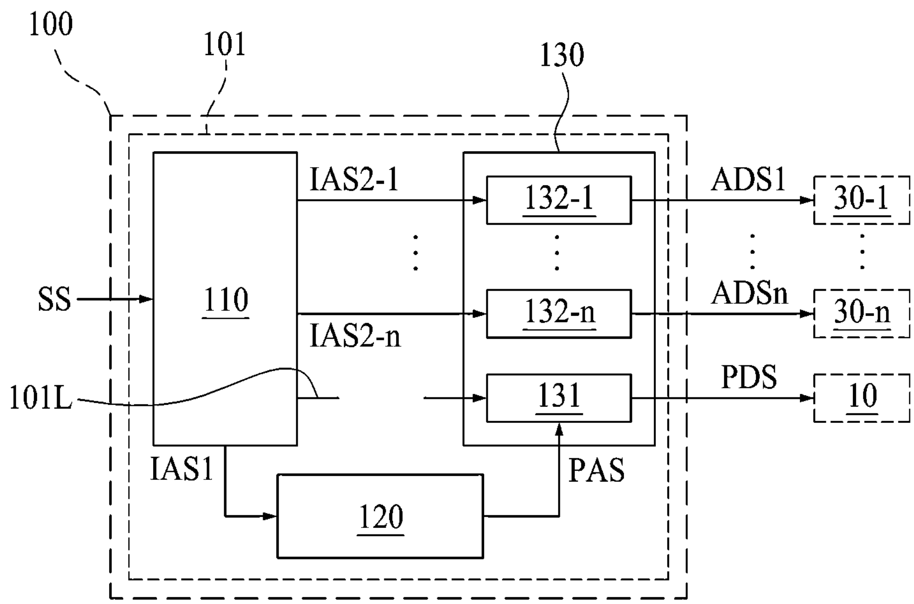

100
101
130
IAS2-1
132-1
ADS1
30-1
SS
110
132-n
ADSn
30-n
IAS2-n
101L
131
PDS
10
IAS1
PAS
120

FIG. 5

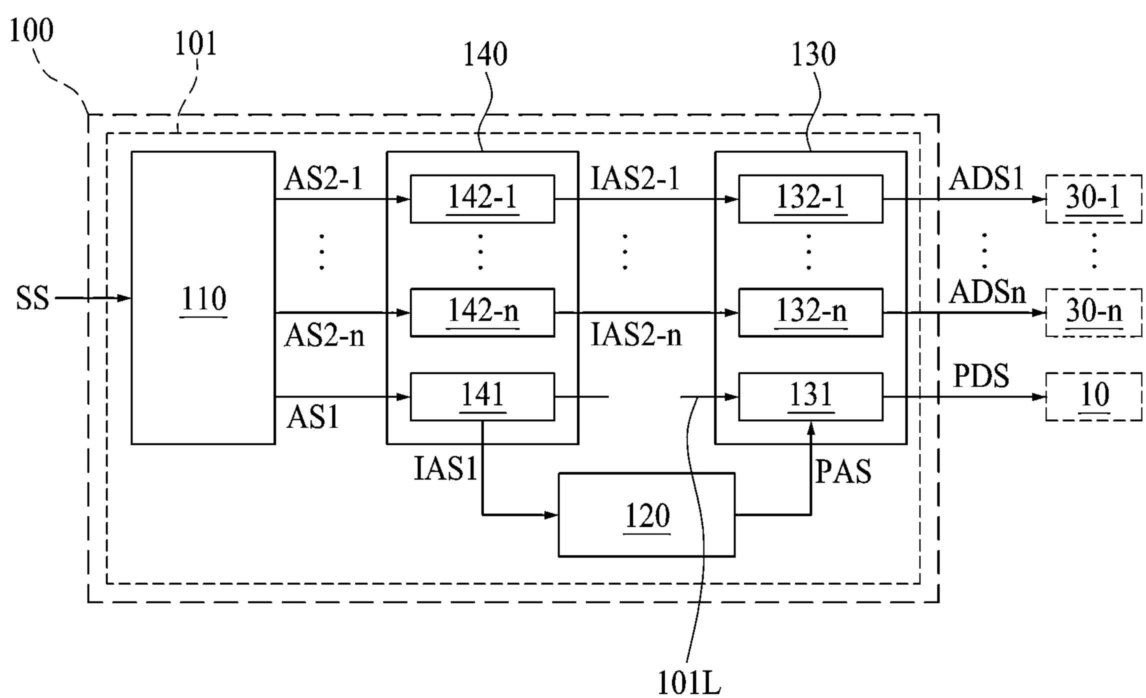

100
101
140
130
AS2-1
142-1
IAS2-1
132-1
ADS1
30-1
SS
110
142-n
132-n
ADSn
30-n
AS2-n
IAS2-n
AS1
141
131
PDS
10
IAS1
PAS
120
101L

FIG. 6

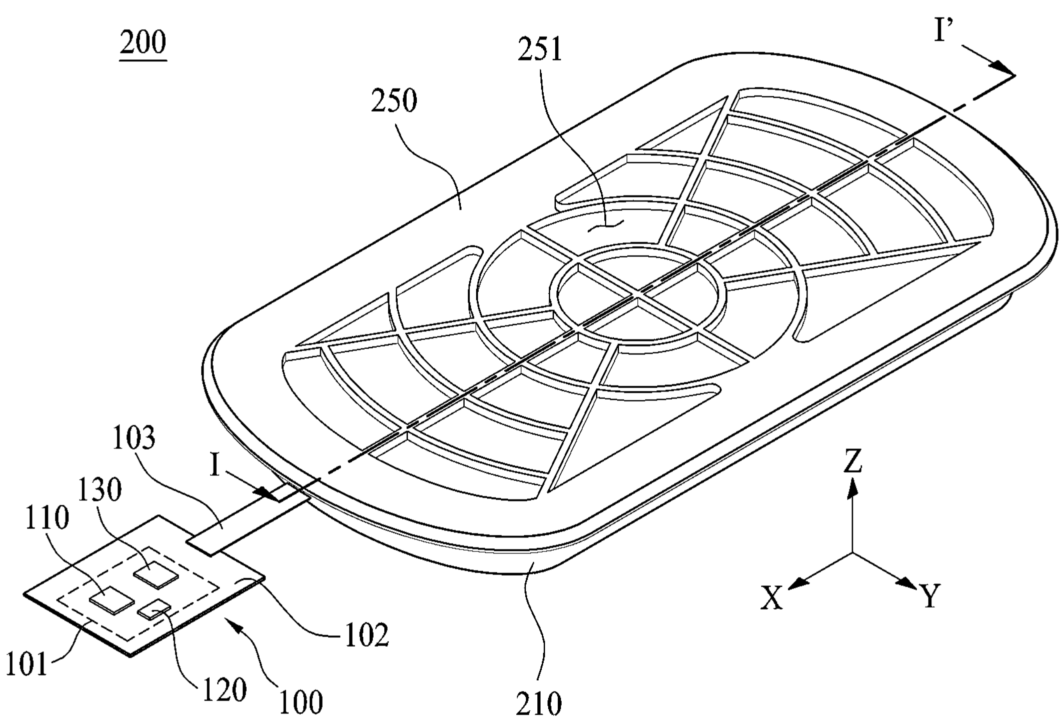

200
I'
251
250
103
I
130
110
102
101
120
100
210
Z
X
Y

FIG. 7

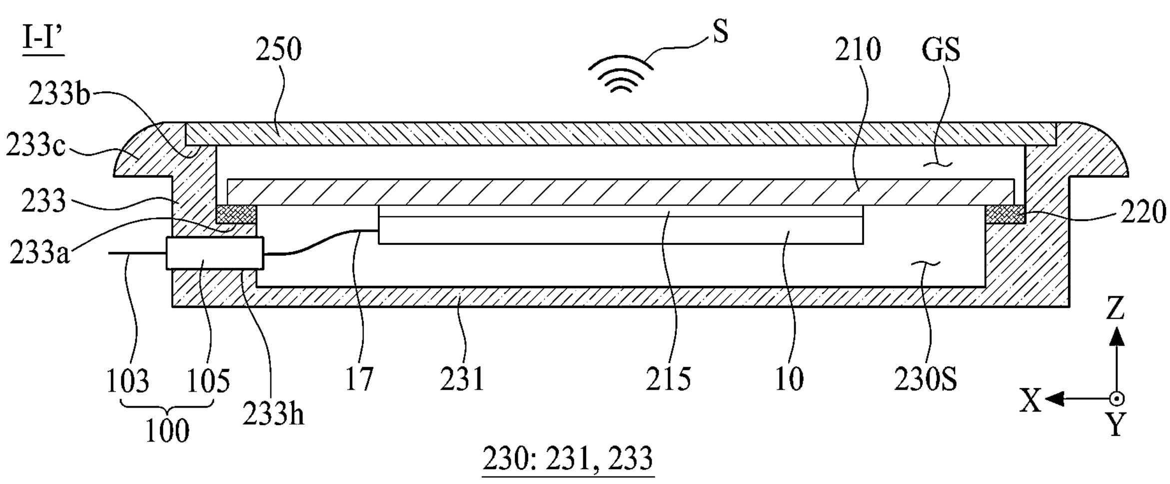

I-I'
S
250
210
GS
233b
233c
233
220
233a
103
105
100
233h
17
231
215
10
230S
Z
X
Y
230: 231, 233

FIG. 8

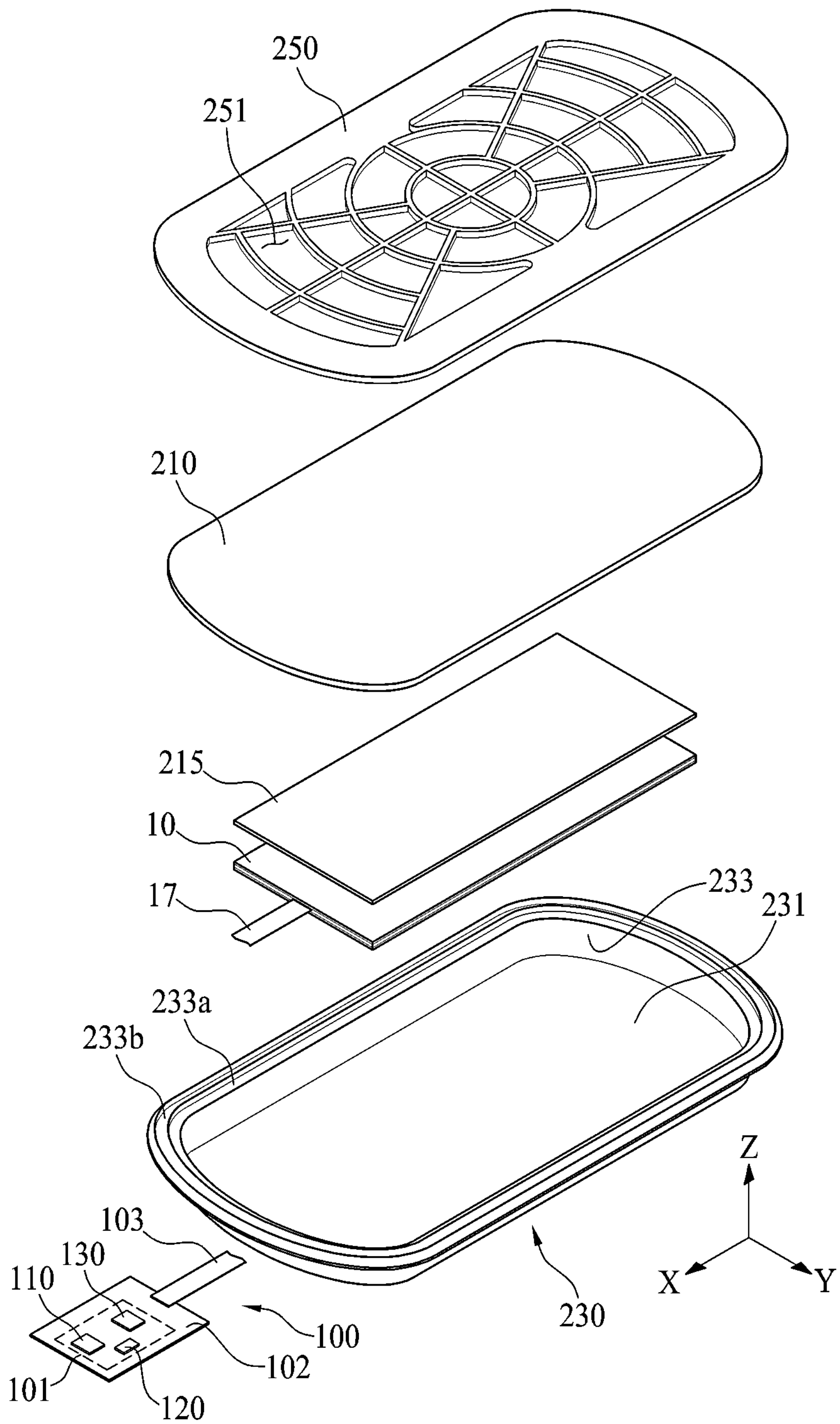

250
251
210
215
10
17
233
231
233a
233b
Z
X
Y
103
130
110
100
102
101
120
230

FIG. 9

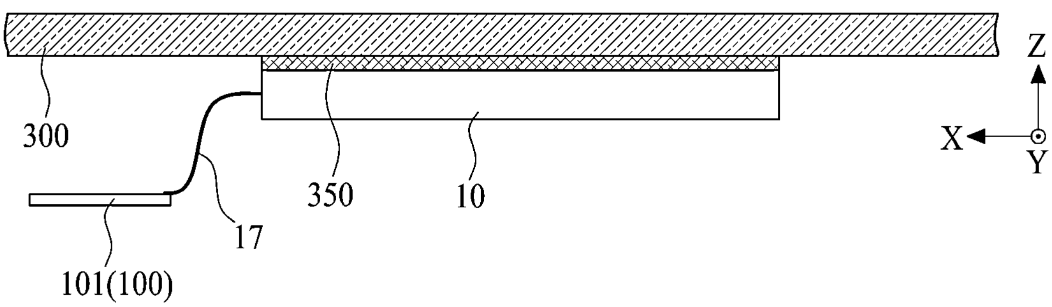

300
350
10
17
101(100)
Z
X
Y

FIG. 10

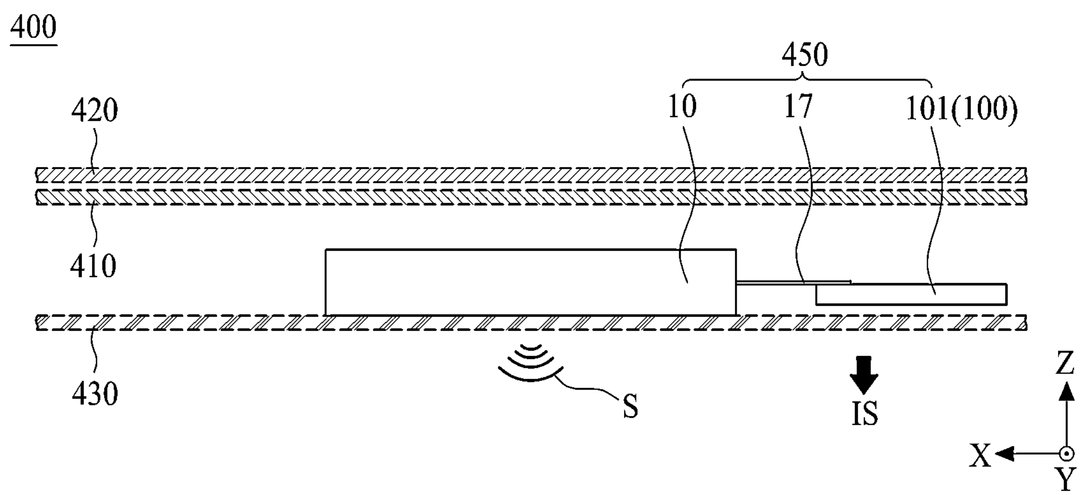

400
450
420
10
17
101(100)
410
430
S
IS
Z
X
Y

FIG. 11

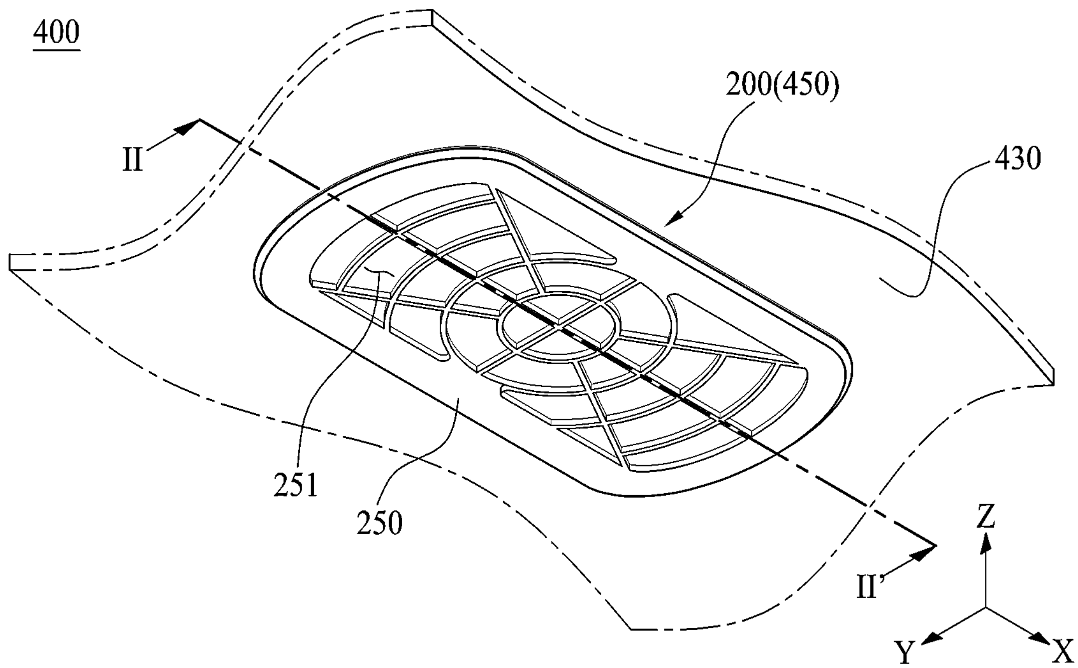

400
200(450)
II
430
251
250
Z
II'
Y
X

FIG. 12

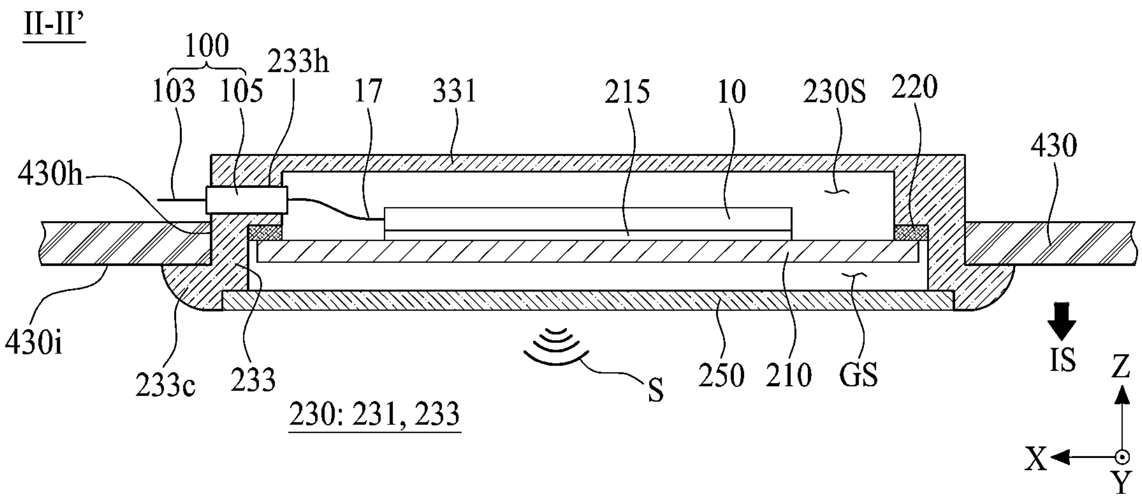
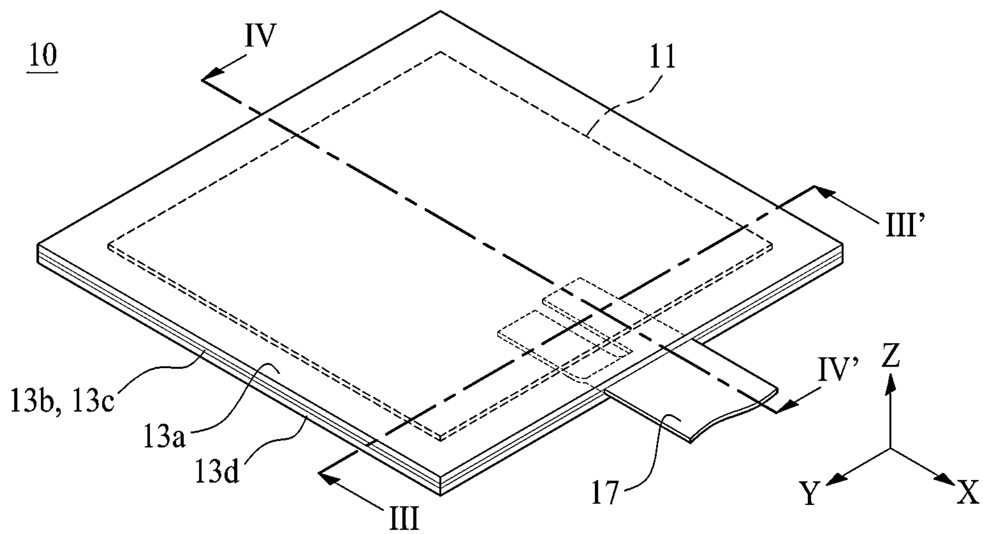

II-II'
100
103 105
233h
17
331
215
10
230S
220
430h
430
430i
233c
233
S
250
210
GS
IS
Z
X
Y
230: 231, 233

FIG. 13



13: 13a, 13b, 13c, 13d

FIG. 14

III-III'

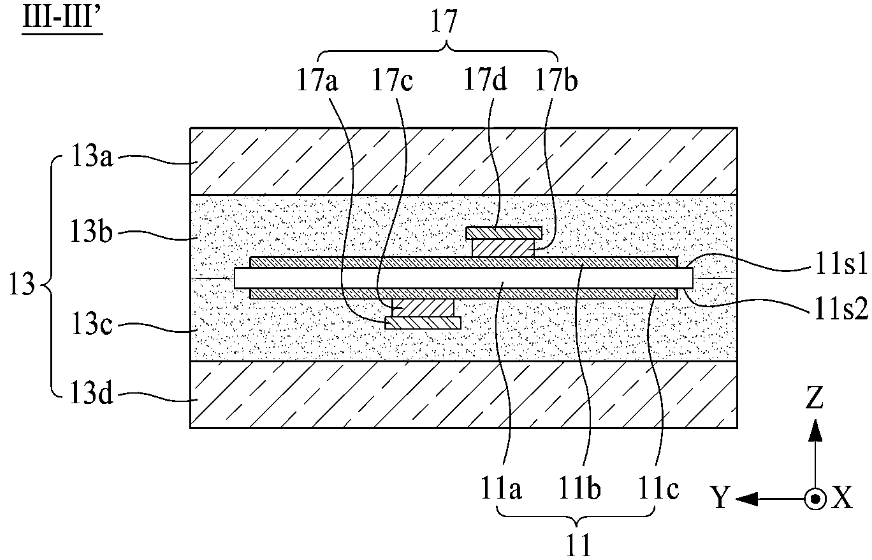


FIG. 15

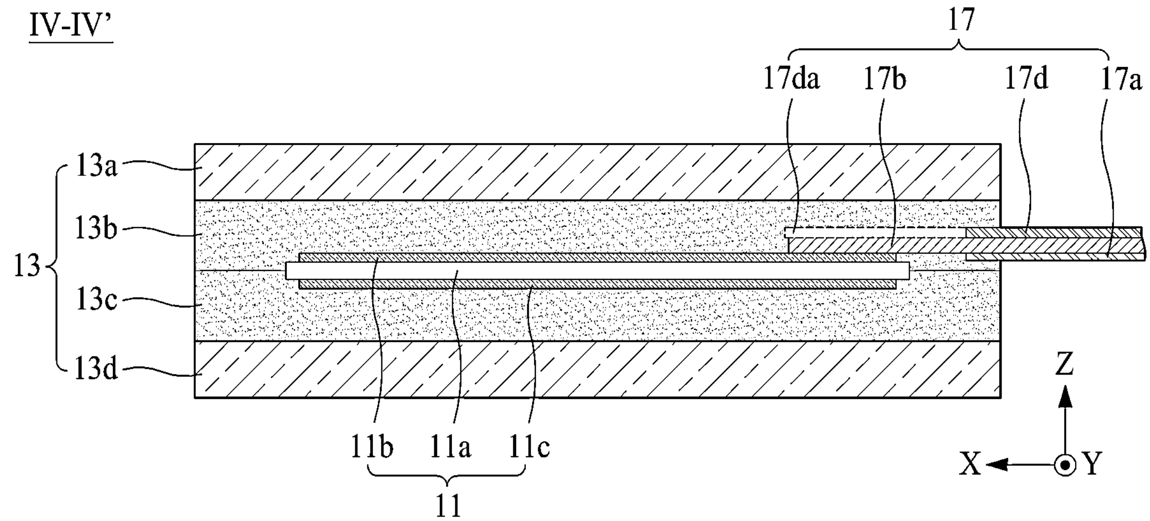

IV-IV'
17
17da
17b
17d
17a
13a
13b
13
13c
13d
11b
11a
11c
11
Z
X
Y

FIG. 16

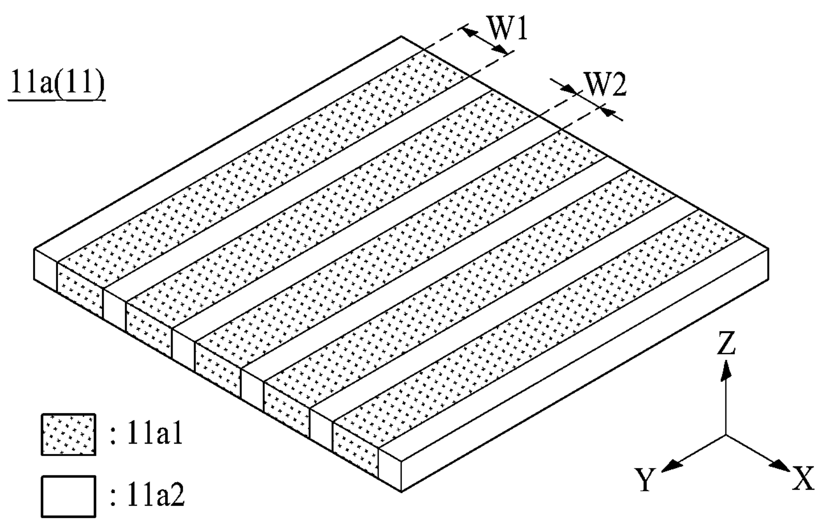

11a(11)
W1
W2
Z
Y
X
: 11a1
: 11a2

FIG. 17

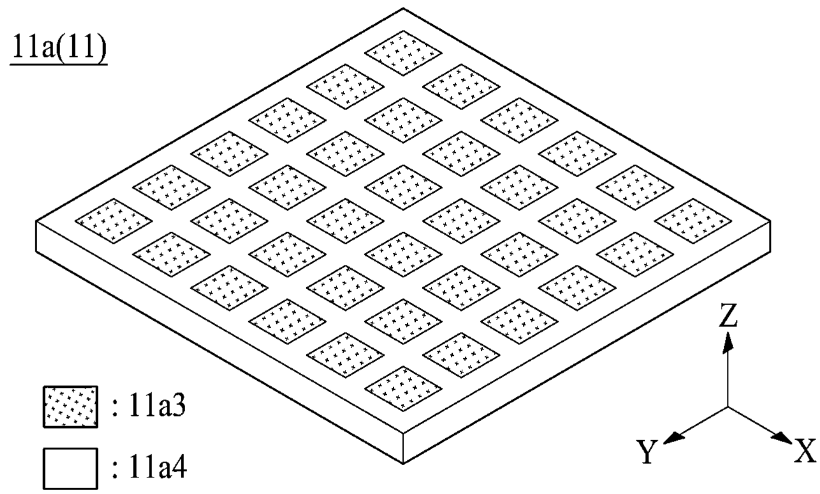

11a(11)
: 11a3
: 11a4
Z
Y
X

FIG. 18

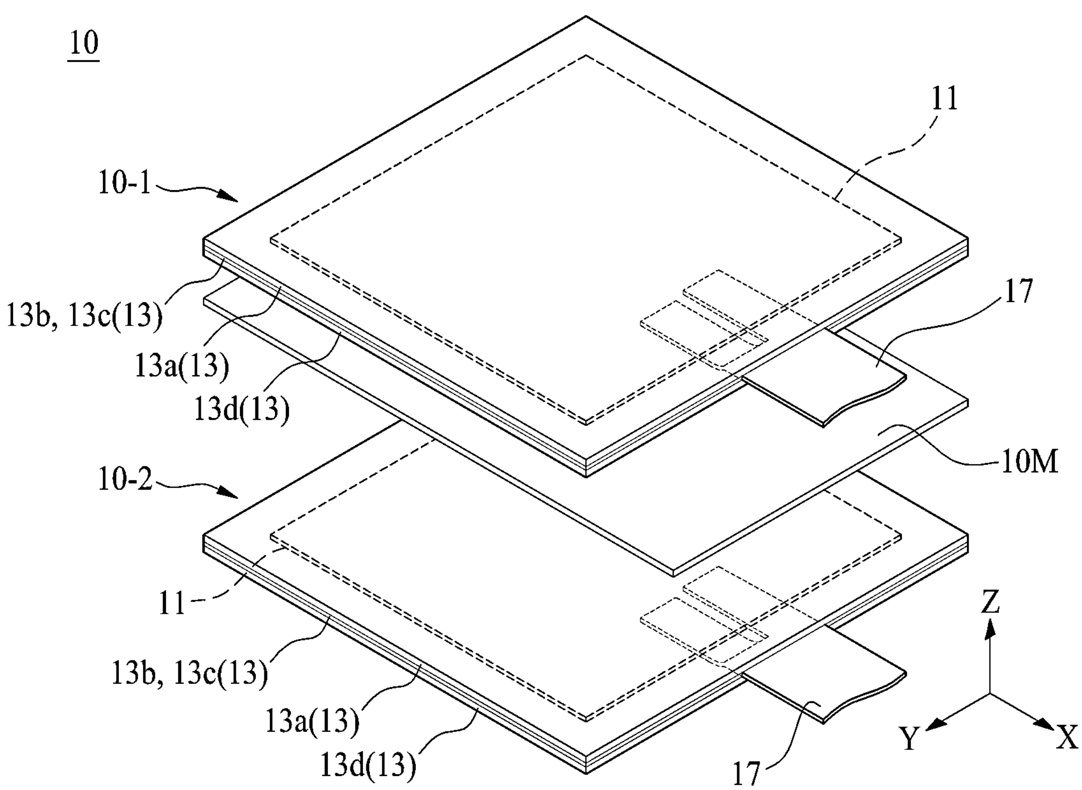

10
10-1
11
13b, 13c(13)
13a(13)
13d(13)
17
10M
10-2
11
13b, 13c(13)
13a(13)
13d(13)
17
Z
Y
X

FIG. 19

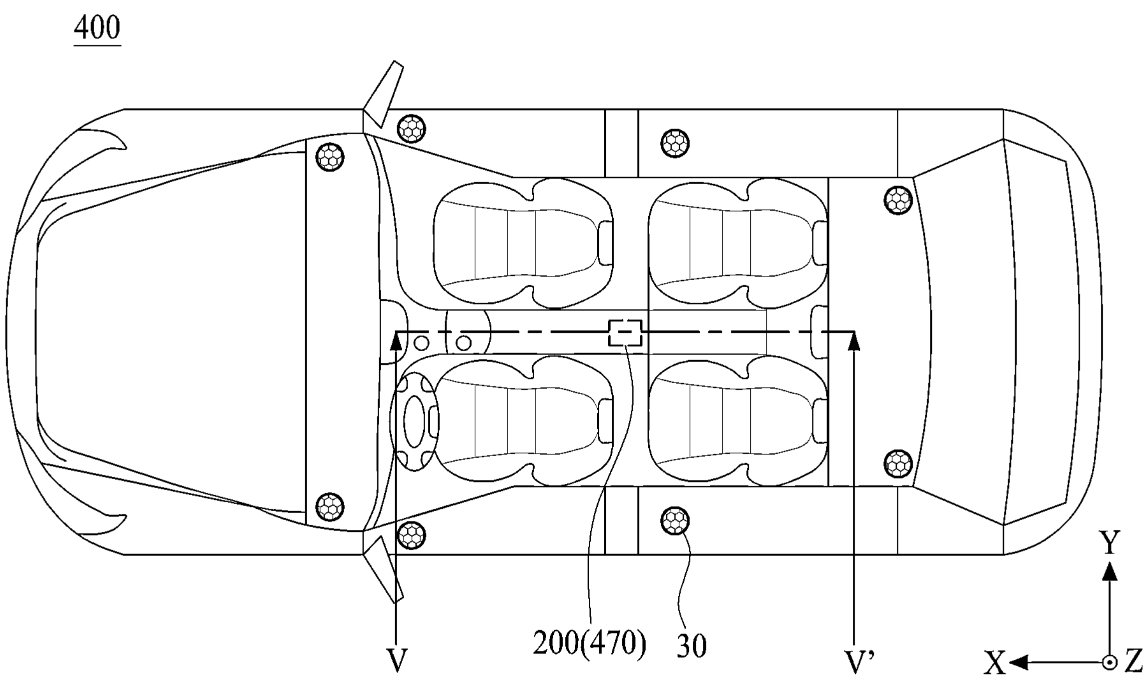
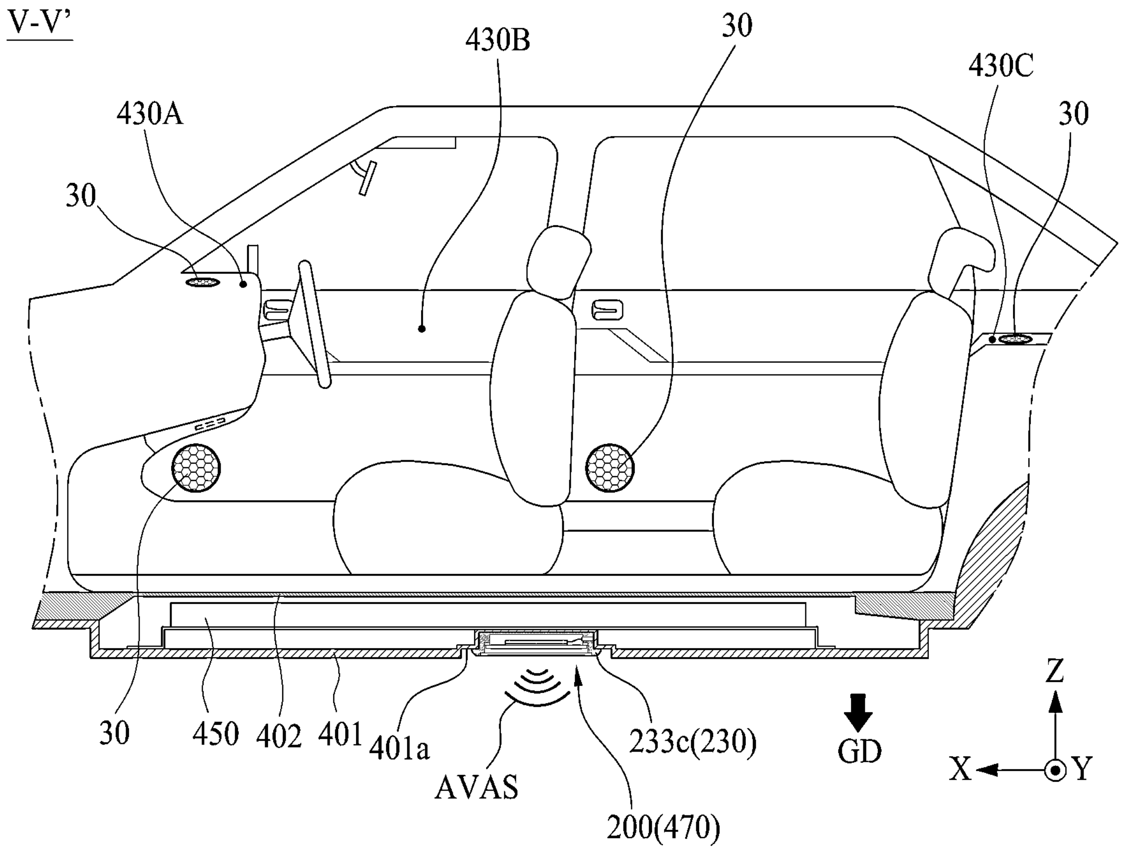


FIG. 20


V-V'
430B
30
430C
30
430A
30
30
450
402
401
401a
AVAS
233c(230)
200(470)
GD
Z
X
Y

SOUND DRIVING CIRCUIT, SOUND APPARATUS INCLUDING THE SAME, AND VEHICULAR APPARATUS INCLUDING THE SOUND APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of and priority to Korean Patent Application No. 10-2024-0019611 filed on Feb. 8, 2024, the entirety of which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

Technical Field

[0002] The present disclosure relates to a sound driving circuit, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus.

Discussion of the Related Art

[0003] A speaker applied to an apparatus may be, for example, an actuator, including a magnet and a coil. However, when the actuator is applied to the apparatus, a thickness thereof is large. Piezoelectric elements that enable thinness to be implemented are attracting much attention.

[0004] A piezoelectric device may have a characteristic where an impedance is progressively lowered toward a high frequency region (or a high-pitched sound band), and due to this, in a case where the piezoelectric device is configured with a sound driving circuit of a speaker, problems such as an overcurrent, a clipping phenomenon, and a reduction in sound quality may occur.

SUMMARY

[0005] The inventors of present disclosure have recognized that a piezoelectric device may be driven when a power resistor is configured in a conventional sound driving circuit of a speaker. However, the inventors of present disclosure have recognized a problem where the conventional sound driving circuit, to which the power resistor is added, increases in power consumption due to the power resistor, and reliability is reduced by heat which occurs in the power resistor due to an increase in power consumption. Through various research and experiments, the inventors of present disclosure have invented a sound driving circuit which may drive a piezoelectric device by using the conventional sound driving circuit of a speaker, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus.

[0006] Accordingly, embodiments of the present disclosure are directed to a sound driving circuit, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus that substantially obviate one or more of the problems due to limitations and disadvantages of the related art.

[0007] An aspect of the present disclosure is to provide a sound driving circuit which may drive a piezoelectric device, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus.

[0008] Another aspect of the present disclosure is to provide a sound driving circuit which may drive a speaker and a piezoelectric device, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus.

[0009] Another aspect of the present disclosure is to provide a vehicular apparatus which may output a virtual engine sound through a sound apparatus including a sound driving circuit capable of driving a piezoelectric device.

[0010] Additional features and aspects will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the inventive concepts provided herein. Other features and aspects of the inventive concepts may be realized and attained by the structure particularly pointed out in the written description, or derivable therefrom, and the claims hereof as well as the appended drawings.

[0011] To achieve these and other aspects of the inventive steps, as embodied and broadly described herein, a sound driving circuit comprises an audio processor generating an input audio signal based on a sound source, a signal conversion circuit converting the input audio signal into a piezoelectric audio signal, and an amplifier circuit amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

[0012] In another aspect, a sound driving circuit comprises an audio processor generating an audio signal based on a sound source, a preamplifier circuit amplifying the audio signal to generate an input audio signal, a signal conversion circuit converting the input audio signal into a piezoelectric audio signal, and an amplifier circuit amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

[0013] In another aspect, a sound driving circuit comprises an audio processor generating a first input audio signal and one or more second input audio signals based on a sound source; a signal conversion circuit converting the first input audio signal into a piezoelectric audio signal, and an amplifier circuit amplifying the one or more second input audio signals to generate one or more actuator driving signals for driving one or more actuators of a coil-type and amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

[0014] In another aspect, a sound driving circuit comprises an audio processor generating a first audio signal and one or more second audio signals based on a sound source; a preamplifier circuit amplifying the one or more second audio signals to generate the one or more second input audio signals and amplifying the first audio signal to generate the first input audio signal; a signal conversion circuit converting the first input audio signal into a piezoelectric audio signal; and an amplifier circuit amplifying the one or more second input audio signals to generate one or more actuator driving signals for driving one or more actuators of a coil-type and amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type

[0015] In another aspect, a sound apparatus comprises a vibration apparatus including a piezoelectric material, and a driving circuit part connected to the vibration apparatus. The driving circuit part comprises a sound driving circuit applying the piezoelectric driving signal to the vibration apparatus, as previously described.

[0016] In another aspect, a sound apparatus comprises a vibration apparatus including a piezoelectric material, one or more actuators including a magnet and a coil, and a driving circuit part connected to the vibration apparatus and the one or more actuators. The driving circuit part comprises a sound driving circuit applying the piezoelectric driving signal to the vibration apparatus and applying the one or more actuator driving signals to the one or more actuators, as previously described.

[0017] In another aspect, a vehicular apparatus comprises an exterior material; an interior material covering the exterior material; and one or more sound generating apparatuses configured to output a sound in one or more of the exterior material, the interior material, and a region between the exterior material and the interior material. The one or more sound generating apparatuses comprise a sound apparatus. The sound apparatus comprises a vibration apparatus including a piezoelectric material, and a driving circuit part connected to the vibration apparatus. The driving circuit part comprises a sound driving circuit applying the piezoelectric driving signal to the vibration apparatus, as previously described.

[0018] In another aspect, a vehicular apparatus comprises an exterior material; an interior material covering the exterior material; and one or more sound generating apparatuses configured to output a sound in one or more of the exterior material, the interior material, and a region between the exterior material and the interior material. The one or more sound generating apparatuses comprise a sound apparatus. The sound apparatus comprises a vibration apparatus including a piezoelectric material, one or more actuators including a magnet and a coil, and a driving circuit part connected to the vibration apparatus and the one or more actuators. The driving circuit part comprises a sound driving circuit applying the piezoelectric driving signal to the vibration apparatus and applying the one or more actuator driving signals to the one or more actuators, as previously described.

[0019] In another aspect, a vehicular apparatus comprises a vehicle body bottom frame, and a vehicle body bottom covering the vehicle body bottom frame, and one or more virtual engine sound apparatuses mounted on the vehicle body bottom or a region between the vehicle body bottom frame and the vehicle body bottom. The one or more virtual engine sound apparatuses comprise a sound apparatus. The sound apparatus comprises a vibration apparatus including a piezoelectric material, and a driving circuit part connected to the vibration apparatus. The driving circuit part comprises a sound driving circuit applying the piezoelectric driving signal to the vibration apparatus, as previously described.

[0020] Details of other exemplary embodiments will be included in the detailed description of the disclosure and the accompanying drawings.

[0021] A sound driving circuit, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus, according to one or more embodiments of the present disclosure, may output a sound based on a vibration (or displacement) of a piezoelectric device and may prevent an overcurrent phenomenon and a clipping phenomenon occurring in a high-pitched sound band (or a high frequency region) when the piezoelectric device is vibrating (or displace).

[0022] A sound driving circuit, a sound apparatus including the same, and a vehicular apparatus including the sound apparatus, according to one or more embodiments of the present disclosure, may drive a speaker and a piezoelectric device.

[0023] A vehicular apparatus according to one or more embodiments of the present disclosure may output a virtual engine sound through a sound apparatus including a sound driving circuit capable of driving a piezoelectric device.

[0024] Other systems, methods, features and advantages will be, or will become, apparent to one with skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description, be within the scope of the present disclosure, and be protected by the following claims. Nothing in this section should be taken as a limitation on those claims. Further aspects and advantages are discussed below in conjunction with aspects of the disclosure.

[0025] It is to be understood that both the foregoing description and the following description of the present disclosure are exemplary and explanatory and are intended to provide further explanation of the disclosure as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The accompanying drawings, which are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this application, illustrate embodiments of the disclosure and together with the description serve to explain principles of the disclosure.

[0027] FIG. **1** illustrates a sound apparatus according to an embodiment of the present disclosure.

[0028] FIG. **2** illustrates a signal conversion circuit illustrated in FIG. **1** according to an embodiment of the present disclosure.

[0029] FIG. **3** illustrates a sound apparatus according to another embodiment of the present disclosure.

[0030] FIG. **4** illustrates a sound apparatus according to another embodiment of the present disclosure.

[0031] FIG. **5** illustrates a sound apparatus according to another embodiment of the present disclosure.

[0032] FIG. **6** illustrates a sound apparatus according to another embodiment of the present disclosure.

[0033] FIG. **7** is a cross-sectional view taken along line I-I' illustrated in FIG. **6** according to an embodiment of the present disclosure.

[0034] FIG. **8** is an exploded perspective view illustrating the sound apparatus illustrated in FIG. **6** according to another embodiment of the present disclosure.

[0035] FIG. **9** is a cross-sectional view illustrating an apparatus according to an embodiment of the present disclosure.

[0036] FIG. **10** is a cross-sectional view illustrating a vehicular apparatus according to an embodiment of the present disclosure.

[0037] FIG. **11** is a perspective view illustrating a vehicular apparatus according to another embodiment of the present disclosure.

[0038] FIG. **12** is a cross-sectional view taken along line II-II' illustrated in FIG. **11** according to an embodiment of the present disclosure.

[0039] FIG. **13** is a perspective view illustrating a vibration apparatus according to an embodiment of the present disclosure.

[0040] FIG. **14** is a cross-sectional view taken along line III-III' illustrated in FIG. **13** according to an embodiment of the present disclosure.

[0041] FIG. **15** is a cross-sectional view taken along line IV-IV' illustrated in FIG. **13** according to an embodiment of the present disclosure.

[0042] FIG. **16** is a perspective view illustrating a vibration layer according to another embodiment of the present disclosure.

[0043] FIG. **17** is a perspective view illustrating a vibration layer according to another embodiment of the present disclosure.

[0044] FIG. **18** is an exploded perspective view illustrating a vibration apparatus according to another embodiment of the present disclosure.

[0045] FIG. **19** is a plan view illustrating a vehicular apparatus according to another embodiment of the present disclosure.

[0046] FIG. **20** is a cross-sectional view taken along line V-V' illustrated in FIG. **19** according to an embodiment of the present disclosure.

[0047] Throughout the drawings and the detailed description, unless otherwise described, the same drawing reference numerals should be understood to refer to the same elements, features, and structures. The sizes, lengths, and thicknesses of layers, regions and elements, and depiction of thereof may be exaggerated for clarity, illustration, and convenience.

DETAILED DESCRIPTION

[0048] Advantages and features of the present disclosure, and implementation methods thereof, are clarified through the aspects described with reference to the accompanying drawings. The present disclosure may, however, be embodied in different forms and should not be construed as limited to the example aspects set forth herein. Rather, these example aspects are examples and are provided so that this disclosure may be thorough and complete to assist those skilled in the art to understand the inventive concepts without limiting the protected scope of the present disclosure.

[0049] A shape, a size, a ratio, an angle, and a number disclosed in the drawings for describing embodiments of the present disclosure are merely an example, and thus, the present disclosure is not limited to the illustrated details. Like reference numerals refer to like elements throughout. In the following description, when the detailed description of the relevant known function or configuration is determined to unnecessarily obscure the important point of the present disclosure, the detailed description will be omitted.

[0050] In a situation where "comprise," "have," and "include" described in the present specification are used, another part may be added unless "only" is used. The terms of a singular form may include plural forms unless referred to the contrary.

[0051] In construing an element, the element is construed as including an error range although there is no explicit description.

[0052] In describing a position relationship, for example, when a position relation between two parts is described as "on," "over," "under," and "next," one or more other parts may be disposed between the two parts unless 'just' or 'direct' is used.

[0053] In describing a temporal relationship, for example, when the temporal order is described as "after," "subsequent," "next," and "before," a situation which is not continuous may be included, unless "just" or "direct" is used.

[0054] It will be understood that, although the terms "first," "second," etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of the present disclosure.

[0055] In describing elements of the present disclosure, the terms "first," "second," "A," "B," "(a)," "(b)," or the like may be used. These terms are intended to identify the corresponding element(s) from the other element(s), and these are not used to define the essence, basis, order, or number of the elements.

[0056] For the expression that an element is "connected," "coupled," or "contact," to another element, the element may not only be directly connected, coupled, or contacted to another element, but also be indirectly connected, coupled, or contacted to another element with one or more intervening elements interposed between the elements, unless otherwise specified.

[0057] For the expression that an element is "contacts" or "overlaps" with another element, the element may not only directly contact, overlap, or the like with another element, but also indirectly contact or overlap with another element with one or more intervening elements disposed or interposed between the elements, unless otherwise specified.

[0058] The term "at least one" should be understood as including any and all combinations of one or more of the associated listed items. For example, the meaning of "at least one of a first item, a second item and a third item" denotes the combination of all items proposed from two or more of the first item, the second item and the third item as well as the first item, the second item or the third item.

[0059] Features of various embodiments of the present disclosure may be partially or overall coupled to or combined with each other and may be variously inter-operated with each other and driven technically as those skilled in the art may sufficiently understand. The embodiments of the present disclosure may be carried out independently from each other or may be carried out together in co-dependent relationship.

[0060] Hereinafter, example embodiments of a sound apparatus according to the present disclosure will be described in detail with reference to the accompanying drawings. For convenience of description, a scale of each of elements illustrated in the accompanying drawings differs from a real scale, and thus, is not limited to a scale illustrated in the drawings.

[0061] FIG. **1** illustrates a sound apparatus according to an embodiment of the present disclosure.

[0062] With reference to FIG. **1**, a sound apparatus according to an embodiment (or a first embodiment) of the present disclosure may include a vibration apparatus **10** and a driving circuit part **100** connected to the vibration apparatus **10**.

[0063] The vibration apparatus **10** may be configured to include a piezoelectric material. The vibration apparatus **10** may vibrate (or displace) based on a piezoelectric driving signal PDS applied from the driving circuit part **100** to output (or generate) a sound (or vibration or sound wave). For example, the vibration apparatus **10** may be a piezoelectric device, a vibration generating device, a vibration film, a vibration generating film, an active vibration generator, a film actuator, or a film exciter, or the like, but embodiments of the present disclosure are not limited thereto.

[0064] The driving circuit part **100** may include a sound driving circuit **101** configured to supply the piezoelectric driving signal PDS to the vibration apparatus **10**.

[0065] The sound driving circuit **101** according to an embodiment of the present disclosure may include a signal conversion circuit **120** and an amplifier circuit **130**.

[0066] The signal conversion circuit **120** may be configured to convert an input audio signal (or an input audio data) IAS into a piezoelectric audio signal PAS. For example, the signal conversion circuit **120** may be configured to convert the input audio signal IAS into the piezoelectric audio signal PAS so as to correspond to a driving characteristic of the vibration apparatus **10** of a piezoelectric type (or a piezoelectric device or a piezoelectric-type vibration device). For example, the vibration apparatus **10** may have a characteristic where an impedance is progressively lowered toward a high frequency region (or a high-pitched sound band), and due to this, an overcurrent caused by a peak component occurring in the high frequency region (or high-pitched sound band), a clipping phenomenon caused by the overcurrent, and a reduction in a sound quality may occur. For example, the clipping phenomenon may occur when a signal which is greater than or equal to an allowable voltage is applied to the amplifier circuit **130**.

[0067] The signal conversion circuit **120** according to an embodiment of the present disclosure may convert the input audio signal IAS into the piezoelectric audio signal PAS so that an overcurrent is prevented in a high-pitched sound band signal (or a high frequency region) of the input audio signal IAS. For example, the signal conversion circuit **120** may be configured to limit a voltage, corresponding to the input audio signal IAS, to less than an allowable voltage of the amplifier circuit **130**. For example, the signal conversion circuit **120** may be configured to generate the piezoelectric audio signal PAS by attenuating the high-pitched sound band signal of the input audio signal IAS. For example, the signal conversion circuit **120** may be configured to generate the piezoelectric audio signal PAS by linearly attenuating the high-pitched sound band signal of the input audio signal IAS. For example, the high-pitched sound band signal may have a frequency of 1 kHz or more, but embodiments of the present disclosure are not limited thereto. For example, the signal conversion circuit **120** may be configured to generate the piezoelectric audio signal PAS by attenuating an attenuation frequency (or a cutoff frequency) or more of the input audio signal IAS. For example, the signal conversion circuit **120** may be configured to generate the piezoelectric audio signal PAS by attenuating a signal of the attenuation frequency or more of the input audio signal IAS. For example, the attenuation frequency may be 1 kHz, but embodiments of the present disclosure are not limited thereto.

[0068] The amplifier circuit **130** may receive the piezoelectric audio signal PAS output from the signal conversion circuit **120** and may amplify the received piezoelectric audio signal PAS to generate the piezoelectric driving signal PDS. For example, the amplifier circuit **130** may amplify the piezoelectric audio signal PAS to generate the piezoelectric driving signal PDS, based on a predetermined gain value. For example, the amplifier circuit **130** may amplify the piezoelectric audio signal PAS to generate the piezoelectric driving signal PDS having a positive polarity and a negative polarity and may supply (or transfer) the piezoelectric driving signal PDS having the positive polarity and the negative polarity to the vibration apparatus **10**.

[0069] According to an embodiment of the present disclosure, the amplifier circuit **130** may receive (or apply) the piezoelectric audio signal PAS from the signal conversion circuit **120** and may amplify the piezoelectric audio signal PAS within a range of an allowable voltage to generate the piezoelectric driving signal PDS. Accordingly, a clipping phenomenon occurring based on a vibration (or displacement) of the vibration apparatus **10** may be prevented.

[0070] The sound driving circuit **101** according to an embodiment of the present disclosure may further include an audio processor **110**.

[0071] The audio processor **110** may be configured to supply (or transfer) the input audio signal IAS to the signal conversion circuit **120**. For example, the audio processor **110** may generate an audio signal, based on a sound source SS input based on control by a host system (or host controller), and may be configured to supply (or transfer) the generated audio signal as the input audio signal IAS to the signal conversion circuit **120**.

[0072] The vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal PDS applied from the amplifier circuit **130** of the driving circuit part **100** (or the sound driving circuit **101**) to output (or generate) the sound (or vibration or sound wave).

[0073] According to an embodiment of the present disclosure, the vibration apparatus **10** may vibrate (or displace) by the piezoelectric driving signal PDS based on the piezoelectric audio signal PAS where an overcurrent is limited by the signal conversion circuit **120** in the high-pitched sound band, and thus, an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region) may be prevented.

[0074] In the sound driving circuit **101** according to an embodiment of the present disclosure, the audio processor **110** and the amplifier circuit **130** may be considered as a conventional sound driving circuit of a speaker. For example, the sound driving circuit **101** according to an embodiment of the present disclosure may include the signal conversion circuit **120** connected between the audio processor **110** and the amplifier circuit **130** in the conventional sound driving circuit of the speaker. Accordingly, because the sound driving circuit **101** according to an embodiment of the present disclosure includes the signal conversion circuit **120** added to the conventional sound driving circuit of the speaker, the sound driving circuit **101** may drive (or vibrate or displace) the vibration apparatus **10** of a piezoelectric type and may prevent an overcurrent phenomenon and a clipping phenomenon from occurring in the high-pitched sound band (or high frequency region) when the vibration apparatus **10** is being driven.

[0075] In the sound driving circuit **101** according to an embodiment of the present disclosure, the audio processor **110**, the signal conversion circuit **120**, and the amplifier circuit **130** may be mounted on one printed circuit board (PCB). For example, in the PCB, a signal line **101**L between the audio processor **110** and the amplifier circuit **130** may be disconnected or there is not a signal line between the audio processor **110** and the amplifier circuit **130**. Accordingly, the input audio signal IAS output from the audio processor **110** may not be supplied to the amplifier circuit **130** (e.g., through the disconnected signal line **101**L) and may be supplied to only the signal conversion circuit **120**. For comparison, in the conventional sound driving circuit of the speaker, the audio processor is connected to the amplifier circuit through the signal line so that the input audio signal is transferred to the amplifier circuit without conversion.

[0076] FIG. **2** illustrates a signal conversion circuit illustrated in FIG. **1** according to an embodiment of the present disclosure.

[0077] With reference to FIGS. **1** and **2**, the signal conversion circuit **120** according to an embodiment of the present disclosure may include a filter circuit **127**.

[0078] The filter circuit **127** may filter the input audio signal IAS to generate the piezoelectric audio signal PAS, so that an overcurrent is prevented in the high-pitched sound band signal (for example, with a frequency of 1 kHz or more) of the input audio signal IAS. For example, the filter circuit **127** may be configured to limit a voltage, corresponding to the input audio signal IAS, to less than an allowable voltage of the amplifier circuit **130**, but embodiments of the present disclosure are not limited thereto.

[0079] The filter circuit **127** may be configured to generate the piezoelectric audio signal PAS by attenuating the high-pitched sound band signal of the input audio signal IAS. The filter circuit **127** may be configured to generate the piezoelectric audio signal PAS by linearly attenuating the high-pitched sound band signal of the input audio signal IAS. For example, the filter circuit **127** may be configured to generate the piezoelectric audio signal PAS by attenuating a signal of the attenuation frequency (for example, 1 kHz) or more of the input audio signal IAS. For example, the filter circuit **127** may be configured to generate the piezoelectric audio signal PAS by linearly attenuating the signal of the attenuation frequency or more of the input audio signal IAS. For example, the filter circuit **127** may be a piezo equalizer, a piezo filter, a low-pass filter, a high-cut filter, or a treble-cut filter, but embodiments of the present disclosure are not limited thereto.

[0080] The signal conversion circuit **120** according to an embodiment of the present disclosure may include a correction circuit **121**, a level control circuit **123**, and a clipping circuit **125**.

[0081] The correction circuit **121** may correct the input audio signal IAS so that a difference between a highest sound pressure level and a lowest sound pressure level is reduced in a specific pitched sound band (or a specific frequency band) of a sound generated based on a vibration (or displacement) of the vibration apparatus **10**. The correction circuit **121** may correct the input audio signal IAS to improve the sound pressure level flatness of a sound generated based on a vibration (or displacement) of the vibration apparatus **10**. For example, the correction circuit **121** may correct the input audio signal IAS so that a dip component (or a dip frequency) and/or a peak component (or a peak frequency) are/is improved in a specific pitched sound band of a sound generated based on a vibration (or displacement) of the vibration apparatus **10**. The peak may be a phenomenon where a sound pressure level bounces in a specific frequency, and the dip may be a phenomenon where a low sound pressure level is generated as the occurrence of a sound having a specific frequency is prevented. The flatness of the sound pressure level may be a level of the deviation between the highest sound pressure level and the lowest sound pressure level in a specific frequency. For example, the correction circuit **121** may be a planarization circuit, a tuning equalizer, or a peak/dip correction circuit, but embodiments of the present disclosure are not limited thereto.

[0082] The correction circuit **121** according to an embodiment of the present disclosure may increase a first pitched sound band signal of the input audio signal IAS and/or may decrease a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal ACS**1**.

[0083] According to an embodiment of the present disclosure, the correction circuit **121** may correct the input audio signal IAS so that a dip phenomenon (or a dip frequency) is improved in the first pitched sound band signal of a sound generated based on a vibration (or displacement) of the vibration apparatus **10**. For example, the correction circuit **121** may be configured to increase the first pitched sound band signal of the input audio signal IAS. For example, the correction circuit **121** may be configured to increase, by a predetermined value, a value (or a level) of the first pitched sound band signal of the input audio signal IAS. For example, the correction circuit **121** may increase the value (or level) of the first pitched sound band signal of the input audio signal IAS by up to a maximum of 3 decibels (+3 dB), but embodiments of the present disclosure are not limited thereto. For example, the first pitched sound band signal may have a frequency of 250 Hz to 600 Hz, but embodiments of the present disclosure are not limited thereto.

[0084] According to an embodiment of the present disclosure, the correction circuit **121** may correct the input audio signal IAS so that a peak phenomenon (or a peak frequency) is improved in the second pitched sound band signal of a sound generated based on a vibration (or displacement) of the vibration apparatus **10**. For example, the correction circuit **121** may be configured to decrease the second pitched sound band signal of the input audio signal IAS. For example, the correction circuit **121** may decrease, by a predetermined value, a value (or a level) of the second pitched sound band signal of the input audio signal IAS to generate the first audio correction signal ACS**1**. For example, the correction circuit **121** may decrease the value (or level) of the second pitched sound band signal of the input audio signal IAS by up to a maximum of 3 decibels (−3 dB), but embodiments of the present disclosure are not limited thereto. For example, the second pitched sound band signal may have a frequency of 1 kHz or more, 4 kHz or more, or 10 kHz or more, but embodiments of the present disclosure are not limited thereto.

[0085] The correction circuit **121** according to an embodiment of the present disclosure may include a first correction circuit **121***a* and a second correction circuit **121***b*.

[0086] The first correction circuit **121***a* may be configured to increase the first pitched sound band signal of the input audio signal IAS. The second correction circuit **121***b* may decrease the second pitched sound band signal in a signal obtained by increasing the first pitched sound band through the first correction circuit **121***a* to generate the first audio correction signal ACS**1**.

[0087] The correction circuit **121** according to another embodiment of the present disclosure may include a first correction circuit **121***a*, a second correction circuit **121***b*, and a mixing circuit.

[0088] The first correction circuit **121***a* may be configured to increase the first pitched sound band signal of the input audio signal IAS. The second correction circuit **121***b* may be configured to decrease the second pitched sound band signal of the input audio signal IAS. The mixing circuit may mix the signal, obtained by increasing the first pitched sound band signal through the first correction circuit **121***a*, with a signal obtained by decreasing the second pitched sound band signal through the second correction circuit **121***b* to generate the first audio correction signal ACS**1**.

[0089] The first audio correction signal ACS**1** output from the correction circuit **121** according to another embodiment of the present disclosure may be a signal where a dip phenomenon and a peak phenomenon have been improved in the input audio signal IAS. For example, the first audio correction signal ACS**1** may be a signal where a dip phenomenon has been improved in the first pitched sound band signal of the input audio signal IAS and a peak phenomenon has been improved in the second pitched sound band signal of the input audio signal IAS.

[0090] The level control circuit **123** may be configured to control a volume (or a volume level) of the first audio correction signal ACS**1** output from the correction circuit **121**. The level control circuit **123** may receive the first audio correction signal ACS**1** output from the correction circuit **121** and may control a volume level of the received first audio correction signal ACS**1** to generate a second audio correction signal ACS**2**. For example, the level control circuit **123** may control one or more of a phase and an amplitude of the first audio correction signal ACS**1** to generate the second audio correction signal ACS**2**, based on a gain value.

[0091] The clipping circuit **125** may be configured to generate a third audio correction signal ACS**3** by removing noise of the second audio correction signal ACS**2** output from the level control circuit **123**. The clipping circuit **125** may receive the second audio correction signal ACS**2** output from the level control circuit **123** and may be configured to generate the third audio correction signal ACS**3** by removing noise of the received second audio correction signal ACS**2**. For example, the clipping circuit **125** may be configured to prevent the occurrence of a clipping phenomenon caused by an increase in frequency band based on the amplification of a signal by the amplifier circuit **130**. The clipping circuit **125** according to an embodiment of the present disclosure may remove a signal of 0 dBFS (dB full scale) or more in the second audio correction signal ACS**2** output from the level control circuit **123** to generate the third audio correction signal ACS**3**. For example, the clipping circuit **125** may be a limiter, but embodiments of the present disclosure are not limited thereto.

[0092] The filter circuit **127** may be configured to generate the piezoelectric audio signal PAS by attenuating a high-pitched sound band (or a high frequency) signal of the third audio correction signal ACS**3** output from the clipping circuit **125**. The filter circuit **127** may receive the third audio correction signal ACS**3** output from the clipping circuit **125** and may attenuate the high-pitched sound band (or high frequency) signal of the received third audio correction signal ACS**3** to generate the piezoelectric audio signal PAS.

[0093] According to an embodiment of the present disclosure, the vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal PDS based on the piezoelectric audio signal PAS generated by the signal conversion circuit **120** including the correction circuit **121**, the level control circuit **123**, the clipping circuit **125**, and the filter circuit **127** to output (or generate) a sound (or vibration or sound wave), may prevent an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region), and may improve the dip phenomenon in the first pitched sound band and the peak phenomenon in the second pitched sound band, thereby enhancing a sound characteristic and/or a sound pressure level characteristic.

[0094] FIG. **3** illustrates a sound apparatus according to another embodiment of the present disclosure. For example, FIG. **3** illustrates an embodiment where a preamplifier circuit is additionally configured in the sound driving circuit of the sound apparatus described above with reference to FIGS. **1** and **2**. In the following description, therefore, a preamplifier circuit will be described in detail, the other elements may be substantially a same as that of descriptions described above with reference to FIGS. **1** and **2**, and thus, like reference numerals refer to like elements and its repeated descriptions may be omitted or will be briefly given below.

[0095] With reference to FIG. **3**, in a sound apparatus according to another embodiment (or a second embodiment) of the present disclosure, the sound driving circuit **101** of the driving circuit part **100** may include a preamplifier circuit **140**, a signal conversion circuit **120**, and an amplifier circuit **130**.

[0096] The preamplifier circuit **140** may amplify an audio signal AS input thereto to generate the input audio signal IAS. For example, the pre-amplifier circuit **140** may primarily amplify the audio signal AS to generate the input audio signal IAS, based on a predetermined gain value. The preamplifier circuit **140** may be configured to supply (or transfer) the input audio signal IAS to the signal conversion circuit **120**.

[0097] The signal conversion circuit **120** may receive the input audio signal IAS output from the preamplifier circuit **140** and may be configured to convert the received input audio signal IAS into a piezoelectric audio signal PAS. Except for that the signal conversion circuit **120** receives the input audio signal IAS output from the preamplifier circuit **140**, the signal conversion circuit **120** may be a same or substantially a same as the signal conversion circuit **120** described above with reference to FIGS. **1** and **2**, and thus, its repeated descriptions are omitted. The descriptions of the signal conversion circuit **120** described above with reference to FIGS. **1** and **2** may be included in descriptions of the signal conversion circuit **120** illustrated in FIG. **3**. The signal conversion circuit **120** may be configured to supply (or transfer) the piezoelectric audio signal PAS to the amplifier circuit **130**.

[0098] The amplifier circuit **130** may amplify the piezoelectric audio signal PAS to generate a piezoelectric driving signal PDS and may be configured to apply the piezoelectric driving signal PDS to the vibration apparatus **10**. For example, the amplifier circuit **130** may be a same or substantially a same as the amplifier circuit **130** described above with reference to FIGS. **1** and **2**, and thus, its repeated descriptions are omitted.

[0099] The sound driving circuit **101** according to another embodiment of the present disclosure may further include an audio processor **110**.

[0100] The audio processor **110** may be configured to supply (or transfer) the audio signal AS to the preamplifier circuit **140**. For example, the audio processor **110** may generate the audio signal AS, based on a sound source SS input based on control by the host system (or host controller), and may be configured to supply (or transfer) the generated audio signal AS to the preamplifier circuit **140**.

[0101] In the sound driving circuit **101** according to an embodiment of the present disclosure, the audio processor **110**, the signal conversion circuit **120**, the amplifier circuit **130**, and the preamplifier circuit **140** may be mounted on one printed circuit board (PCB). For example, in the PCB, a signal line **101**L between the preamplifier circuit **140** and the amplifier circuit **130** may be disconnected or there is not a signal line between the preamplifier circuit **140** and the amplifier circuit **130**. Accordingly, the input audio signal IAS output from the preamplifier circuit **140** may not be supplied to the amplifier circuit **130** (e.g., through the disconnected signal line **101**L) and may be supplied to only the signal conversion circuit **120**.

[0102] The vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal PDS applied from the amplifier circuit **130** of the driving circuit part **100** (or the sound driving circuit **101**) to output (or generate) the sound (or vibration or sound wave), may prevent an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region), and may improve the dip phenomenon in the first pitched sound band and the peak phenomenon in the second pitched sound band, thereby enhancing a sound characteristic and/or a sound pressure level characteristic.

[0103] FIG. **4** illustrates a sound apparatus according to another embodiment of the present disclosure.

[0104] With reference to FIG. **4**, a sound apparatus according to another embodiment (or a third embodiment) of the present disclosure may include a vibration apparatus **10**, one or more (or a plurality of) actuators (or speakers) **30-1** to **30-*n*** including a magnet and a coil (or a voice coil), and a driving circuit part **100** connected to the vibration apparatus **10** and the one or more (or plurality of) actuators **30-1** to **30-*n***.

[0105] The vibration apparatus (or piezoelectric device) **10** may vibrate (or displace) based on the piezoelectric driving signal PDS applied from the driving circuit part **100** to output (or generate) a sound (or vibration or sound wave).

[0106] The one or more (or plurality of) actuators **30-1** to **30-*n*** may be a coil-type vibration apparatus or a coil-type actuator. For example, the one or more (or plurality of) actuators **30-1** to **30-*n*** may vibrate (or be driven) based on actuator driving signals (or speaker driving signals) ADS**1** to ADSn applied from the driving circuit part **100** according to Fleming's left-hand rule to output (or generate) a sound (or vibration or sound wave).

[0107] The driving circuit part **100** may include a sound driving circuit **101** configured to drive the vibration apparatus **10** and the one or more (or plurality of) actuators **30-1** to **30-*n***. The sound driving circuit **101** may supply the piezoelectric driving signal PDS to the vibration apparatus **10** and may supply the actuator driving signals ADS**1** to ADSn to the one or more (or plurality of) actuators **30-1** to **30-*n***.

[0108] The sound driving circuit **101** according to another embodiment of the present disclosure may include a signal conversion circuit **120** and an amplifier circuit **130** and may further include an audio processor **110**.

[0109] The audio processor **110** may be configured to generate a first input audio signal (or a first input audio data) IAS**1** and one or more (or a plurality of) second input audio signals (or second input audio data) IAS**2-1** to IAS**2-*n***. For example, the audio processor **110** may generate the first audio signal and one or more (or a plurality of) second audio signals based on a sound source SS input based on control by a host system (or host controller). The audio processor **110** may be configured to supply (or transfer) the first audio signal as the first input audio signal IAS**1** to the signal conversion circuit **120** and may be configured to supply (or transfer) the one or more (or plurality of) second audio signals as the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2-*n*** to the amplifier circuit **130**.

[0110] The audio processor **110** according to an embodiment of the present disclosure may be configured to generate the plurality of second input audio signals IAS**2-1** to IAS**2-*n*** to supply (or transfer) the second input audio signals IAS**2-1** to IAS**2-*n*** to the amplifier circuit **130**, based on the sound source SS. For example, the plurality of second input audio signals IAS**2-1** to IAS**2-*n*** may be equal to or different from one another.

[0111] The signal conversion circuit **120** may receive the first input audio signal IAS**1** output from the audio processor **110** and may be configured to convert the received first input audio signal IAS**1** into a piezoelectric audio signal PAS. Except for that the signal conversion circuit **120** receives the first input audio signal IAS**1** output from the audio processor **110**, the signal conversion circuit **120** may be a same or substantially a same as the signal conversion circuit **120** described above with reference to FIGS. **1** and **2**, and thus, its repeated descriptions are omitted. The descriptions of the signal conversion circuit **120** described above with reference to FIGS. **1** and **2** may be included in descriptions of the signal conversion circuit **120** illustrated in FIG. **4**. The signal conversion circuit **120** may be configured to supply (or transfer) the piezoelectric audio signal PAS to the amplifier circuit **130**.

[0112] The amplifier circuit **130** may be configured to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn by amplifying the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2-*n*** and may also be configured to generate the piezoelectric driving signal PDS by amplifying the piezoelectric audio signal PAS.

[0113] The amplifier circuit **130** may receive the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2-*n*** output from the audio processor **110** and may amplify the received one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2-*n*** to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn. For example, the amplifier circuit **130** may amplify the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2-*n*** to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn, based on a predetermined gain value. For example, the amplifier circuit **130** may amplify the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2-*n*** to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn having a positive polarity and a negative polarity and may supply (or transfer) the one or more (or plurality of) actuator driving signals ADS**1** to ADSn having the positive polarity and the negative polarity to the one or more (or plurality of) actuators **30-1** to **30**-*n*.

[0114] The amplifier circuit **130** may receive the piezoelectric audio signal PAS output from the signal conversion circuit **120** and may amplify the received piezoelectric audio signal PAS to generate the piezoelectric driving signal PDS. For example, the amplifier circuit **130** may amplify the piezoelectric audio signal PAS to generate the piezoelectric driving signal PDS, based on a predetermined gain value. For example, the amplifier circuit **130** may amplify the piezoelectric audio signal PAS to generate the piezoelectric driving signal PDS having a positive polarity and a negative polarity and may supply (or transfer) the piezoelectric driving signal PDS having the positive polarity and the negative polarity to the vibration apparatus **10**.

[0115] According to an embodiment of the present disclosure, the amplifier circuit **130** may receive (or apply) the piezoelectric audio signal PAS from the signal conversion circuit **120** and may amplify the piezoelectric audio signal PAS within a range of an allowable voltage to generate the piezoelectric driving signal PDS. Accordingly, a clipping phenomenon occurring based on a vibration (or displacement) of the vibration apparatus **10** may be prevented.

[0116] The amplifier circuit **130** according to an embodiment of the present disclosure may include a first amplifier circuit **131** and one or more (or a plurality of) second amplifier circuits **132-1** to **132**-*n*.

[0117] The first amplifier circuit **131** may generate the piezoelectric driving signal PDS by amplifying the piezoelectric audio signal PAS output from the signal conversion circuit **120**, based on a predetermined gain value. For example, the first amplifier circuit **131** may generate the piezoelectric driving signal PDS having a positive polarity and a negative polarity by amplifying the piezoelectric audio signal PAS and may be configured to supply (or transfer) the piezoelectric driving signal PDS having the positive polarity and the negative polarity to the vibration apparatus **10**.

[0118] The first amplifier circuit **131** according to an embodiment of the present disclosure may receive (or apply) the piezoelectric audio signal PAS from the signal conversion circuit **120** and may generate the piezoelectric driving signal PDS by amplifying the piezoelectric audio signal PAS within a range of an allowable voltage. Accordingly, the vibration apparatus **10** may vibrate (or displace) by the piezoelectric driving signal PDS based on the piezoelectric audio signal PAS where an overcurrent is limited by the signal conversion circuit **120** in the high-pitched sound band, and thus, an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region) may be prevented.

[0119] The one or more (or plurality of) second amplifier circuits **132-1** to **132**-*n* may amplify the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn, based on a predetermined gain value. For example, the one or more (or plurality of) second amplifier circuits **132-1** to **132**-*n* may amplify the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn having a positive polarity and a negative polarity and may be configured to supply (or transfer) the one or more (or plurality of) actuator driving signals ADS**1** to ADSn having the positive polarity and the negative polarity to the one or more (or plurality of) actuators **30-1** to **30**-*n*.

[0120] In the sound driving circuit **101** according to another embodiment of the present disclosure, the audio processor **110**, the signal conversion circuit **120**, and the amplifier circuit **130** may be mounted on one printed circuit board (PCB). For example, in the PCB, a signal line **101**L between the audio processor **110** and the first amplifier circuit **131** may be disconnected or there is not a signal line between the audio processor **110** and the first amplifier circuit **131**. Accordingly, the first input audio signal IAS**1** output from the audio processor **110** may not be supplied to the first amplifier circuit **131** (e.g., through the disconnected signal line **101**L) and may be supplied to only the signal conversion circuit **120**.

[0121] The vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal PDS applied from the first amplifier circuit **131** in the sound driving circuit **101** (or the amplifier circuit **130** of the sound driving circuit **101**) to output (or generate) the sound (or vibration or sound wave), may prevent an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region), and may improve the dip phenomenon in the first pitched sound band and the peak phenomenon in the second pitched sound band, thereby enhancing a sound characteristic and/or a sound pressure level characteristic.

[0122] Each of the plurality of actuators **30-1** to **30**-*n* may be configured to generate (or output) a sound (or a vibration) by vibrating (or driving) based on the actuator driving signals ADS**1** to ADSn applied from a corresponding second amplifier circuit of the plurality of second amplifier circuits **132-1** to **132**-*n* in the sound driving circuit **101** (or the amplifier circuit **130** of the sound driving circuit **101**).

[0123] In the sound driving circuit **101** according to another embodiment of the present disclosure, the audio processor **110** and the amplifier circuit **130** may be considered as a conventional sound driving circuit of a speaker. For example, the sound driving circuit **101** according to another embodiment of the present disclosure may include the signal conversion circuit **120** connected between the audio processor **110** and the amplifier circuit **130** in the conventional sound driving circuit of the speaker. Accordingly, because the sound driving circuit **101** according to another embodiment of the present disclosure includes the signal conversion circuit **120** added to the conventional sound driving circuit of the speaker, the sound driving circuit **101** may drive (or vibrate or displace) both an actuator including a magnet and a coil and the vibration apparatus **10** of a piezoelectric type and may prevent an overcurrent phenomenon and a clipping phenomenon from occurring in the high-pitched sound band (or high frequency region) when the vibration apparatus **10** is being driven (or vibrated or displaced).

[0124] FIG. **5** illustrates a sound apparatus according to another embodiment of the present disclosure. For example, FIG. **5** illustrates an embodiment where a preamplifier circuit is additionally configured in the driving circuit part described above with reference to FIG. **4**. In the following description, therefore, a preamplifier circuit will be described in detail, the other elements may be substantially a same as that of descriptions described above with reference to FIG. **4**, and thus, like reference numerals refer to like elements and its repeated descriptions may be omitted or will be briefly given below.

[0125] With reference to FIG. **5**, in a sound apparatus according to another embodiment (or a fourth embodiment) of the present disclosure, the sound driving circuit **101** of the driving circuit part **100** may include a preamplifier circuit **140**, a signal conversion circuit **120**, and an amplifier circuit **130**, and may further include an audio processor **110**.

[0126] The audio processor **110** may be configured to supply (or transfer) a first audio signal AS**1** and one or more (or a plurality of) second audio signals AS**2-1** to AS**2**-*n* to the preamplifier circuit **140**. For example, the audio processor **110** may generate the first audio signal AS**1** and the one or more (or a plurality of) second audio signals AS**2-1** to AS**2**-*n* based on a sound source SS input based on control by a host system (or host controller). The audio processor **110** may be configured to supply (or transfer) the first audio signal AS**1** and the one or more (or plurality of) second audio signals AS**2-1** to AS**2**-*n* to the preamplifier circuit **140**.

[0127] The audio processor **110** according to an embodiment of the present disclosure may be configured to generate the plurality of second audio signals AS**2-1** to AS**2**-*n* to supply (or transfer) the plurality of second audio signals AS**2-1** to AS**2**-*n* to the preamplifier circuit **140**, based on the sound source SS. For example, the plurality of second audio signals AS**2-1** to AS**2**-*n* may be equal to or different from one another.

[0128] The preamplifier circuit **140** may amplify the first audio signal AS**1** input thereto to generate the first input audio signal IAS**1**. For example, the preamplifier circuit **140** may be configured to generate a first input audio signal IAS**1** by primarily amplifying the first audio signal AS**1** input from the audio processor **110**, based on a predetermined gain value. The preamplifier circuit **140** may be configured to supply (or transfer) the first input audio signal IAS**1** to the signal conversion circuit **120**.

[0129] The preamplifier circuit **140** may amplify the one or more (or a plurality of) second audio signals AS**2-1** to AS**2**-*n* input thereto to generate one or more (or a plurality of) second input audio signals IAS**2-1** to IAS**2**-*n*. For example, the preamplifier circuit **140** may be configured to generate the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* by primarily amplifying the one or more (or plurality of) second audio signals AS**2-1** to AS**2**-*n* input from the audio processor **110**, based on a predetermined gain value. The preamplifier circuit **140** may be configured to supply (or transfer) the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* to the amplifier circuit **130**.

[0130] The preamplifier circuit **140** according to an embodiment of the present disclosure may include a first preamplifier circuit **141** and one or more (or a plurality of) second preamplifier circuit **142-1** to **142**-*n*.

[0131] The first preamplifier circuit **141** may amplify the first audio signal AS**1** input thereto to generate the first input audio signal IAS**1**. For example, the first preamplifier circuit **141** may generate the first input audio signal IAS**1** by primarily amplifying the first audio signal AS**1** input from the audio processor **110**, based on the predetermined gain value. The first preamplifier circuit **141** may be configured to supply (or transfer) the first input audio signal IAS**1** to the signal conversion circuit **120**.

[0132] The one or more (or plurality of) second preamplifier circuit **142-1** to **142**-*n* may amplify the one or more (or plurality of) second audio signals AS**2-1** to AS**2**-*n* input thereto to generate the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n*. For example, the one or more (or plurality of) second preamplifier circuit **142-1** to **142**-*n* may be configured to generate the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* by primarily amplifying the one or more (or plurality of) second audio signals AS**2-1** to AS**2**-*n* input from the audio processor **110**, based on a predetermined gain value. The one or more (or plurality of) second preamplifier circuit **142-1** to **142**-*n* may be configured to supply (or transfer) the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* to the amplifier circuit **130**.

[0133] The signal conversion circuit **120** may receive the first input audio signal IAS**1** output from the preamplifier circuit **140** (or the first preamplifier circuit **141**) and may be configured to convert the received first input audio signal IAS**1** into a piezoelectric audio signal PAS. Except for that the signal conversion circuit **120** receives the first input audio signal IAS**1** output from the preamplifier circuit **140**, the signal conversion circuit **120** may be a same or substantially a same as the signal conversion circuit **120** described above with reference to FIG. **4**, and thus, its repeated descriptions are omitted. The descriptions of the signal conversion circuit **120** described above with reference to FIG. **4** may be included in descriptions of a signal conversion circuit **120** illustrated in FIG. **5**. The signal conversion circuit **120** may be configured to supply (or transfer) the piezoelectric audio signal PAS to the amplifier circuit **130**.

[0134] The amplifier circuit **130** may amplify the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* supplied from the preamplifier circuit **140** to generate one or more (or a plurality of) actuator driving signals ADS**1** to ADSn and amplify the piezoelectric audio signal PAS supplied from the signal conversion circuit **120** to generate a piezoelectric driving signal PDS.

[0135] Except for that the amplifier circuit **130** receives the one or more (or plurality of) second input audio signals IAS**2-1** to IAS**2**-*n* output from the preamplifier circuit **140**, the amplifier circuit **130** may be a same or substantially a same as the amplifier circuit **130** described above with reference to FIG. **4**, and thus, its repeated descriptions may be omitted or will be briefly given below. The descriptions of the amplifier circuit **130** described above with reference to FIG. **4** may be included in descriptions of the amplifier circuit **130** illustrated in FIG. **5**.

[0136] The amplifier circuit **130** according to an embodiment of the present disclosure may include a first amplifier circuit **131** and one or more (or a plurality of) second amplifier circuits **132-1** to **132**-*n*.

[0137] The first amplifier circuit **131** may generate the piezoelectric driving signal PDS by amplifying the piezoelectric audio signal PAS output from the signal conversion circuit **120**, based on a predetermined gain value. For example, the first amplifier circuit **131** may generate the piezoelectric driving signal PDS having a positive polarity and a negative polarity by amplifying the piezoelectric audio signal PAS and may be configured to supply (or transfer) the piezoelectric driving signal PDS having the positive polarity and the negative polarity to the vibration apparatus **10**.

[0138] The one or more (or plurality of) second amplifier circuits **132-1** to **132**-*n* may amplify the one or more (or plurality of) second input audio signals IAS**2**-**1** to IAS**2**-*n* supplied from the preamplifier circuit **140** to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn, based on a predetermined gain value. For example, the one or more (or plurality of) second amplifier circuits **132**-**1** to **132**-*n* may amplify the one or more (or plurality of) second input audio signals IAS**2**-**1** to IAS**2**-*n* to generate the one or more (or plurality of) actuator driving signals ADS**1** to ADSn having a positive polarity and a negative polarity and may be configured to supply (or transfer) the one or more (or plurality of) actuator driving signals ADS**1** to ADSn having the positive polarity and the negative polarity to the one or more (or plurality of) actuators **30**-**1** to **30**-*n*.

[0139] In the sound driving circuit **101** according to another embodiment of the present disclosure, the audio processor **110**, the signal conversion circuit **120**, the amplifier circuit **130**, and the preamplifier circuit **140** may be mounted on one printed circuit board (PCB). For example, in the PCB, a signal line **101**L between the first preamplifier circuit **141** of the preamplifier circuit **140** and the first amplifier circuit **131** of the amplifier circuit **130** may be disconnected or there is not a signal line between the first preamplifier circuit **141** and the first amplifier circuit **131**. Accordingly, the first input audio signal IAS**1** output from the preamplifier circuit **140** may not be supplied to the amplifier circuit **130** (e.g., through the disconnected signal line **101**L) and may be supplied to only the signal conversion circuit **120**.

[0140] The vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal PDS applied from the first amplifier circuit **131** in the sound driving circuit **101** (or the amplifier circuit **130** of the sound driving circuit **101**) to output (or generate) the sound (or vibration or sound wave), may prevent an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region), and may improve the dip phenomenon in the first pitched sound band and the peak phenomenon in the second pitched sound band, thereby enhancing a sound characteristic and/or a sound pressure level characteristic.

[0141] Each of the plurality of actuators **30**-**1** to **30**-*n* may be configured to generate (or output) a sound (or a vibration) by vibrating (or driving) based on the actuator driving signals ADS**1** to ADSn applied from a corresponding second amplifier circuit of the plurality of second amplifier circuits **132**-**1** to **132**-*n* in the sound driving circuit **101** (or the amplifier circuit **130** of the sound driving circuit **101**).

[0142] In the sound driving circuit **101** according to another embodiment of the present disclosure, the audio processor **110**, the amplifier circuit **130**, and the preamplifier circuit **140** may be considered as a conventional sound driving circuit of a speaker. For example, the sound driving circuit **101** according to another embodiment of the present disclosure may include the signal conversion circuit **120** connected between the preamplifier circuit **140** and the amplifier circuit **130** in the conventional sound driving circuit of the speaker. Accordingly, because the sound driving circuit **101** according to another embodiment of the present disclosure includes the signal conversion circuit **120** added to the conventional sound driving circuit of the speaker, the sound driving circuit **101** may drive (or vibrate or displace) both an actuator including a magnet and a coil and the vibration apparatus **10** of a piezoelectric type and may prevent an overcurrent phenomenon and a clipping phenomenon from occurring in the high-pitched sound band (or high frequency region) when the vibration apparatus **10** is being driven (or vibrated or displaced).

[0143] FIG. **6** illustrates a sound apparatus according to another embodiment of the present disclosure. FIG. **7** is a cross-sectional view taken along line I-I' illustrated in FIG. **6** according to an embodiment of the present disclosure. FIG. **8** is an exploded perspective view illustrating the sound apparatus illustrated in FIG. **6** according to another embodiment of the present disclosure.

[0144] With reference to FIGS. **6** to **8**, the sound apparatus **200** according to another embodiment of the present disclosure may include a vibration member **210**, a supporting member **230**, a vibration apparatus **10**, and a driving circuit part **100**.

[0145] The vibration member **210** may generate a vibration or may output a sound (or a sound wave or a sound pressure level) S, based on a vibration (or displacement) of the vibration apparatus **10**. For example, the vibration member **210** may be a vibration plate, a sound plate, a diaphragm, a sound output plate, or a sound vibration plate, or the like, but embodiments of the present disclosure are not limited thereto.

[0146] The supporting member **230** may be disposed at a periphery portion of the vibration member **210**. The supporting member **230** may have an internal space **230**S and may be configured to support the vibration member **210**. For example, the supporting member **230** may be configured to accommodate the vibration member **210**. For example, the supporting member **230** may be a case, an outer case, a case member, a housing, a housing member, a cabinet, or an enclosure, but embodiments of the present disclosure are not limited thereto.

[0147] The supporting member **230** according to an embodiment of the present disclosure may be configured to be transparent, semitransparent, or opaque. For example, the supporting member **230** may include one or more of a metal material and a nonmetal material (or a composite nonmetal material), but embodiments of the present disclosure are not limited thereto. For example, the supporting member **230** may include one or more materials of a metal material, plastic, and wood, but embodiments of the present disclosure are not limited thereto.

[0148] The supporting member **230** according to an embodiment of the present disclosure may include a bottom part **231** and a sidewall part **233**.

[0149] The bottom part **231** may be disposed to be spaced apart from the vibration member **210**. The bottom part **231** may be disposed to face a rear surface of the vibration member **210**.

[0150] The sidewall part **233** may be configured or disposed at a periphery portion of the bottom part **231**. For example, the sidewall part **233** may be vertically connected to the periphery portion of the bottom part **231**. For example, the sidewall part **233** may include a structure bent from the periphery portion of the bottom part **231**, but embodiments of the present disclosure are not limited thereto.

[0151] The sidewall part **233** may be configured to support the vibration member **210**. For example, the sidewall part **233** may be configured to support a periphery portion of the vibration member **210**. For example, the sidewall part **233** may be configured to support the vibration member **210** and surround a lateral surface of the vibration member **210**.

[0152] According to an embodiment of the present disclosure, the sidewall part **233** may be integrated with the bottom part **231**. For example, the bottom part **231** and the sidewall part **233** may be integrated as one body (a single body), and thus, the internal space **200S** surrounded by the sidewall part **233** may be provided over the bottom part **231**. Accordingly, the supporting member **230** may include a box shape where one side (or an upper side) is opened by the bottom part **231** and the sidewall part **233**.

[0153] The sidewall part **233** according to an embodiment of the present disclosure may include a first supporting surface **233***a*. The first supporting surface **233***a* may be configured to support the periphery portion of the vibration member **210**. For example, the first supporting surface **233***a* may protrude from an inner surface of the sidewall part **233**. The vibration member **210** may be connected or coupled to the first supporting surface **233***a* by using a coupling member **220**. For example, a rear periphery portion of the vibration member **210** may be connected or coupled to the first supporting surface **233***a* by using the coupling member **220**.

[0154] The vibration apparatus **10** may be configured to vibrate the vibration member **210**. The vibration apparatus **10** may be a piezoelectric-type vibration apparatus including a piezoelectric material.

[0155] The vibration apparatus **10** may be disposed or configured at any one of a first surface (or a front surface or an upper surface) and a second surface (or a rear surface or a lower surface) opposite to the first surface of the vibration member **210**. For example, the vibration apparatus **10** may be disposed or configured at the second surface of the vibration member **210**, but embodiments of the present disclosure are not limited thereto. For example, the vibration apparatus **10** may be disposed or configured at each of the first surface and the second surface of the vibration member **210**. For example, the vibration apparatus **10** may be disposed or configured at one or more of the first surface and the second surface of the vibration member **210**.

[0156] The vibration apparatus **10** may be connected or coupled to the vibration member **110** by a connection member **215**. For example, the vibration apparatus **10** may be connected or coupled to one or more of the first surface and the second surface of the vibration member **210** by using the connection member **215**. Accordingly, the vibration member **210** may vibrate based on a vibration (or displacement) of the vibration apparatus **10** to generate one or more of a vibration and a sound. For example, the vibration apparatus **10** may generate one or more of a vibration and a sound using the vibration member **210** as a vibration plate.

[0157] The driving circuit part **100** may be electrically connected to the vibration apparatus **10** through a signal supply member **17**. The driving circuit part **100** may be configured to apply the piezoelectric driving signal to the vibration apparatus **10** through the signal supply member **17**. The driving circuit part **100** may include the sound driving circuit **101** described above with reference to FIGS. **1** to **5**, and thus, its repeated descriptions are omitted.

[0158] The vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal applied through the signal supply member **17** from the sound driving circuit **101** to vibrate the vibration member **210**. Accordingly, the vibration apparatus **10** may prevent an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region), and may improve the dip phenomenon in the first pitched sound band and the peak phenomenon in the second pitched sound band, thereby enhancing a sound characteristic and/or a sound pressure level characteristic.

[0159] The driving circuit part **100** according to an embodiment of the present disclosure may further include a signal cable **103** and a connector **105**.

[0160] The signal cable **103** may be electrically connected to a printed circuit board (PCB) **102** of the driving circuit part **100**.

[0161] The connector **105** may be disposed or configured at the supporting member **230** and may be configured to be electrically connected to the signal cable **103**. A portion of the connector **105** may pass through the sidewall part **233** of the supporting member **230** and may be accommodated into the internal space **230S**. For example, the connector **105** may be inserted (or accommodated) into a portion of the sidewall part **233** of the supporting member **230**. For example, the supporting member **230** may further include a connector inserting hole (or a connector accommodating hole) **233***h* which is provided at the sidewall part **233** so that a portion (or an inner side portion) of the connector **105** is inserted (or accommodated) therein. For example, a waterproof member (or waterproof adhesive or waterproof tape) may be disposed or interposed between the connector inserting hole and the connector **105**.

[0162] The sound apparatus **200** according to another embodiment of the present disclosure may further include a cover **250**.

[0163] The cover **250** may be configured to cover the vibration member **210**. The cover **250** may be configured to protect the vibration member **210** and the vibration apparatus **10**. For example, the cover **250** may be supported by the supporting member **230** to cover the first surface of the vibration member **210**. For example, the cover **250** may be supported by the supporting member **230** to be spaced apart from the first surface of the vibration member **210**. For example, the cover **250** may be supported by the supporting member **230** with a gap space GS therebetween.

[0164] The sidewall part **233** according to an embodiment of the present disclosure may include a second supporting surface **233***b*. The second supporting surface **233***b* may be configured to support a periphery portion of the cover **250**. For example, the second supporting surface **233***b* may be formed concavely from an inner side surface and an uppermost surface of the sidewall part **233**. The second supporting surface **233***b* may be between the uppermost surface of the sidewall part **233** and the first supporting surface **233***a*.

[0165] The supporting member **230** according to an embodiment of the present disclosure may further include a protrusion part **233***c*. For example, the protrusion part **233***c* may protrude from an upper outer surface of the sidewall part **233** to have a predetermined width.

[0166] The cover **250** according to an embodiment of the present disclosure may be detachably coupled to the sidewall part **233** of the supporting member **230** by a hook coupling scheme, but embodiments of the present disclosure are not limited thereto. For example, the cover **250** according to another embodiment of the present disclosure may be attached to the second supporting surface **233***b* of the supporting member **230** by using an attachment member.

[0167] The cover **250** according to an embodiment of the present disclosure may include a sound emission part (or a sound emission port) **251**. The sound emission part **251** may be formed to vertically pass through the cover **250** along a thickness direction Z of the cover **250**. Accordingly, a sound (or sound wave) S generated by a vibration (or displacement) of the vibration member **210** based on a vibration (or displacement) of the vibration apparatus **10** may be output to an outside through the sound emission part **251** of the cover **250**.

[0168] The sound emission part **251** according to an embodiment of the present disclosure may include one or more holes formed to overlap (or correspond to) a center of the vibration apparatus **10**. The sound emission part **251** according to another embodiment of the present disclosure may include one or more holes based on a mesh structure or a radial mesh structure.

[0169] FIG. **9** is a cross-sectional view illustrating an apparatus according to an embodiment of the present disclosure.

[0170] With reference to FIG. **9**, an apparatus according to an embodiment of the present disclosure may be an apparatus for outputting a sound. For example, the apparatus according to an embodiment of the present disclosure may be an apparatus for outputting one or more of a sound and a vibration. For example, the apparatus according to an embodiment of the present disclosure may implement or realize a display apparatus, a sound apparatus, a sound output apparatus, a vibration apparatus, a vibration generating apparatus, a sound bar, a sound system, a sound apparatus for electronic apparatuses, a sound apparatus for displays, a sound apparatus for vehicular apparatuses, or a sound bar for vehicular apparatuses, or the like. For example, a vehicular apparatus may include one or more seats and one or more glass windows. For example, the vehicular apparatus may include a vehicle, a train, a ship, or an aircraft, but embodiments of the present disclosure are not limited thereto. In addition, the apparatus according to an embodiment of the present disclosure may implement or realize an analog signage or a digital signage, or the like such as an advertising signboard, a poster, or a noticeboard, or the like.

[0171] The apparatus according to an embodiment of the present disclosure may include a passive vibration member **300**, a vibration apparatus **10**, and a driving circuit part **100**.

[0172] The passive vibration member **300** may vibrate based on a vibration (or displacement) of the vibration apparatus **10**. For example, the passive vibration member **300** may generate one or more of a vibration and a sound based on driving of the vibration apparatus **10**.

[0173] The passive vibration member **300** according to an embodiment of the present disclosure may be a display panel including a display area (or a screen) having a plurality of pixels which implement a black/white or color image. Thus, the passive vibration member **300** may generate one or more of a vibration and a sound based on driving of the vibration apparatus **10**. For example, the passive vibration member **300** may vibrate based on vibration of the vibration apparatus **10** while a display area is displaying an image, and thus, may generate or output a sound synchronized with the image displayed on the display area. For example, the passive vibration member **300** may be a vibration object, a display member, a display panel, a signage panel, a vibration plate, a passive vibration plate, a front cover, a front member, a vibration panel, a sound panel, a passive vibration panel, a sound output plate, a sound vibration plate, or an image screen, or the like, but embodiments of the present disclosure are not limited thereto.

[0174] The passive vibration member **300** according to another embodiment of the present disclosure may be configured with a material having a material characteristic suitable for being vibrated by the vibration apparatus **10** to output a sound. The passive vibration member **300** may include a metal material or a nonmetal material (or a composite nonmetal material), but embodiments of the present disclosure are not limited thereto. For example, the passive vibration member **300** may include one or more materials of metal, plastic, paper, wood, fiber, cloth, leather, glass, carbon, and a mirror, but embodiments of the present disclosure are not limited thereto. For example, the paper may be cone paper for speakers. For example, the cone paper may be pulp or foamed plastic, or the like, but embodiments of the present disclosure are not limited thereto.

[0175] The passive vibration member **300** according to another embodiment of the present disclosure may include a display panel including a pixel displaying an image, or may include a non-display panel. For example, the passive vibration member **300** may include one or more of a display panel including a pixel displaying an image, a screen panel on which an image is projected from a display apparatus, a lighting panel, a signage panel, a vehicular interior material, a vehicular exterior material, a vehicular glass window, a vehicular seat interior material, a vehicular ceiling material, a building ceiling material, a building interior material, a building glass window, an aircraft interior material, an aircraft glass window, and a mirror, but embodiments of the present disclosure are not limited thereto. For example, the non-display panel may be a light-emitting diode lighting panel (or apparatus), an organic light-emitting lighting panel (or apparatus), an inorganic light-emitting lighting panel (or apparatus), a mini light-emitting diode panel (or apparatus), or a micro light-emitting diode panel (or apparatus), but embodiments of the present disclosure are not limited thereto.

[0176] The vibration apparatus **10** may be configured to vibrate the passive vibration member **300**. The vibration apparatus **10** may be a piezoelectric-type vibration apparatus including a piezoelectric material. For example, the vibration apparatus **10** may be configured to be transparent, semitransparent, or opaque.

[0177] The vibration apparatus **10** may be connected or coupled to the passive vibration member **300** by a connection member **350**. For example, the vibration apparatus **10** may be connected to a rear surface of the passive vibration member **300** by using the connection member **350**. Accordingly, the passive vibration member **300** may vibrate based on a vibration (or displacement) of the vibration apparatus **10** to generate one or more of a vibration and a sound. For example, the vibration apparatus **10** may generate one or more of a vibration and a sound using the passive vibration member **300** as a vibration plate.

[0178] The driving circuit part **100** may be electrically connected to the vibration apparatus **10** through a signal supply member **17**. The driving circuit part **100** may be configured to apply the piezoelectric driving signal to the vibration apparatus **10** through the signal supply member **17**. The driving circuit part **100** may include the sound driving circuit **101** described above with reference to FIGS. **1** to **5**, and thus, its repeated descriptions are omitted.

[0179] The vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal applied through the signal supply member **17** from the sound driving circuit **101** to vibrate the passive vibration member **300**. Accordingly, the vibration apparatus **10** may prevent an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region), and may improve the dip phenomenon in the first pitched sound band and the peak phenomenon in the second pitched sound band, thereby enhancing a sound characteristic and/or a sound pressure level characteristic.

[0180] FIG. **10** is a cross-sectional view illustrating a vehicular apparatus according to an embodiment of the present disclosure.

[0181] With reference to FIG. **10**, a vehicular apparatus **400** according to an embodiment of the present disclosure may be a vehicular apparatus which includes one or more seats and one or more windows. For example, the vehicular apparatus **400** may include a vehicle, a train, a ship, or an aircraft, or the like, but embodiments of the present disclosure are not limited thereto.

[0182] The vehicular apparatus **400** may include a main structure **410**, an exterior material **420**, and an interior material **430**.

[0183] The main structure **410** may be a vehicle body, a vehicle structure, or a frame structure, or the like, but embodiments of the present disclosure are not limited thereto. For example, the main structure **410** may include a main frame, a sub-frame, a side frame, a door frame, an under-frame, and a seat frame, or the like, but embodiments of the present disclosure are not limited thereto.

[0184] The exterior material **420** may be configured to cover the main structure **410**. For example, the exterior material **420** may be configured to cover an outer portion of the main structure **410**. In the following description, the exterior material **420** may be a vehicle exterior material **420**, and may be used interchangeably. For example, the vehicle exterior material **420** may include at least one or more of a hood panel, a front fender panel, a dash panel, a pillar panel, a trunk panel, a roof panel (or ceiling), a floor panel, a door panel, a door inner panel, and a door outer panel, a front bumper, a rear bumper, a spoiler, a headlight, a taillight, a fog light, and a vehicle body bottom, but embodiments of the present disclosure are not limited thereto.

[0185] The vehicle exterior material **420** according to an embodiment of the present disclosure may include at least one or more of a planar portion (or a flat portion) and a curved portion (or a flexural portion or an uneven portion). For example, the vehicle exterior material **420** may have a structure corresponding to a structure of a corresponding main structure **410**, or may have a structure which differs from a structure of a corresponding main structure **410**.

[0186] In the following description, the interior material **430** may be a vehicle interior material **430**, and may be used interchangeably. The vehicle interior material **430** may include all elements (or components) configuring an inner portion of the vehicular apparatus **400**, or may include all elements disposed at an interior space (or an indoor space) IS of the vehicular apparatus **400**. For example, the vehicle interior material **430** may be an interior member or an interior finish material of the vehicular apparatus **400**, but embodiments of the present disclosure are not limited thereto.

[0187] The vehicle interior material **430** according to an embodiment of the present disclosure may be configured to cover one or more of main structure **410** and the vehicle exterior material **420** in the interior space IS. For example, the vehicle interior material **430** may cover one or more of main structure **410** and the vehicle exterior material **420** in the interior space IS of the vehicular apparatus **400** and may be configured to be exposed at the interior space IS of the vehicular apparatus **400**.

[0188] The vehicle interior material **430** according to an embodiment of the present disclosure may be configured to be exposed at the inner portion and/or the interior space IS of the vehicular apparatus **400**. For example, the vehicle interior material **430** may be configured to cover one surface (or an interior surface) of one or more of a main frame (or a vehicle body), a side frame (or a side body), a door frame (or a door body), a handle frame (or a steering hub), and a seat frame, which are exposed at the interior space IS of the vehicular apparatus **400**.

[0189] The vehicle interior material **430** according to an embodiment of the present disclosure may include a dashboard, a pillar interior material (or a pillar trim), a floor interior material (or a floor carpet), a roof interior material (or a headliner), a door interior material (or a door trim), a handle interior material (or a steering cover), a seat interior material, a rear package interior material (or a back seat shelf), an overhead console (or an illumination interior material), a rear view mirror, a glove box, and a sun visor, or the like, but embodiments of the present disclosure are not limited thereto.

[0190] The vehicle interior material **430** according to an embodiment of the present disclosure may include one or more of metal, wood, rubber, plastic, glass, fiber, cloth, paper, a mirror, leather, and carbon, but embodiments of the present disclosure are not limited thereto. The vehicle interior material **430** including a plastic material may be an injection material which is implemented by an injection process using a thermoplastic resin or a thermosetting resin, but embodiments of the present disclosure are not limited thereto. The vehicle interior material **430** including a fiber material may include at least one or more of a plastic composite fiber, a carbon fiber (or an aramid fiber), and a natural fiber, but embodiments of the present disclosure are not limited thereto. The vehicle interior material **430** including the cloth material may include a textile sheet, a knit sheet, or a nonwoven fabric, or the like, but embodiments of the present disclosure are not limited thereto. For example, the paper may be cone paper for speakers. For example, the cone paper may be pulp or foamed plastic, or the like, but embodiments of the present disclosure are not limited thereto. The vehicle interior material **430** including a leather material may include natural leather or artificial leather, but embodiments of the present disclosure are not limited thereto.

[0191] The vehicle interior material **430** according to an embodiment of the present disclosure may include at least one or more of a planar portion (or a flat portion) and a curved portion (or a flexural portion or an uneven portion). For example, the vehicle interior material **430** may have a structure corresponding to a structure (or an inner surface structure) of a corresponding main structure **410**, or may have a structure which differs from a structure of a corresponding main structure **410**.

[0192] The vehicular apparatus **400** according to an embodiment of the present disclosure may include one or more sound generating apparatuses **450**.

[0193] The one or more sound generating apparatuses **450** may be configured to output a sound from one or more of a region between the vehicle exterior material **420** and the vehicle interior material **430**, the vehicle exterior material **420** and the vehicle interior material **430**.

[0194] According to an embodiment of the present disclosure, the one or more sound generating apparatuses **450** may be disposed at the vehicle interior material **430**. The one or more sound generating apparatuses **450** may vibrate (or directly vibrate) the vehicle interior material **430** to generate a sound S based on a vibration of the vehicle interior material **430**. For example, the one or more sound generating apparatuses **450** may be configured to vibrate the vehicle interior material **430** to output the sound S toward the inner portion and/or the interior space IS of the vehicular apparatus **400**. Thus, the one or more sound generating apparatuses **450** may use the vehicle interior material **430** as a sound vibration plate. The vehicle interior material **430** may be a vibration plate, a sound vibration plate, or a sound generating plate for outputting the sound S, but embodiments of the present disclosure are not limited thereto. For example, the vehicle interior material **430** may have a size which is greater than that of the one or more sound generating apparatuses **450**, but embodiments of the present disclosure are not limited thereto.

[0195] According to an embodiment of the present disclosure, the one or more sound generating apparatuses **450** may be disposed in at least one or more of a dashboard, a pillar interior material, a floor interior material, a roof interior material, a door interior material, a handle interior material, and a seat interior material, or may be disposed in or connected to (or coupled to) at least one or more of a rear package interior material, an overhead console, a rear view mirror, a glove box, and a sun visor. For example, the one or more sound generating apparatuses **450** may vibrate (or directly vibrate) at least one or more of the dashboard, the pillar interior material, the floor interior material, the roof interior material, the door interior material, the handle interior material, the seat interior material, the rear package interior material, the overhead console, the rear view mirror, the glove box, and the sun visor to output the sound S toward the inner portion and/or the interior space IS of the vehicular apparatus **400**.

[0196] According to an embodiment of the present disclosure, the one or more sound generating apparatuses **450** may be disposed in or connected to at least one or more regions (or portions) of the vehicle interior material **430**. The one or more sound generating apparatuses **450** may vibrate the at least one or more regions (or portions) of the vehicle interior material **430** to output a realistic sound S and/or stereo sound including a multichannel toward the interior space IS of the vehicular apparatus **400**.

[0197] According to an embodiment of the present disclosure, the one or more sound generating apparatuses **450** may be disposed in one or more of a region between the vehicle interior material **430** and the main structure **410** and a region between the vehicle interior material **430** and the vehicle exterior material **420**, and may be configured to output a sound S.

[0198] According to an embodiment of the present disclosure, the one or more sound generating apparatuses **450** may be disposed in one or more of the region between the vehicle interior material **430** and the main structure **410** and the region between the vehicle interior material **430** and the vehicle exterior material **420**, and may indirectly or directly vibrate one or more of the main structure **410**, the vehicle exterior material **420**, and the vehicle interior material **430** to output a sound S. For example, one or more of the main structure **410**, the vehicle exterior material **420**, and the vehicle interior material **430** may output a sound S based on driving (or vibration or displacement) of the one or more sound generating apparatuses **450**.

[0199] According to an embodiment of the present disclosure, the one or more sound generating apparatuses **450** may be disposed in one or more of a region (or a first region) between the main structure **410** and the vehicle exterior material **420**, a region (or a second region) between the main structure **410** and the vehicle interior material **430**, the vehicle exterior material **420**, and the vehicle interior material **430**, and may be configured to output a sound. For example, the one or more sound generating apparatuses **450** may be disposed in one or more of the region (or first region) between the main structure **410** and the vehicle exterior material **420**, the region (or second region) between the main structure **410** and the vehicle interior material **430**, the vehicle exterior material **420**, and the vehicle interior material **430**, and may indirectly or directly vibrate one or more of the main structure **410**, the vehicle exterior material **420**, and the vehicle interior material **430** to output a sound.

[0200] According to an embodiment of the present disclosure, one or more of the vehicle exterior material **420** and the vehicle interior material **430** of the vehicular apparatus **400** may be a vibration plate, a sound vibration plate, or a sound generating plate, for outputting the sound S. For example, each of the vehicle exterior material **420** and the vehicle interior material **430** for outputting the sound S may have a size (or an area) which is greater than that of the one or more sound generating apparatuses **450**, and thus, may perform a function of a large-area vibration plate, a large-area sound vibration plate, or a large-area sound generating plate, thereby enhancing a sound characteristic and/or a sound pressure level characteristic of a pitched sound band including a low-pitched sound band generated by the sound generating apparatus **450**. For example, a frequency of a sound of the low-pitched sound band may be 300 Hz or less, 400 Hz or less, or 500 Hz or less, but embodiments of the present disclosure are not limited thereto.

[0201] The one or more sound generating apparatuses **450** according to an embodiment of the present disclosure may include a vibration apparatus **10** and a driving circuit part **100**.

[0202] The vibration apparatus **10** may be a piezoelectric-type vibration apparatus including a piezoelectric material.

[0203] The vibration apparatus **10** according to an embodiment of the present disclosure may be disposed in one or more of a region between the vehicle interior material **430** and the main structure **410** and a region between the vehicle interior material **430** and the vehicle exterior material **420**, and may be configured to output a sound.

[0204] The vibration apparatus **10** according to another embodiment of the present disclosure may be disposed in one or more of the region between the vehicle interior material **430** and the main structure **410** and the region between the vehicle interior material **430** and the vehicle exterior material **420**, and may indirectly or directly vibrate one or more of the main structure **410**, the vehicle exterior material **420**, and the vehicle interior material **430** to output a sound S.

[0205] The vibration apparatus **10** according to another embodiment of the present disclosure may be disposed in one or more of the region (or first region) between the main structure **410** and the vehicle exterior material **420**, the region (or second region) between the main structure **410** and the vehicle interior material **430**, the vehicle exterior material **420**, and the vehicle interior material **430**, and may indirectly or directly vibrate one or more of the main structure **410**, the vehicle exterior material **420**, and the vehicle interior material **430** to output a sound.

[0206] The vibration apparatus **10** according to another embodiment of the present disclosure may be connected or coupled to one or more of the main structure **410**, the vehicle exterior material **420**, and the vehicle interior material **430** by using a connection member. Accordingly, one or more of the main structure **410**, the vehicle exterior material **420**, and the vehicle interior material **430** may vibrate based on a vibration (or displacement) of the vibration apparatus **10** to generate (or output) one or more of a vibration and a sound.

[0207] The driving circuit part **100** may be electrically connected to the vibration apparatus **10** through a signal supply member **17**. The driving circuit part **100** may be configured to apply the piezoelectric driving signal to the vibration apparatus **10** through the signal supply member **17**. The driving circuit part **100** may include the sound driving circuit **101** described above with reference to FIGS. **1** to **5**, and thus, its repeated descriptions are omitted.

[0208] The vibration apparatus **10** may vibrate (or displace) based on the piezoelectric driving signal applied through the signal supply member **17** from the sound driving circuit **101** to vibrate one or more of the vehicle exterior material **420** and the vehicle interior material **430**. Accordingly, the vibration apparatus **10** may prevent an overcurrent phenomenon and a clipping phenomenon occurring in the high-pitched sound band (or high frequency region), and may improve the dip phenomenon in the first pitched sound band and the peak phenomenon in the second pitched sound band, thereby enhancing a sound characteristic and/or a sound pressure level characteristic.

[0209] The vehicular apparatus **400** according to an embodiment of the present disclosure may further include a woofer speaker which is disposed in at least one or more of the dashboard, the door frame, and the rear package interior material.

[0210] The woofer speaker according to an embodiment of the present disclosure may include one or more of a woofer, a mid-woofer, and a sub-woofer, but embodiments of the present disclosure are not limited thereto. For example, the woofer speaker may be a speaker which outputs a sound of about 60 Hz to about 150 Hz, but embodiments of the present disclosure are not limited thereto. Therefore, the woofer speaker may output a sound of about 60 Hz to about 150 Hz, and thus, may enhance a low-pitched sound band characteristic of a sound which is output to an interior space.

[0211] The woofer speaker may drive (or vibrate) based on the actuator driving signal applied through the signal supply member **17** from the sound driving circuit **101** of the driving circuit part **100** in the sound apparatus described above with reference to FIGS. **4** and **5**, to generate (or output) a sound.

[0212] According to an embodiment of the present disclosure, when the vehicular apparatus **400** includes the vibration apparatus **10** and one or more woofer speakers, the sound driving circuit **101** of the driving circuit part **100** may drive (or vibrate) the vibration apparatus **10** and the one or more woofer speakers, respectively, but embodiments of the present disclosure are not limited thereto.

[0213] FIG. **11** is a perspective view illustrating a vehicular apparatus according to another embodiment of the present disclosure. FIG. **12** is a cross-sectional view taken along line II-II' illustrated in FIG. **11** according to an embodiment of the present disclosure.

[0214] With reference to FIGS. **11** and **12**, a vehicular apparatus **400** according to another embodiment of the present disclosure may include a vehicle interior material **430** and one or more sound generating apparatuses **450**.

[0215] The vehicle interior material **430** may include all elements (or components) configuring an inner portion of the vehicular apparatus **400**, or may include all elements disposed at an interior space IS of the vehicular apparatus **400**. The vehicle interior material **430** may be a same or substantially a same as the vehicle interior material **430** described above with reference to FIG. **10**, and thus, its repeated descriptions are omitted. For example, the vehicle interior material **430** may be a roof interior material (or a headliner), but embodiments of the present disclosure are not limited thereto.

[0216] The one or more sound generating apparatuses **450** may be disposed or mounted on the vehicle interior material **430**.

[0217] The one or more sound generating apparatuses **450** may include the sound apparatus **200** described above with reference to FIGS. **6** to **8**, and thus, its repeated descriptions may be omitted or will be briefly given below.

[0218] The sound apparatus **200** may be accommodated into a hole **433*h*** provided in the vehicle interior material **430**. For example, the supporting member **230** of the sound apparatus **200** may be accommodated (or inserted) into the hole **433*h*** of the vehicle interior material **430** in the interior space IS of the vehicular apparatus **400**. For example, the protrusion part **233*c*** of the supporting member **230** may be in contact with an interior surface **430*i*** of the vehicle interior material **430**.

[0219] The vibration apparatus **10** of the sound apparatus **200** may vibrate (or displace or drive) based on the piezoelectric driving signal applied through the signal supply member **17** from the sound driving circuit **101** of the driving circuit part **100** to output a sound S toward the interior space IS of the vehicular apparatus **400**.

[0220] FIG. **13** is a perspective view illustrating a vibration apparatus according to an embodiment of the present disclosure. FIG. **14** is a cross-sectional view taken along line III-III' illustrated in FIG. **13** according to an embodiment of the present disclosure. FIG. **15** is a cross-sectional view taken along line IV-IV' illustrated in FIG. **13** according to an embodiment of the present disclosure. In particular, FIGS. **13** to **15** illustrate the vibration apparatus described above with reference to FIGS. **1** to **12**.

[0221] With reference to FIGS. **13** to **15**, the vibration apparatus **10** according to an embodiment of the present disclosure may include a piezoelectric material having a piezoelectric characteristic.

[0222] The vibration apparatus **10** may be configured as a ceramic-based piezoelectric material for implementing a relatively strong vibration, or may be configured as a piezoelectric ceramic having a perovskite-based crystal structure.

[0223] The vibration apparatus **10** according to an embodiment of the present disclosure may include a vibration part **11**.

[0224] The vibration part **11** may be configured to vibrate by a piezoelectric effect based on a piezoelectric driving signal. The vibration part **11** may include at least one or more of a piezoelectric inorganic material and a piezoelectric organic material. For example, the vibration part **11** may be a vibration device, a piezoelectric device layer, a piezoelectric structure, a piezoelectric vibration part, or a piezoelectric vibration layer, or the like, but embodiments of the present disclosure are not limited thereto.

[0225] The vibration part **11** according to an embodiment of the present disclosure may include a vibration layer **11***a*, a first electrode layer **11***b*, and a second electrode layer **11***c*.

[0226] The vibration layer **11***a* may include a piezoelectric material or an electroactive material which has a piezoelectric effect. For example, the piezoelectric material may have a characteristic in which, when pressure or twisting phenomenon is applied to a crystalline structure by an external force, a potential difference occurs due to dielectric polarization caused by a relative position change of a positive (+) ion and a negative (−) ion, and a vibration is generated by an electric field based on a reverse voltage applied thereto. For example, the vibration layer **11***a* may be a piezoelectric layer, a piezoelectric material layer, an electroactive layer, a piezoelectric composite layer, a piezoelectric composite, or a piezoelectric ceramic composite, or the like, but embodiments of the present disclosure are not limited thereto.

[0227] The vibration layer **11***a* may be configured as a ceramic-based material for implementing a relatively strong vibration, or may be configured as a piezoelectric ceramic having a perovskite-based crystalline structure. The perovskite crystalline structure may have a piezoelectric effect and/or an inverse piezoelectric effect and may be a plate-shaped structure having orientation.

[0228] The piezoelectric ceramic may be configured as a single crystalline ceramic having a single crystalline structure, or may be configured as a ceramic material or polycrystalline ceramic having a polycrystalline structure. A piezoelectric material including the single crystalline ceramic may include α-$AlPO_4$, α-SiO_2, $LiNbO_3$, $Tb_2(MoO_4)_3$, $Li_2B_4O_7$, or ZnO, but embodiments of the present disclosure are not limited thereto. A piezoelectric material including the polycrystalline ceramic may include a lead zirconate titanate (PZT)-based material, including lead (Pb), zirconium (Zr), and titanium (Ti), or may include a lead zirconate nickel niobate (PZNN)-based material, including lead (Pb), zirconium (Zr), nickel (Ni), and niobium (Nb), but embodiments of the present disclosure are not limited thereto. For example, the vibration layer **11***a* may include at least one or more of calcium titanate ($CaTiO_3$), barium titanate ($BaTiO_3$), and strontium titanate ($SrTiO_3$), without lead (Pb), but embodiments of the present disclosure are not limited thereto.

[0229] The first electrode layer **11***b* may be disposed at a first surface (or an upper surface or a front surface) **11***s***1** of the vibration layer **11***a*. The first electrode layer **11***b* may have a same size as that of the vibration layer **11***a*, or may have a size which is smaller than that of the vibration layer **11***a*. For example, the first electrode layer **11***b* may have a same shape as that of the vibration layer **11***a*, but embodiments of the present disclosure are not limited thereto.

[0230] The second electrode layer **11***c* may be disposed at a second surface (or a lower surface or a rear surface) **11***s***2** which is opposite to or different from the first surface **11***s***1** of the vibration layer **11***a*. The second electrode layer **11***c* may have a same size as that of the vibration layer **11***a*, or may have a size which is smaller than that of the vibration layer **11***a*. For example, the second electrode layer **11***c* may have a same shape as that of the vibration layer **11***a*, but embodiments of the present disclosure are not limited thereto.

[0231] According to an embodiment of the present disclosure, one or more of the first electrode layer **11***b* and the second electrode layer **11***c* may be formed of a transparent conductive material, a semitransparent conductive material, or an opaque conductive material. For example, the transparent conductive material or the semitransparent conductive material may include indium tin oxide (ITO) or indium zinc oxide (IZO), but embodiments of the present disclosure are not limited thereto. The opaque conductive material may include gold (Au), silver (Ag), platinum (Pt), palladium (Pd), molybdenum (Mo), magnesium (Mg), carbon, or silver (Ag) including glass frit, or the like, or may be formed of an alloy thereof, but embodiments of the present disclosure are not limited thereto. Additionally, to enhance an electrical characteristic and/or a vibration characteristic of the vibration layer **11***a*, each of the first electrode layer **11***b* and the second electrode layer **11***c* may include silver (Ag) having a low resistivity. In addition, carbon may be carbon black, ketjen black, carbon nanotube, and a carbon material including graphite, but embodiments of the present disclosure are not limited thereto.

[0232] The vibration layer **11***a* may be polarized (or poling) by a certain voltage applied to the first electrode layer **11***b* and the second electrode layer **11***c* in a certain temperature atmosphere, or a temperature atmosphere that may be changed from a high temperature to a room temperature, but embodiments of the present disclosure are not limited thereto. For example, a polarization direction (or a poling direction) formed in the vibration layer **11***a* may be formed or aligned (or arranged) from the first electrode layer **11***b* to the second electrode layer **11***c*, but is not limited thereto, and a polarization direction (or a poling direction) formed in the vibration layer **11***a* may be formed or aligned (or arranged) from the second electrode layer **11***c* to the first electrode layer **11***b*.

[0233] The vibration layer **11***a* may alternately and repeatedly contract and/or expand based on an inverse piezoelectric effect according to a piezoelectric driving signal applied to the first electrode layer **11***b* and the second electrode layer **11***c* from an outside to vibrate. For example, the vibration layer **11***a* may vibrate in a vertical direction (or a thickness direction) and in a planar direction by the piezoelectric driving signal applied to the first electrode layer **11***b* and the second electrode layer **11***c*. The vibration layer **11***a* may be displaced (or vibrated or driven) by contraction and/or expansion of the planar direction, thereby improving a sound characteristic and/or a sound pressure level characteristic of the vibration apparatus **10**.

[0234] The vibration apparatus **10** according to an embodiment of the present disclosure may further include a cover member **13**.

[0235] The cover member **13** may be configured to cover at least one or more of a first surface and a second surface of the vibration part **11**. The cover member **13** may be configured to protect at least one or more of the first surface and the second surface of the vibration part **11**. For example, the first surface of the vibration part **11** may be a front surface or an upper surface. For example, the second surface of the vibration part **11** may be a rear surface or a lower surface which are opposite to the first surface.

[0236] The cover member **13** according to an embodiment of the present disclosure may include a first cover member **13***a*.

[0237] The first cover member **13***a* may be disposed at the first surface of the vibration part **11**. For example, the first cover member **13***a* may be configured to cover the first electrode layer **11***b* of the vibration part **11**. For example, the first cover member **13***a* may be configured to have a larger size than the vibration part **11**. The first cover member **13***a* may be configured to protect the first surface of the vibration part **11** and the first electrode layer **11***b*.

[0238] The first cover member **13***a* according to an embodiment of the present disclosure may include an adhesive layer. For example, the first cover member **13***a* may include a base film, and an adhesive layer which is in the base film and is connected or coupled to the first surface of the vibration part **11**. For example, the adhesive layer may include an electrical insulating material which has adhesive properties and is capable of compression and decompression, but embodiments of the present disclosure are not limited thereto.

[0239] The first cover member **13***a* according to another embodiment of the present disclosure may be connected or coupled to the first surface of the vibration part **11** by a first adhesive layer **13***b*. For example, the first cover member **13***a* may be connected or coupled to the first surface or the first electrode layer **11***b* of the vibration part **11** by the first adhesive layer **13***b*. For example, the first cover member **13***a* may be connected or coupled to the first surface or the first electrode layer **11***b* of the vibration part **11** by a film laminating process by the first adhesive layer **13***b*. The first adhesive layer **13***b* may be configured to surround an entire first surface or a portion of a lateral surface of the vibration part **11**.

[0240] The cover member **13** according to an embodiment of the present disclosure may include a second adhesive layer **13***c*.

[0241] The second adhesive layer **13***c* may be disposed at the second surface of the vibration part **11**. For example, the second adhesive layer **13***c* may be configured to cover the second electrode layer **11***c* of the vibration part **11**. The second adhesive layer **13***c* may be configured to protect the second surface and the second electrode layer **11***c* of the vibration part **11**. The second adhesive layer **13***c* may be configured to surround an entire second surface or a portion of a lateral surface of the vibration part **11**. For example, the second adhesive layer **13***c* may be a protection layer or a protection member, but embodiments of the present disclosure are not limited thereto.

[0242] The second adhesive layer **13***c* may be connected or coupled to the first adhesive layer **13***b* in the lateral surface of the vibration part **11** or a periphery portion of the first cover member **13***a*. Thus, the first adhesive layer **13***b* and the second adhesive layer **13***c* may be configured to surround or completely surround the vibration part **11**. The first adhesive layer **13***b* and the second adhesive layer **13***c* may be configured to cover or surround all surfaces of the vibration part **11**. For example, the vibration part **11** may be inserted (or accommodated) or embedded (or built-in) at an inner portion of the adhesive layer including the first adhesive layer **13***b* and the second adhesive layer **13***c*.

[0243] The cover member **13** according to an embodiment of the present disclosure may further include a second cover member **13***d*, but embodiments of the present disclosure are not limited thereto.

[0244] The second cover member **13***d* may be disposed at the second surface of the vibration part **11**. For example, the second cover member **13***d* may be configured to cover the second electrode layer **11***c* of the vibration part **11**. For example, the second cover member **13***d* may be configured to have a larger size than the vibration part **11** and may be configured to have a same size as the first cover member **13***a*, but embodiments of the present disclosure are not limited thereto. The second cover member **13***d* may be configured to protect the second surface and the second electrode layer **11***c* of the vibration part **11**.

[0245] The first cover member **13***a* and the second cover member **13***d* according to an embodiment of the present disclosure may include a same material or a different material. For example, each of the first cover member **13***a* and the second cover member **13***d* may be a polyimide film, a polyethylene naphthalate film, or a polyethylene terephthalate film, but embodiments of the present disclosure are not limited thereto.

[0246] The second cover member **13***d* may be connected or coupled to the second surface or the second electrode layer **11***c* of the vibration part **11** by using the second adhesive layer **13***c*. For example, the second cover member **13***d* may be connected or coupled to the second surface or the second electrode layer **11***c* of the vibration part **11** by a film laminating process by the second adhesive layer **13***c*.

[0247] The vibration part **11** may be disposed or inserted (or accommodated) between the first cover member **13***a* and the second cover member **13***d*. For example, the vibration part **11** may be inserted (or accommodated) or embedded (or built-in) at an inner portion of the adhesive layer including the first adhesive layer **13***b* and the second adhesive layer **13***c*, but embodiments of the present disclosure are not limited thereto.

[0248] Each of the first adhesive layer **13***b* and the second adhesive layer **13***c* according to an embodiment of the present disclosure may include an electrical insulating material which has adhesive properties and is capable of compression and decompression. For example, each of the first adhesive layer **13***b* and the second adhesive layer **13***c* may include epoxy resin, acrylic resin, silicone resin, urethane resin, a pressure sensitive adhesive (PSA), an optically cleared adhesive (OCA), or an optically cleared resin (OCR), or the like, but embodiments of the present disclosure are not limited thereto.

[0249] The first adhesive layer **13***b* and the second adhesive layer **13***c* may be configured between the first cover member **13***a* and the second cover member **13***d* to surround the vibration part **11**. For example, one or more of the first adhesive layer **13***b* and the second adhesive layer **13***c* may be configured to surround the vibration part **11**.

[0250] The vibration apparatus **10** according to an embodiment of the present disclosure may further include a signal supply member **17**.

[0251] The signal supply member **17** may be configured to supply a piezoelectric driving signal supplied from a driving circuit part to the vibration part **11**. The signal supply member **17** may be configured to be electrically connected to the vibration part **11**. The signal supply member **17** may be configured to be electrically connected to the first electrode layer **11***b* and the second electrode layer **11***c* of the vibration part **11**.

[0252] A portion of the signal supply member **17** may be accommodated (or inserted) between the cover member **13** and the vibration part **11**. For example, the portion of the signal supply member **17** may be accommodated (or inserted) between the first surface of the vibration part **11** and the first cover member **13***a*. For example, the portion of the signal supply member **17** may be accommodated (or inserted) between the first cover member **13***a* and the second cover member **13***d*.

[0253] According to an embodiment of the present disclosure, an end portion (or a distal end portion or one side) of the signal supply member **17** may be disposed or inserted (or accommodated) between one periphery portion of the cover member **13** and the vibration part **11**. For example, the end portion of the signal supply member **17** may be disposed or inserted (or accommodated) between one periphery portion of the first cover member **13***a* and the first surface of the vibration part **11**. For example, the signal supply member **17** may be configured as a signal cable, a flexible cable, a flexible printed circuit cable, a flexible flat cable, a single-sided flexible printed circuit, a single-sided flexible printed circuit board, a flexible multilayer printed circuit, or a flexible multilayer printed circuit board, but embodiments of the present disclosure are not limited thereto.

[0254] The signal supply member **17** according to an embodiment of the present disclosure may include a base member **17***a* and a plurality of signal lines **17***b* and **17***c*. For example, the signal supply member **17** may include a base member **17***a*, a first signal line **17***b*, and a second signal line **17***c*.

[0255] The base member **17***a* may include a transparent or opaque plastic material, but embodiments of the present disclosure are not limited thereto.

[0256] The first and second signal lines **17***b* and **17***c* may be disposed at a first surface of the base member **17***a* and may be spaced apart from each other or electrically separated from each other. The first and second signal lines **17***b* and **17***c* may be disposed in parallel to each other at the first surface of the base member **17***a*. For example, the first and second signal lines **17***b* and **17***c* may be implemented in a line shape by patterning of a metal layer (or a conductive layer) formed or deposited at the first surface of the base member **17***a*.

[0257] End portions (or distal end portions or one sides) of the first and second signal lines **17***b* and **17***c* may be separated from each other, and thus, may be individually curved or bent.

[0258] The end portion of the first signal line **17***b* may be electrically connected to the first electrode layer **11***b* of the vibration part **11**. For example, the end portion of the first signal line **17***b* may be electrically connected to at least a portion of the first electrode layer **11***b* of the vibration part **11** in the one periphery portion of the first cover member **13***a*. For example, the end portion of the first signal line **17***b* may be electrically and directly connected to at least a portion of the first electrode layer **11***b* of the vibration part **11**. For example, the end portion of the first signal line **17***b* may be electrically connected to or directly contact the first electrode layer **11***b* of the vibration part **11**. For example, the end portion of the first signal line **17***b* may be electrically connected to the first electrode layer **11***b* through a conductive double-sided tape. Accordingly, the first signal line **17***b* may be configured to supply a first piezoelectric driving signal component, supplied from the driving circuit part, to the first electrode layer **11***b* of the vibration part **11**.

[0259] The end portion of the second signal line **17***c* may be electrically connected to the second electrode layer **11***c* of the vibration part **11**. For example, the end portion of the second signal line **17***c* may be electrically connected to at least a portion of the second electrode layer **11***c* of the vibration part **11** in one periphery portion of the second cover member **13***d*. For example, the end portion of the second signal line **17***c* may be electrically and directly connected to at least a portion of the second electrode layer **11***c* of the vibration part **11**. For example, the end portion of the second signal line **17***c* may be electrically connected to or directly contact the second electrode layer **11***c* of the vibration part **11**. For example, the end portion of the second signal line **17***c* may be electrically connected to the second electrode layer **11***c* through a conductive double-sided tape. Accordingly, the second signal line **17***c* may be configured to supply a second piezoelectric driving signal component, supplied from the driving circuit part, to the second electrode layer **11***c* of the vibration part **11**. The first and second piezoelectric driving signal components constitutes the piezoelectric driving signal.

[0260] The signal supply member **17** according to an embodiment of the present disclosure may further include an insulation layer **17***d*.

[0261] The insulation layer **17***d* may be disposed at the first surface of the base member **17***a* to cover each of the first signal line **17***b* and the second signal line **17***c* other than the end portion (or one side) of the signal supply member **17**.

[0262] According to an embodiment of the present disclosure, an end portion (or one side) of the signal supply member **17** including an end portion (or one side) of the base member **17***a* and an end portion (or one side) of the insulation layer **17***d* may be inserted (or accommodated) between the cover member **13** and the vibration part **11** and may be fixed between the cover member **13** (or first cover member **13***a*) and the vibration part **11** by the first adhesive layer **13***b* and the second adhesive layer **13***c*.

[0263] According to another embodiment of the present disclosure, an end portion (or one side) of the signal supply member **17** including an end portion of the base member **17***a* and an end portion of the insulation layer **17***d* may be inserted (or accommodated) between the first cover member **13***a* and the second cover member **13***d* and may be fixed between the first cover member **13***a* and the second cover member **13***d* by the first adhesive layer **13***b* and the second adhesive layer **13***c*. Accordingly, the end portion of the first signal line **17***b* may be maintained with being electrically connected to the first electrode layer **11***b* of the vibration part **11**, and the end portion of the second signal line **17***c* may be maintained with being electrically connected to the second electrode layer **11***c* of the vibration part **11**. In addition, the end portion of the signal supply member **17** may be inserted (or accommodated) and fixed between the vibration part **11** and the first cover member **13***a*, and thus, a contact defect between the vibration apparatus **10** and the signal supply member **17** caused by the movement of the signal supply member **17** may be prevented. Alternatively, the end portion of the signal supply member **17** may be inserted (or accommodated) and fixed between the vibration part **11** and the second cover member **13***d*.

[0264] In the signal supply member **17** according to an embodiment of the present disclosure, each of the end portion of the base member **17***a* and the end portion of the insulation layer **17***d* may be disposed from the corresponding end portions of the first and second signal lines **17***b*, **17***c* by a certain distance. For example, each of the end portion of the first signal line **17***b* and the end portion of the second signal line **17***c* may be exposed at the outside without being supported or covered by each of the end portion of the base member **17***a* and the end portion of the insulation layer **17***d*, respectively. For example, the end portion of each of the first signal line **17***b* and the second signal line **17***c* may protrude (or extend) to have a certain length from an end of the base member **17***a* or an end of the insulation layer **17***d*. Accordingly, each of the end portion of each of the first signal line **17***b* and the second signal line **17***c* may be individually or independently bent.

[0265] The end portion of the first signal line **17***b*, which is not supported by the end portion of the base member **17***a* and the end portion of the insulation layer **17***d*, may be directly connected to or directly contact the first electrode layer **11***b* of the vibration part **11**. The end portion of the second signal line **17***c*, which is not supported by the end portion of the base member **17***a* and the end portion of the insulation layer **17***d*, may be directly connected to or directly contact the second electrode layer **11***c* of the vibration part **11**.

[0266] According to an embodiment of the present disclosure, a portion of the signal supply member **17** or a portion of the base member **17***a* may be disposed or inserted (or accommodated) between the cover member **13** and the vibration part **11**, and thus, the signal supply member **17** may be integrated as one body with the vibration part **11**. Further, a portion of the signal supply member **17** or a portion of the base member **17***a* may be disposed or inserted (or accommodated) between the first cover member **13***a* and the second cover member **13***d*, and thus, the signal supply member **17** may be integrated as one body with the vibration apparatus **10**. Accordingly, the vibration apparatus **10** and the signal supply member **17** may be configured as one part (or one element or one component), and thus, an effect of uni-materialization may be obtained.

[0267] According to an embodiment of the present disclosure, the first signal line **17***b* and the second signal line **17***c* of the signal supply member **17** may be integrated as one body with the vibration apparatus **10**, and thus, a soldering process for an electrical connection between the vibration apparatus **10** and the signal supply member **17** is not be needed. Accordingly, a manufacturing process and a structure of the vibration apparatus **10** may be simplified, and hazards associated with the soldering process may be reduced.

[0268] FIG. **16** is a perspective view illustrating a vibration layer according to another embodiment of the present disclosure. For example, FIG. **16** illustrates another embodiment of the vibration layer described above with reference to FIGS. **13** to **15**.

[0269] With reference to FIGS. **14** and **16**, the vibration layer **11***a* according to another embodiment of the present disclosure may include a plurality of first portions **11***a***1** and a plurality of second portions **11***a***2**. For example, the plurality of first portions **11***a***1** and the plurality of second portions **11***a***2** may be alternately and repeatedly disposed along a first direction X (or second direction Y).

[0270] Each of the plurality of first portions **11***a***1** may include an inorganic material portion having a piezoelectric effect (or a piezoelectric characteristic). For example, each of the plurality of first portions **11***a***1** may include at least one or more of a piezoelectric inorganic material and a piezoelectric organic material. For example, each of the plurality of first portions **11***a***1** may be an inorganic portion, an inorganic material portion, a piezoelectric portion, a piezoelectric material portion, or an electroactive portion, but embodiments of the present disclosure are not limited thereto.

[0271] According to an embodiment of the present disclosure, each of the plurality of first portions **11***a***1** may have a first width W**1** parallel to the first direction X (or the second direction Y) and may be extended along the second direction Y (or the first direction X). Each of the plurality of first portions **11***a***1** may be substantially a same as a vibration layer **11***a* described above with reference to FIGS. **13** to **15**, and thus, its repeated descriptions are omitted.

[0272] Each of the plurality of second portions **11***a***2** may be disposed between the plurality of first portions **11***a***1**. For example, each of the plurality of first portions **11***a***1** may be disposed between two adjacent second portions **11***a***2** of the plurality of second portions **11***a***2**. Each of the plurality of second portions **11***a***2** may have a second width W**2** parallel to the first direction X (or the second direction Y) and may be extended along the second direction Y (or the first direction X). The first width W**1** may be a same as or different from the second width W**2**. For example, the first width W**1** may be greater than the second width W**2**. For example, the first portion **11***a***1** and the second portion **11***a***2** may include a line shape or a stripe shape which has a same size or different sizes, but embodiments of the present disclosure are not limited thereto.

[0273] Each of the plurality of second portions **11***a***2** may be configured to fill a gap between two adjacent first portions of the plurality of first portions **11***a***1**. Each of the plurality of second portions **11***a***2** may be configured to fill a gap between two adjacent first portions of the plurality of first portions **11***a***1**, and thus, may be connected to or attached at lateral surfaces of the first portion **11***a***1** adjacent thereto. According to an embodiment of the present disclosure, each of the plurality of first portions **11***a***1** and the plurality of second portions **11***a***2** may be disposed (or arranged) at a same plane (or a same layer) in parallel with each other. Therefore, the vibration layer **11***a* may be expanded to a desired size or length by a lateral coupling (or connection) of the first portions **11***a***1** and the second portions **11***a***2**.

[0274] According to an embodiment of the present disclosure, each of the plurality of second portions **11***a***2** may absorb an impact applied to the first portions **11***a***1**, and thus, may enhance the total durability of the first portions **11***a***1** and provide flexibility to the vibration layer **11***a*. Each of the plurality of second portions **11***a***2** may include an organic material having a ductile characteristic. For example, each of the plurality of second portions **11***a***2** may include one or more of an epoxy-based polymer, an acrylic-based polymer, and a silicone-based polymer, but embodiments of the present disclosure are not limited thereto. For example, each of the plurality of second portions **11***a***2** may be an organic portion, an organic material portion, an adhesive portion, a stretch portion, a bending portion, a damping portion, or a ductile portion, but embodiments of the present disclosure are not limited thereto.

[0275] A first surface of each of the plurality of first portions **11**a**1** and the plurality of second portions **11**a**2** may be connected to the first electrode layer **11**b in common. A second surface of each of the plurality of first portions **11**a**1** and the plurality of second portions **11**a**2** may be connected to the second electrode layer **11**c in common.

[0276] The plurality of first portions **11**a**1** and the plurality of second portion **11**a**2** may be disposed (or connected) at a same plane, and thus, the vibration part **11**a according to another embodiment of the present disclosure may have a single thin film-type. Accordingly, the vibration layer **11** or the vibration apparatus **10** including the vibration layer **11**a according to another embodiment of the present disclosure may vibrate by the first portion **11**a**1** having a vibration characteristic and may be bent in a curved shape by the second portion **11**a**2** having flexibility.

[0277] FIG. **17** is a perspective view illustrating a vibration layer according to another embodiment of the present disclosure. For example, FIG. **17** illustrates another embodiment of the vibration layer described above with reference to FIGS. **13** to **15**.

[0278] With reference to FIGS. **14** and **17**, the vibration layer **11**a according to another embodiment of the present disclosure may include a plurality of first portions **11**a**3** and a second portion **11**a**4** disposed between the plurality of first portions **11**a**3**.

[0279] Each of the plurality of first portions **11**a**3** may be disposed to be spaced apart from one another along each of the first direction X and the second direction Y. For example, each of the plurality of first portions **11**a**3** may have a hexahedral shape having a same size and may be disposed in a lattice shape, but embodiments of the present disclosure are not limited thereto. For example, each of the plurality of first portions **11**a**3** may have a circular shape plate, an oval shape plate, or a polygonal shape plate, which has a same size as each other, but embodiments of the present disclosure are not limited thereto.

[0280] Each of the plurality of first portions **11**a**3** may be substantially a same as the first portion **11**a**1** described above with reference to FIG. **16**, and thus, its repeated descriptions are omitted.

[0281] The second portion **11**a**4** may be disposed between the plurality of first portions **11**a**3** along each of the first direction X and the second direction Y. The second portion **11**a**4** may be configured to fill a gap between two adjacent first portions **11**a**3**, or to be adjacent to each of the plurality of first portions **11**a**3** or to surround each of the plurality of first portions **11**a**3**, and thus, the second portion **11**a**4** may be connected to or attached at the first portion **11**a**3** adjacent thereto. The second portion **11**a**4** may be substantially a same as the second portion **11**a**2** described above with reference to FIG. **16**, and thus, its repeated descriptions are omitted.

[0282] A first surface of each of the plurality of first portions **11**a**3** and the second portions **11**a**4** may be connected to the first electrode layer **11**b in common. A second surface of each of the plurality of first portions **11**a**3** and the second portions **11**a**4** may be connected to the second electrode layer **11**c in common.

[0283] The plurality of first portions **11**a**3** and the second portion **11**a**4** may be disposed (or connected) at a same plane, and thus, the vibration layer **11**a according to another embodiment of the present disclosure may have a single thin film-type, but embodiments of the present disclosure are not limited thereto. Accordingly, the vibration part **11** of the vibration apparatus **10** including the vibration layer **11**a according to another embodiment of the present disclosure may vibrate by the first portion **11**a**3** having a vibration characteristic and may be bent in a curved shape by the second portion **11**a**4** having flexibility.

[0284] FIG. **18** is an exploded perspective view illustrating a vibration apparatus according to another embodiment of the present disclosure. For example, FIG. **18** illustrates a vibration apparatus described above with reference to FIGS. **1** to **12**.

[0285] With reference to FIG. **18**, the vibration apparatus **10** according to another embodiment of the present disclosure can include two or more vibration generating parts **10-1** and **10-2**. For example, the vibration apparatus **10** may include a first vibration generating part **10-1** and a second vibration generating part **10-2**.

[0286] The first vibration generating part **10-1** and the second vibration generating part **10-2** may overlap or be stacked with each other to be displaced (or driven or vibrated) in a same direction to maximize an amplitude displacement of the vibration apparatus **10** or an amplitude displacement of the vibration member. For example, the first vibration generating part **10-1** and the second vibration generating part **10-2** may have substantially a same size, but embodiments of the present disclosure are not limited thereto. For example, the first vibration generating part **10-1** and the second vibration generating part **10-2** may have substantially a same size within an error range of a manufacturing process, but embodiments of the present disclosure are not limited thereto. Therefore, the first vibration generating part **10-1** and the second vibration generating part **10-2** may maximize the amplitude displacement of the vibration apparatus **10** and/or the amplitude displacement of the vibration member.

[0287] Each of the first vibration generating part **10-1** and the second vibration generating part **10-2** may be a same as or substantially a same as the vibration apparatus **10** described above with reference to FIGS. **13** to **17**, and thus, like reference numeral refer to like element and its repeated descriptions are omitted.

[0288] The vibration apparatus **10** according to another embodiment of the present disclosure may further include an intermediate adhesive member **10**M.

[0289] The intermediate adhesive member **10**M may be disposed or connected between the first vibration generating part **10-1** and the second vibration generating part **10-2**. As an embodiment of the present disclosure, the intermediate adhesive member **10**M may be disposed or connected between the second adhesive layer **13**c of the first vibration generating part **10-1** and the first cover member **13**a of the second vibration generating part **10-2**. As another embodiment of the present disclosure, the intermediate adhesive member **10**M may be disposed or connected between the second cover member **13**d of the first vibration generating part **10-1** and the first cover member **13**a of the second vibration generating part **10-2**. For example, the intermediate adhesive member **10**M may be an intermediate member, an adhesive member, or a connection member, but embodiments of the present disclosure are not limited thereto.

[0290] The intermediate adhesive member **10**M according to an embodiment of the present disclosure may be configured in a material including an adhesive layer which is good in adhesive force or attaching force with respect to each of the first vibration generating part **10-1** and the second vibration generating part **10-2**, but embodiments of the present disclosure are not limited thereto. For example, the intermediate adhesive member **10**M may include a foam pad, a double-sided tape, a double-sided foam tape, a double-sided foam pad, a double-sided adhesive tape, or an adhesive, or the like, but embodiments of the present disclosure are not limited thereto. For example, an adhesive layer of the intermediate adhesive member **10**M may include epoxy, acrylic, silicone, or urethane, but embodiments of the present disclosure are not limited thereto. For example, the adhesive layer of the intermediate adhesive member **10**M may include a urethane-based material (or substance) having relatively ductile characteristic. Accordingly, the vibration loss caused by displacement interference between the first vibration generating part **10-1** and the second vibration generating part **10-2** may be reduced or minimized, or each of the first vibration generating part **10-1** and the second vibration generating part **10-2** may be freely displaced (or vibrated or driven).

[0291] The vibration apparatus **10** according to another embodiment of the present disclosure may include the first vibration generating part **10-1** and the second vibration generating part **10-2** which are stacked (or piled or overlap) to vibrate (or displace or drive) in a same direction, and thus, the amount of displacement or an amplitude displacement may be maximized or increase. Accordingly, the amount of displacement (or a bending force or a driving force) or an amplitude displacement of the vibration member may be more maximized or more increased, thereby more enhancing a sound characteristic and/or a sound pressure level characteristic of a low-pitched sound band.

[0292] FIG. **19** is a plan view illustrating a vehicular apparatus according to another embodiment of the present disclosure. FIG. **20** is a cross-sectional view taken along line V-V' illustrated in FIG. **19** according to an embodiment of the present disclosure.

[0293] With reference to FIGS. **19** and **20**, the vehicular apparatus **400** according to an embodiment of the present disclosure may include a vehicle body bottom **401**, a battery module **450**, and one or more virtual engine sound apparatuses **470**.

[0294] The vehicle body bottom (or vehicle body floor) **401** may be a structure of the vehicular apparatus **400**. The vehicle body bottom **401** may be configured to support or cover a vehicle body lower frame **402**. For example, the vehicle body bottom **401** may be a vehicle body panel or a vehicle body frame, but embodiments of the present disclosure are not limited thereto.

[0295] The battery module **450** may be disposed at or mount on a vehicle body bottom frame **402**. For example, the battery module **450** may be disposed between the vehicle body bottom frame **402** and the vehicle body bottom **401**. For example, the battery module **450** may be disposed to be covered by the vehicle body bottom **401**.

[0296] The one or more virtual engine sound apparatuses **470** may be an apparatus (or a device) for transferring a location and/or driving information of the vehicular apparatus **400** to a pedestrian. For example, the one or more virtual engine sound apparatuses **470** may be a virtual engine sound system or a vehicle access information apparatus, but embodiments of the present disclosure are not limited thereto.

[0297] The one or more virtual engine sound apparatuses **470** may include the sound apparatus **200** described above with reference to FIGS. **6** to **8**, and thus, its repeated descriptions are omitted. For example, the one or more virtual engine sound apparatuses **470** may be configured to output a sound or a virtual engine sound AVAS of 150 Hz to 20 kHz.

[0298] The one or more virtual engine sound apparatuses **470** or the supporting member **230** of the sound apparatus **200** according to an embodiment of the present disclosure may be disposed in (or mounted on) a region between the battery module **450** and the vehicle body bottom **401** or a region between the vehicle body bottom frame **402** and the vehicle body bottom **401**. For example, the one or more virtual engine sound apparatuses **470** may be configured to be covered by the vehicle body bottom **401**. For example, a portion of the vehicle body bottom **401** overlapping the one or more virtual engine sound apparatuses **470** may include one or more holes for outputting a sound (or a virtual engine sound) AVAS, output from the one or more virtual engine sound apparatuses **470**, in an earth-surface direction (or a ground direction) GD.

[0299] The one or more virtual engine sound apparatuses **470** according to another embodiment of the present disclosure may be accommodated (or received) into the vehicle body bottom **401**. The vehicle body bottom **401** may include an accommodating part **401***a* for accommodating (or receiving) the one or more virtual engine sound apparatuses **470**. For example, the accommodating part **401***a* of the vehicle body bottom **401** may protrude toward the battery module **450** from the vehicle body bottom **401** to include an accommodating space.

[0300] The one or more virtual engine sound apparatuses **470** according to another embodiment of the present disclosure may be accommodated (or received) into the accommodating part **401***a* of the vehicle body bottom **401** by a plurality of fastening members and may be fixed to (or mounted on) the vehicle body bottom **401**. For example, the supporting member **230** of the sound apparatus **200** configured in the one or more virtual engine sound apparatuses **470** may be accommodated (or received) into the accommodating part **401***a* of the vehicle body bottom **401**. For example, the protrusion part **233***c* of the supporting member **230** may be in contact with the vehicle body bottom **401** in a periphery of the accommodating part **401***a* of the vehicle body bottom **401**. Accordingly, one or more virtual engine sound apparatuses **470** may be fixed to (or mounted on) the vehicle body bottom **401** and output the sound (or virtual engine sound) AVAS toward the earth-surface direction GD.

[0301] The one or more virtual engine sound apparatuses **470** may include the piezoelectric-type vibration apparatus **10**, and thus, may be lightweight and may have a thin thickness, and may output a sound (or a virtual engine sound) AVAS having a wide directivity angle or a non-directivity angle, based on a non-directivity characteristic of the vibration apparatus **10**. The one or more virtual engine sound apparatuses **470** according to an embodiment of the present disclosure may output a sound (or a virtual engine sound) AVAS having a wide directivity angle compared to a sound generated based on a vibration of an actuator including a magnet and a coil. For example, in a case where the one or more virtual engine sound apparatuses **470** are disposed (or configured) corresponding to a center of the vehicular apparatus **400** or the vehicle body bottom **401** to output a virtual engine sound AVAS, the one or more virtual engine sound apparatuses **470** may output a uniform virtual engine sound AVAS in (toward) each of a forward direction, a rearward direction, a left direction, and a right direction with respect to the center of the vehicular apparatus **400** or the vehicle body bottom **401**. The one or more virtual engine sound apparatuses **470** according to an embodiment of the present disclosure may output a sound or a virtual engine sound AVAS having a sound pressure level of 60 dB or more in a pitched sound band of 300 Hz or more, but embodiments of the present disclosure are not limited thereto.

[0302] The vehicular apparatus **400** according to an embodiment of the present disclosure may further include one or more actuators **30**.

[0303] The one or more actuators **30** may be disposed at one or more of a dashboard **430**A, a door frame **430**B, and a rear package interior material **430**C, but embodiments of the present disclosure are not limited thereto. For example, one or more actuators **30** may be disposed at one or more of a pillar interior material, a roof interior material, a door interior material, a seat interior material, a handle interior material, and a floor interior material, but embodiments of the present disclosure are not limited thereto.

[0304] The one or more actuators **30** may include a magnet and a coil. The one or more actuators **30** may be one or more of a woofer, a mid-woofer, and a sub-woofer, but embodiments of the present disclosure are not limited thereto. For example, the one or more actuators **30** may be a speaker which outputs a sound of about 30 Hz to about 150 Hz, or about 300 Hz or less, but embodiments of the present disclosure are not limited thereto. Therefore, the one or more actuators **30** may output a sound of about 30 Hz to about 150 Hz, or about 300 Hz or less, and thus, may enhance a low-pitched sound band characteristic of a sound which is output to an interior space.

[0305] The one or more actuators **30** may drive (or vibrate) based on the actuator driving signals applied through the signal supply member **17** from the sound driving circuit **101** of the driving circuit part **100** in the sound apparatus described above with reference to FIGS. **4** and **5**, to generate (or output) a sound.

[0306] According to an embodiment of the present disclosure, the sound driving circuit **101** of the driving circuit part **100** may drive (or vibrate) the one or more virtual engine sound apparatuses **470** and the one or more actuators **30**, respectively, but embodiments of the present disclosure are not limited thereto.

[0307] A sound driving circuit, a sound apparatus comprising the same, and a vehicular apparatus comprising the sound apparatus according to one or more embodiments of the present disclosure will be described below.

[0308] A sound driving circuit according to one or more embodiments of the present disclosure may comprise an audio processor generating an input audio signal based on a sound source, a signal conversion circuit converting the input audio signal into a piezoelectric audio signal, and an amplifier circuit amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

[0309] According to one or more embodiments of the present disclosure, the signal conversion circuit may comprise a filter circuit attenuating a high-pitched sound band signal of the input audio signal to generate the piezoelectric driving signal.

[0310] According to one or more embodiments of the present disclosure, the high-pitched sound band signal may have a frequency of 1 kHz or more.

[0311] According to one or more embodiments of the present disclosure, the signal conversion circuit further may comprise a correction circuit increasing a first pitched sound band signal of the input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal, a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal, and a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal. The filter circuit may attenuate the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

[0312] According to one or more embodiments of the present disclosure, the first pitched sound band signal may have a frequency of 250 Hz to 600 Hz. The second pitched sound band signal may have a frequency of 1 kHz or more.

[0313] According to one or more embodiments of the present disclosure, the correction circuit may include a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

[0314] A sound driving circuit according to one or more embodiments of the present disclosure may comprise an audio processor generating an audio signal based on a sound source, a preamplifier circuit amplifying the audio signal to generate an input audio signal, a signal conversion circuit converting the input audio signal into a piezoelectric audio signal, and an amplifier circuit amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

[0315] According to one or more embodiments of the present disclosure, the signal conversion circuit may comprise a filter circuit attenuating a high-pitched sound band signal of the input audio signal to generate the piezoelectric driving signal.

[0316] According to one or more embodiments of the present disclosure, the high-pitched sound band signal may have a frequency of 1 kHz or more.

[0317] According to one or more embodiments of the present disclosure, the signal conversion circuit further may comprise a correction circuit increasing a first pitched sound band signal of the input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal, a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal, and a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal. The filter circuit may attenuate the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

[0318] According to one or more embodiments of the present disclosure, the first pitched sound band signal may have a frequency of 250 Hz to 600 Hz. The second pitched sound band signal may have a frequency of 1 kHz or more.

[0319] According to one or more embodiments of the present disclosure, the correction circuit may include a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

[0320] A sound driving circuit according to one or more embodiments of the present disclosure may comprise an audio processor generating a first input audio signal and one or more second input audio signals based on a sound source, a signal conversion circuit converting the first input audio signal into a piezoelectric audio signal, and an amplifier circuit amplifying the one or more second input audio signals to generate one or more actuator driving signals for driving one or more actuators of a coil-type and amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

[0321] According to one or more embodiments of the present disclosure, the signal conversion circuit may comprise a filter circuit attenuating a high-pitched sound band signal of the first input audio signal to generate the piezoelectric driving signal.

[0322] According to one or more embodiments of the present disclosure, the high-pitched sound band signal may have a frequency of 1 kHz or more.

[0323] According to one or more embodiments of the present disclosure, the signal conversion circuit further may comprise a correction circuit increasing a first pitched sound band signal of the first input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal, a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal, and a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal. The filter circuit may attenuate the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

[0324] According to one or more embodiments of the present disclosure, the first pitched sound band signal may have a frequency of 250 Hz to 600 Hz. The second pitched sound band signal may have a frequency of 1 kHz or more.

[0325] According to one or more embodiments of the present disclosure, the correction circuit may include a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

[0326] A sound driving circuit according to one or more embodiments of the present disclosure may comprise an audio processor generating a first audio signal and one or more second audio signals based on a sound source, a preamplifier circuit amplifying the one or more second audio signals to generate the one or more second input audio signals and amplifying the first audio signal to generate the first input audio signal, a signal conversion circuit converting the first input audio signal into a piezoelectric audio signal, and an amplifier circuit amplifying the one or more second input audio signals to generate one or more actuator driving signals for driving one or more actuators of a coil-type and amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

[0327] According to one or more embodiments of the present disclosure, the signal conversion circuit may comprise a filter circuit attenuating a high-pitched sound band signal of the first input audio signal to generate the piezoelectric driving signal.

[0328] According to one or more embodiments of the present disclosure, the high-pitched sound band signal may have a frequency of 1 kHz or more.

[0329] According to one or more embodiments of the present disclosure, the signal conversion circuit further may comprise a correction circuit increasing a first pitched sound band signal of the first input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal, a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal, and a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal. The filter circuit may attenuate the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

[0330] According to one or more embodiments of the present disclosure, the first pitched sound band signal may have a frequency of 250 Hz to 600 Hz. The second pitched sound band signal may have a frequency of 1 kHz or more.

[0331] According to one or more embodiments of the present disclosure, the correction circuit may include a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

[0332] A sound apparatus according to one or more embodiments of the present disclosure may comprise a vibration apparatus including a piezoelectric material, and a driving circuit part connected to the vibration apparatus. The driving circuit part comprises a sound driving circuit applying the piezoelectric driving signal to the vibration apparatus, as previously described.

[0333] According to one or more embodiments of the present disclosure, the vibration apparatus may comprise a vibration part including the piezoelectric material, a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface, and a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

[0334] According to one or more embodiments of the present disclosure, the sound apparatus may further comprise a passive vibration member. The vibration apparatus may be disposed to vibrate the passive vibration member.

[0335] According to one or more embodiments of the present disclosure, the passive vibration member may comprise any one of a display panel including a pixel configured to display an image, a screen panel on which an image is to be projected from a display apparatus, a lighting panel, a signage panel, a vehicular interior material, a vehicular exterior material, a vehicular glass window, a vehicular seat interior material, a vehicular ceiling material, a building ceiling material, a building interior material, a building glass window, an aircraft interior material, an aircraft glass window, and a mirror.

[0336] According to one or more embodiments of the present disclosure, the sound apparatus may further comprise a vibration member, and a supporting member having an internal space and configured at a periphery of the vibration member. The vibration apparatus may be in the internal space of the supporting member and is disposed to vibrate the vibration member.

[0337] A sound apparatus according to one or more embodiments of the present disclosure may comprise a vibration apparatus including a piezoelectric material, one or more actuators including a magnet and a coil, and a driving circuit part connected to the vibration apparatus and the one or more actuators. The driving circuit part may comprise a sound driving circuit. The sound driving circuit may apply the piezoelectric driving signal to the vibration apparatus and may apply the one or more actuator driving signals to the one or more actuators, as previously described.

[0338] According to one or more embodiments of the present disclosure, the vibration apparatus may comprise a vibration part including the piezoelectric material, a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface, and a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

[0339] A vehicular apparatus according to one or more embodiments of the present disclosure may comprise an exterior material, an interior material covering the exterior material, and one or more sound generating apparatuses configured to output a sound in one or more of the exterior material, the interior material, and a region between the exterior material and the interior material. The one or more sound generating apparatuses may comprise a sound apparatus, as previously described.

[0340] According to one or more embodiments of the present disclosure, the vehicular apparatus may further comprise a vibration member, and a supporting member having an internal space and supporting the vibration member. The vibration apparatus of the sound apparatus may be in the internal space of the supporting member and may be disposed to vibrate the vibration member.

[0341] According to one or more embodiments of the present disclosure, the vibration apparatus of the sound apparatus may comprise a vibration part including the piezoelectric material, a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface, and a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

[0342] According to one or more embodiments of the present disclosure, a portion of the signal supply member may be accommodated between the cover member and the vibration part.

[0343] According to one or more embodiments of the present disclosure, the interior material may comprise at least one or more of a dash board, a pillar interior material, a roof interior material, a door interior material, a seat interior material, a handle interior material, a floor interior material, and a rear package interior material.

[0344] According to one or more embodiments of the present disclosure, the exterior material may comprise at least one or more of a hood panel, a front fender panel, a door panel, a roof panel, a pillar panel, a trunk panel, a front bumper, a rear bumper, a spoiler, a headlight, a taillight, a fog light, and a vehicle body bottom.

[0345] A vehicular apparatus according to one or more embodiments of the present disclosure may comprise an exterior material, an interior material covering the exterior material, and one or more sound generating apparatuses configured to output a sound in one or more of the exterior material, the interior material, and a region between the exterior material and the interior material. the one or more sound generating apparatuses may comprise a sound apparatus, as previously described.

[0346] According to one or more embodiments of the present disclosure, the vibration apparatus of the sound apparatus may comprise a vibration part including the piezoelectric material, a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface, and a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

[0347] According to one or more embodiments of the present disclosure, a portion of the signal supply member may be accommodated between the cover member and the vibration part.

[0348] According to one or more embodiments of the present disclosure, the interior material may comprise at least one or more of a dash board, a pillar interior material, a roof interior material, a door interior material, a seat interior material, a handle interior material, a floor interior material, and a rear package interior material.

[0349] According to one or more embodiments of the present disclosure, the exterior material may comprise at least one or more of a hood panel, a front fender panel, a door panel, a roof panel, a pillar panel, a trunk panel, a front bumper, a rear bumper, a spoiler, a headlight, a taillight, a fog light, and a vehicle body bottom.

[0350] According to one or more embodiments of the present disclosure, the one or more actuators of the sound apparatus may be disposed at one or more of a dash board, a door frame, a rear package interior material, a pillar interior material, a roof interior material, a door interior material, a seat interior material, a handle interior material, and a floor interior material.

[0351] A vehicular apparatus according to one or more embodiments of the present disclosure may comprise a vehicle body bottom frame, and a vehicle body bottom covering the vehicle body bottom frame, and one or more virtual engine sound apparatuses mounted on the vehicle body bottom or a region between the vehicle body bottom frame and the vehicle body bottom. The one or more virtual engine sound apparatuses comprise a sound apparatus, as previously described.

[0352] According to one or more embodiments of the present disclosure, the one or more virtual engine sound apparatuses may be disposed to correspond to a center of the vehicle body bottom.

[0353] According to one or more embodiments of the present disclosure, the vibration apparatus of the sound apparatus may comprise a vibration part including the piezoelectric material, a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface, and a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

[0354] According to one or more embodiments of the present disclosure, a portion of the signal supply member may be accommodated between the cover member and the vibration part.

[0355] According to one or more embodiments of the present disclosure, the sound apparatus further may comprise a vibration member, and a supporting member having an internal space and supporting the vibration member. The vibration apparatus of the sound apparatus may be in the internal space of the supporting member and is disposed to vibrate the vibration member.

[0356] According to one or more embodiments of the present disclosure, the vehicle body bottom may comprise an accommodation part configured to accommodate the one or more virtual engine sound apparatuses. The supporting member of the sound apparatus may be accommodated into the accommodation part. The sound apparatus may output a virtual engine sound toward an earth-surface direction.

[0357] A sound apparatus according to an embodiment of the present disclosure may be applied to or included in a sound generating apparatus disposed at an apparatus or a display apparatus. The apparatus or the display apparatus according to an embodiment of the present disclosure may be applied to or included in mobile apparatuses, video phones, smart watches, watch phones, wearable apparatuses, foldable apparatuses, rollable apparatuses, bendable apparatuses, flexible apparatuses, curved apparatuses, sliding apparatuses, variable apparatuses, electronic organizers, electronic books, portable multimedia players (PMPs), personal digital assistants (PDAs), MP3 players, mobile medical devices, desktop personal computers (PCs), laptop PCs, netbook computers, workstations, navigation apparatuses, automotive navigation apparatuses, automotive display apparatuses, automotive apparatuses, theatre apparatuses, theatre display apparatuses, TVs, wall paper display apparatuses, signage apparatuses, game machines, notebook computers, monitors, cameras, camcorders, and home appliances, or the like. Further, the sound apparatus according to one or more embodiments of the present disclosure may be applied to or included in an organic light-emitting lighting apparatus or an inorganic light-emitting lighting apparatus. When the sound apparatus is applied to or included in the lighting apparatuses, the lighting apparatuses may act as lighting and a speaker. In addition, when the sound apparatus according to one or more embodiments of the present disclosure is applied to or included in the mobile apparatuses, or the like, the sound apparatus may be one or more of a speaker, a receiver, and a haptic device, but embodiments of the present disclosure are not limited thereto.

[0358] It will be apparent to those skilled in the art that various modifications and variations can be made in the sound driving circuit, the sound apparatus including the same, and the vehicular apparatus including the sound apparatus of the present disclosure without departing from the technical idea or scope of the disclosure. Thus, it is intended that the present disclosure cover the modifications and variations of this disclosure provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A sound driving circuit, comprising:

an audio processor generating an input audio signal based on a sound source;

a signal conversion circuit converting the input audio signal into a piezoelectric audio signal; and

an amplifier circuit amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

2. The sound driving circuit of claim **1**, wherein the signal conversion circuit comprises a filter circuit attenuating a high-pitched sound band signal of the input audio signal to generate the piezoelectric driving signal.

3. The sound driving circuit of claim **2**, wherein the high-pitched sound band signal has a frequency of 1 kHz or more.

4. The sound driving circuit of claim **2**,

wherein the signal conversion circuit further comprises:

a correction circuit increasing a first pitched sound band signal of the input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal;

a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal; and

a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal, and

wherein the filter circuit attenuates the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

5. The sound driving circuit of claim **4**,

wherein the first pitched sound band signal has a frequency of 250 Hz to 600 Hz, and

wherein the second pitched sound band signal has a frequency of 1 kHz or more.

6. The sound driving circuit of claim **4**,

wherein the correction circuit includes a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

7. A sound driving circuit, comprising:

an audio processor generating an audio signal based on a sound source;

a preamplifier circuit amplifying the audio signal to generate an input audio signal;

a signal conversion circuit converting the input audio signal into a piezoelectric audio signal; and

an amplifier circuit amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

8. The sound driving circuit of claim **7**, wherein the signal conversion circuit comprises a filter circuit attenuating a high-pitched sound band signal of the input audio signal to generate the piezoelectric driving signal.

9. The sound driving circuit of claim **8**, wherein the high-pitched sound band signal has a frequency of 1 kHz or more.

10. The sound driving circuit of claim 8,

wherein the signal conversion circuit further comprises:

a correction circuit increasing a first pitched sound band signal of the input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal;

a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal; and

a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal, and

wherein the filter circuit attenuates the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

11. The sound driving circuit of claim 10,

wherein the first pitched sound band signal has a frequency of 250 Hz to 600 Hz, and

wherein the second pitched sound band signal has a frequency of 1 kHz or more.

12. The sound driving circuit of claim 10,

wherein the correction circuit includes a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

13. A sound driving circuit, comprising:

an audio processor generating a first input audio signal and one or more second input audio signals based on a sound source;

a signal conversion circuit converting the first input audio signal into a piezoelectric audio signal; and

an amplifier circuit amplifying the one or more second input audio signals to generate one or more actuator driving signals for driving one or more actuators of a coil-type and amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

14. The sound driving circuit of claim 13, wherein the signal conversion circuit comprises a filter circuit attenuating a high-pitched sound band signal of the first input audio signal to generate the piezoelectric driving signal.

15. The sound driving circuit of claim 14, wherein the high-pitched sound band signal has a frequency of 1 kHz or more.

16. The sound driving circuit of claim 14,

wherein the signal conversion circuit further comprises:

a correction circuit increasing a first pitched sound band signal of the first input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal;

a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal; and

a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal, and

wherein the filter circuit attenuates the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

17. The sound driving circuit of claim 16,

wherein the first pitched sound band signal has a frequency of 250 Hz to 600 Hz, and

wherein the second pitched sound band signal has a frequency of 1 kHz or more.

18. The sound driving circuit of claim 16,

wherein the correction circuit includes a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

19. A sound driving circuit, comprising:

an audio processor generating a first audio signal and one or more second input audio input signals based on a sound source;

a preamplifier circuit amplifying the one or more second audio signals to generate the one or more second input audio signals and amplifying the first audio signal to generate the first input audio signal;

a signal conversion circuit converting the first input audio signal into a piezoelectric audio signal; and

an amplifier circuit amplifying the one or more second input audio signals to generate one or more actuator driving signals for driving one or more actuators of a coil-type and amplifying the piezoelectric audio signal to generate a piezoelectric driving signal for driving a vibration apparatus of a piezoelectric-type.

20. The sound driving circuit of claim 19, wherein the signal conversion circuit comprises a filter circuit attenuating a high-pitched sound band signal of the first input audio signal to generate the piezoelectric driving signal.

21. The sound driving circuit of claim 20, wherein the high-pitched sound band signal has a frequency of 1 kHz or more.

22. The sound driving circuit of claim 20,

wherein the signal conversion circuit further comprises:

a correction circuit increasing a first pitched sound band signal of the first input audio signal and/or decreasing a second pitched sound band signal differing from the first pitched sound band signal to generate a first audio correction signal;

a level control circuit controlling a volume level of the first audio correction signal to generate a second audio correction signal; and

a clipping circuit removing noise of the second audio correction signal to generate a third audio correction signal, and

wherein the filter circuit attenuates the high-pitched sound band signal of the third audio correction signal to generate the piezoelectric driving signal.

23. The sound driving circuit of claim 22,

wherein the first pitched sound band signal has a frequency of 250 Hz to 600 Hz, and

wherein the second pitched sound band signal has a frequency of 1 kHz or more.

24. The sound driving circuit of claim 22,

wherein the correction circuit includes a first correction circuit for increasing the first pitched sound band signal, a second correction circuit for decreasing the second pitched sound band signal, and a mixing circuit for mixing the increased first pitched sound band signal and the decreased second pitched sound band signal to generate the first audio correction signal.

25. A sound apparatus, comprising:

a vibration apparatus including a piezoelectric material; and

a driving circuit part connected to the vibration apparatus,

wherein the driving circuit part comprises the sound driving circuit of claim **1**, and

wherein the sound driving circuit applies the piezoelectric driving signal to the vibration apparatus.

26. The sound apparatus of claim **25**, wherein the vibration apparatus comprises:

a vibration part including the piezoelectric material;

a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface; and

a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

27. The sound apparatus of claim **25**, further comprising a passive vibration member,

wherein the vibration apparatus is disposed to vibrate the passive vibration member.

28. The sound apparatus of claim **27**, wherein the passive vibration member comprises any one of a display panel including a pixel configured to display an image, a screen panel on which an image is to be projected from a display apparatus, a lighting panel, a signage panel, a vehicular interior material, a vehicular exterior material, a vehicular glass window, a vehicular seat interior material, a vehicular ceiling material, a building ceiling material, a building interior material, a building glass window, an aircraft interior material, an aircraft glass window, and a mirror.

29. The sound apparatus of claim **25**, further comprising:

a vibration member; and

a supporting member having an internal space and configured at a periphery of the vibration member,

wherein the vibration apparatus is in the internal space of the supporting member and is disposed to vibrate the vibration member.

30. A sound apparatus, comprising:

a vibration apparatus including a piezoelectric material;

one or more actuators including a magnet and a coil; and

a driving circuit part connected to the vibration apparatus and the one or more actuators,

wherein the driving circuit part comprises the sound driving circuit of claim **13**, and

wherein the sound driving circuit applies the piezoelectric driving signal to the vibration apparatus and applies the one or more actuator driving signals to the one or more actuators.

31. The sound apparatus of claim **30**, wherein the vibration apparatus comprises:

a vibration part including the piezoelectric material;

a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface; and

a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

32. A vehicular apparatus, comprising:

an exterior material;

an interior material covering the exterior material; and

one or more sound generating apparatuses configured to output a sound in one or more of the exterior material, the interior material, and a region between the exterior material and the interior material,

wherein the one or more sound generating apparatuses comprise the sound apparatus of claim **25**.

33. The vehicular apparatus of claim **32**, further comprising:

a vibration member; and

a supporting member having an internal space and supporting the vibration member,

wherein the vibration apparatus of the sound apparatus is in the internal space of the supporting member and is disposed to vibrate the vibration member.

34. The vehicular apparatus of claim **32**, wherein the vibration apparatus of the sound apparatus comprises:

a vibration part including the piezoelectric material;

a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface; and

a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

35. The vehicular apparatus of claim **34**, wherein a portion of the signal supply member is accommodated between the cover member and the vibration part.

36. The vehicular apparatus of claim **32**, wherein the interior material comprises at least one or more of a dash board, a pillar interior material, a roof interior material, a door interior material, a seat interior material, a handle interior material, a floor interior material, and a rear package interior material.

37. The vehicular apparatus of claim **32**, wherein the exterior material comprises at least one or more of a hood panel, a front fender panel, a door panel, a roof panel, a pillar panel, a trunk panel, a front bumper, a rear bumper, a spoiler, a headlight, a taillight, a fog light, and a vehicle body bottom.

38. A vehicular apparatus, comprising:

an exterior material;

an interior material covering the exterior material; and

one or more sound generating apparatuses configured to output a sound in one or more of the exterior material, the interior material, and a region between the exterior material and the interior material,

wherein the one or more sound generating apparatuses comprise the sound apparatus of claim **30**.

39. The vehicular apparatus of claim **38**, wherein the vibration apparatus of the sound apparatus comprises:

a vibration part including the piezoelectric material;

a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface; and

a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

40. The vehicular apparatus of claim **39**, wherein a portion of the signal supply member is accommodated between the cover member and the vibration part.

41. The vehicular apparatus of claim **38**, wherein the interior material comprises at least one or more of a dash board, a pillar interior material, a roof interior material, a door interior material, a seat interior material, a handle interior material, a floor interior material, and a rear package interior material.

42. The vehicular apparatus of claim **38**, wherein the exterior material comprises at least one or more of a hood panel, a front fender panel, a door panel, a roof panel, a pillar panel, a trunk panel, a front bumper, a rear bumper, a spoiler, a headlight, a taillight, a fog light, and a vehicle body bottom.

43. The vehicular apparatus of claim **38**, wherein the one or more actuators of the sound apparatus are disposed at one or more of a dash board, a door frame, a rear package interior material, a pillar interior material, a roof interior material, a door interior material, a seat interior material, a handle interior material, and a floor interior material.

44. A vehicular apparatus, comprising:

a vehicle body bottom frame; and

a vehicle body bottom covering the vehicle body bottom frame; and

one or more virtual engine sound apparatuses mounted on the vehicle body bottom or a region between the vehicle body bottom frame and the vehicle body bottom,

wherein the one or more virtual engine sound apparatuses comprise the sound apparatus of claim **25**.

45. The vehicular apparatus of claim **44**, wherein the one or more virtual engine sound apparatuses are disposed to correspond to a center of the vehicle body bottom.

46. The vehicular apparatus of claim **44**, wherein the vibration apparatus of the sound apparatus comprises:

a vibration part including the piezoelectric material;

a cover member covering at least one or more of a first surface of the vibration part and a second surface of the vibration part opposite to the first surface; and

a signal supply member electrically connected to the vibration part and connected to the driving circuit part.

47. The vehicular apparatus of claim **46**, wherein a portion of the signal supply member is accommodated between the cover member and the vibration part.

48. The vehicular apparatus of claim **44**, wherein the sound apparatus further comprises:

a vibration member; and

a supporting member having an internal space and supporting the vibration member,

wherein the vibration apparatus of the sound apparatus is in the internal space of the supporting member and is disposed to vibrate the vibration member.

49. The vehicular apparatus of claim **48**,

wherein the vehicle body bottom comprises an accommodation part configured to accommodate the one or more virtual engine sound apparatuses,

wherein the supporting member of the sound apparatus is accommodated into the accommodation part, and

wherein the sound apparatus outputs a virtual engine sound toward an earth-surface direction.

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