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(54) Title: AUDIO DEVICE AND MANUFACTURING METHOD THEREOF

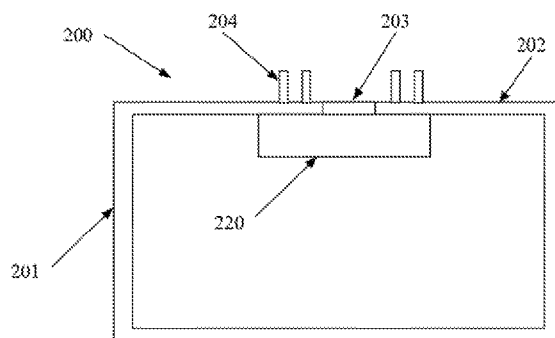


FIG. 4

(57) Abstract: An audio device and a manufacturing method thereof are disclosed. The audio device comprises: a housing for containing at least one microphone, the housing comprises: an outer surface with at least one microphone inlet, wherein the microphone is to be mounted under the microphone inlet and receives sound wave through the microphone inlet; wherein a damping structure is formed around the microphone inlet on the outer surface and stands out of the outer surface.

AUDIO DEVICE AND MANUFACTURING METHOD THEREOF

FIELD OF THE INVENTION

The present invention relates to technical field of microphone, and more specifically, to an audio device and a method for manufacturing an audio device.

BACKGROUND OF THE INVENTION

An audio device such as a portable device generally incorporates a microphone for recording or transmitting sound. The audio device has a microphone inside its housing. The housing has an inlet for passing sound wave into the microphone. The microphone is beneath the inlet.

In the prior art, generally, a series of holes are placed in the outer surface of the housing and act as the inlet for sound. Alternatively, some special material or slit is flush-mounted on the outer surface of housing and act as the inlet. In these solutions, the designers try make the inlet to be 'invisible' to the wind flow.

The audio device often encounters wind noise problems when being exposed to wind. In order to reduce the problem, a designer often covers the microphone with a thick layer of foam, or with an artificial hairy structure.

These solutions are not effective and are especially not suitable for wearable audio devices. For example, the foam layer covering the microphone has to be quite thick in order to efficiently reduce wind noise. It will often be difficult to attach a foam material on a small wearable or portable device. Furthermore, the foam material is not very durable, and will often be thorn off the product when being used. Besides, from a pure aesthetic design perspective, a foam material can also be undesirable for an audio device.

SUMMARY OF THE INVENTION

One object of this invention is to provide a new technical solution for reducing wind noise picked up by a microphone.

According to a first aspect of the present invention, there is provided an audio device, comprising: a housing for containing at least one microphone, the housing comprises: an outer surface with at least one microphone inlet, wherein the microphone is to be mounted under the microphone inlet and receives sound wave through the microphone inlet; wherein a damping structure is formed around the microphone inlet on the outer surface and stands out of the outer surface.

According to a second aspect of the present invention, there is provided method for manufacturing an audio device, comprising: forming a housing with at least one microphone inlet in an outer surface of the housing; providing at least one microphone in the housing, wherein the microphone is to be mounted under the microphone inlet and receives sound wave through the microphone inlet; and forming a damping structure around the microphone inlet on the outer surface and stands out of the outer surface.

According to an embodiment of this disclosure, the wind noise picked up by a microphone can be reduced.

Further features of the present invention and advantages thereof will become apparent from the following detailed description of exemplary embodiments according to the present invention with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description thereof, serve to explain the principles of the invention.

Fig. 1 is a schematic diagram showing a typical microphone inlet.

Fig. 2 is a perspective view of the typical microphone inlet.

Fig. 3 is a schematic diagram showing the situation where wind is passing by the typical microphone inlet.

Fig. 4 shows a schematic diagram of an audio device according to an embodiment of this disclosure.

Fig. 5 is a schematic diagram showing the situation where wind is passing by the

microphone inlet according to an embodiment of this disclosure.

Fig. 6 schematically shows various damping structures according to embodiments of this disclosure.

Fig. 7 schematically shows an embodiment of a damping structure with combined
5 protrusions.

Fig. 8 schematically shows another embodiment of a damping structure with combined protrusions.

Fig. 9 schematically shows a wearable audio device worn by a person.

Fig. 10 schematically shows various audio devices which the embodiments of this
10 disclosure can apply to.

Fig. 11 schematically shows a flow chart of a method for manufacturing an audio device according to another embodiment of this disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Various exemplary embodiments of the present invention will now be described in
15 detail with reference to the drawings. It should be noted that the relative arrangement of the components and steps, the numerical expressions, and numerical values set forth in these embodiments do not limit the scope of the present invention unless it is specifically stated otherwise.

The following description of at least one exemplary embodiment is merely
20 illustrative in nature and is in no way intended to limit the invention, its application, or uses.

Techniques, methods and apparatus as known by one of ordinary skill in the relevant art may not be discussed in detail but are intended to be part of the specification where appropriate.

In all of the examples illustrated and discussed herein, any specific values should be
25 interpreted to be illustrative only and non-limiting. Thus, other examples of the exemplary embodiments could have different values.

Notice that similar reference numerals and letters refer to similar items in the following figures, and thus once an item is defined in one figure, it is possible that it need

not be further discussed for following figures.

The image below illustrates a typical microphone inlet. The microphone is placed behind a surface, and the hole is an inlet through the surface to the microphone.

Fig. 1 is a schematic diagram showing a typical microphone inlet. As shown in Fig. 1, an inlet 103 is provided through the outer surface 102 of a housing of an audio device. A microphone 120 is arranged beneath the inlet 103 inside the housing.

Fig. 2 is a perspective view of the typical microphone inlet. In Fig. 2, the part of the inlet 103 and the microphone 120 beneath the outer surface 102 are shown in dash line.

Fig. 3 is a schematic diagram showing the situation where wind is passing by the typical microphone inlet. When wind is passing by the microphone inlet 103, it will create turbulence around the inlet 103, as schematically illustrated in Fig. 3. The turbulence will create fluctuations in air pressures in the microphone inlet 103, which will then be picked up as noise (wind noise) by the microphone.

Fig. 4 shows a schematic diagram of an audio device according to an embodiment of this disclosure.

As shown in Fig. 4, the audio device 200 comprises a housing 201 and at least one microphone 220 arranged in the housing 201. The housing 201 contains the at least one microphone 220. The housing 201 comprises: an outer surface 202 with at least one microphone inlet 203. The microphone 220 is to be mounted under the microphone inlet 203 and receives sound wave through the microphone inlet 203.

As shown in Fig. 4, a damping structure 204 is formed around the microphone inlet 203 on the outer surface 202 and stands out of the outer surface 202.

Fig. 5 is a schematic diagram showing the situation where wind is passing by the microphone inlet according to an embodiment of this disclosure and shows the effect of audio device in Fig. 4. As shown in Fig. 5, when wind is passing by the outer surface 202 of the housing 201, turbulences will be generated at the damping structure 204, so that the turbulence at the microphone inlet 203 will be reduced. As such, the amount of wind noise picked up by the microphone 220 will also be reduced.

Here, the damping structure is an “extra” structure on the outer surface of the

housing. It is intended to interact with the wind flow, and create a controlled turbulent layer. This local turbulent layer ends up actively “pushing” the wind away from the microphone inlet, resulting in less wind noise.

In wearable devices such as wireless headsets, the space inside is so sparse that it may be too difficult to find extra space to put a cavity around the microphone, or have space for a damping material inside the product. Many of these products also need to be waterproof, so the solutions with cavities, lots of holes, slits or a sintered material may not be applicable.

In this embodiment, the damping structure is on the outer surface of the housing of the audio device. The height and density of the standing-out structure of the damping structure will mainly depend on the shape of the standing-out structure, the size of the audio device, and the wind speed that it needs to cope with.

Fig. 6 schematically shows various damping structures according to embodiments of this disclosure. As shown in Fig. 6, as wind may pass over the microphone inlet from any direction, it is desirable to arrange the dampening structure 204 on all sides of the microphone inlet 203 or around the microphone inlet 203.

The patterns of the damping structure 204 may include round, ellipse, square, triangle and polygon such as pentagon, hexagon and so on. Exemplary patterns of hexagon, octagon and round of the damping structure 204 are shown in A, B, C of Fig. 6, respectively.

As shown in Fig. 6, the damping structure 204 may include a plurality of protrusions, and the shape of each protrusion may be column, cone or at least part of a sphere. Various exemplary column protrusions are shown in A-G, I of Fig. 6, and an exemplary hemispheroid protrusion is shown in I of Fig. 6.

For example, the column may include cylinder or prism, the cone may include circular cone or pyramid, and the at least part of a sphere may include hemispheroid. Exemplary cylinder columns are shown in A-F of Fig. 6, exemplary prism columns are shown in G of Fig. 6.

The damping structure 204 may include a sound-through structure over the

microphone inlet 203. An exemplary sound-through structure is shown in H of Fig. 6, which is a cross structure over the microphone inlet 203.

As shown in Fig. 6, the protrusions are formed around the microphone inlet and take the microphone inlet as their center.

5 As shown in D, E, F of Fig. 6, the protrusions may have different or same heights. Optionally, as shown in G, H, I of Fig. 6, the protrusions may have different or same shape.

The damping structure 204 may include a combination of various protrusions. Fig. 7 schematically shows combined protrusions including the cylinder columns shown in A of Fig. 6 and the sound-through structure shown in H of Fig. 6.

10 Fig. 8 schematically shows another embodiment of a damping structure with combined protrusions. As shown in Fig. 8, the damping structure may include at least three ring portions around the microphone inlet. The at least three ring portions include, outward from the microphone inlet, a first ring portion of cylinder, a second ring portion of prism and a third portion of hemispheroid.

15 The damping structure 204 can obstruct the wind flow around the microphone inlet and can be implemented in a variety of ways. The damping structure 204 may be made of a same material as the outer surface 202 of the housing 201, so that it can simply be incorporated as a surface structure. Alternatively, the damping structure 204 is made of a material softer than that of the outer surface. This softer damping structure 204 may be more
20 comfortable to wear, or be more robust. The height of the damping structure 204 may be less than 2 mm above the outer surface, so that the damping structure 204 can reduce the wind noise while it does not have too much influence on the usage of the audio device by a person.

Fig. 9 schematically shows a wearable audio device worn by a person. As shown in
25 Fig. 9, the audio device 200 is a wireless earphone, and the person wears it on his ear. As shown in Fig. 9, the microphone inlet may be arranged on the back surface of the earphone or on the side surface of the earphone.

The audio device adopting the solution of this disclosure can be various electronic device, such as headphone, headset, camera, wearable device, biometric sensor, smartphone,

laptop and so on. Fig. 10 schematically shows some audio devices, which the embodiments of this disclosure can apply to. The audio device can be an earbud, a smart watch, a smart phone, a headset as shown in a-d of Fig. 10, respectively.

The embodiments in this disclosure can reduce the wind noise picked up by a microphone. It will be advantageous to adopt them in portable and wearable devices, where it may not be possible or desirable to use foam.

Fig. 11 schematically shows a flow chart of a method for manufacturing an audio device according to another embodiment of this disclosure. Fig. 11 explains the processes of manufacturing the audio device which could be that as described above, and thus some repetitive description thereof will be omitted.

As shown in Fig. 11, at step S2100, a housing is formed with at least one microphone inlet in an outer surface of the housing.

At step S2200, at least one microphone is provided in the housing, wherein the microphone is to be mounted under the microphone inlet and receives sound wave through the microphone inlet.

At step S2300, a damping structure is formed around the microphone inlet on the outer surface and stands out of the outer surface.

For example, the step S2300 may include forming the pattern of the damping structure as one of round, ellipse, square, triangle and polygon. The step S2300 may include forming the damping structure as a plurality of protrusions, and the shape of each protrusion is formed as a column, cone or at least part of a sphere, wherein the column includes cylinder or prism, the cone includes circular cone or pyramid, and the at least part of a sphere includes hemispheroid. The step S2300 may include forming the protrusions around the microphone inlet and take the microphone inlet as their center. The step S2300 may include forming the protrusions in different or same heights; and/or, forming the protrusions in different or same shape.

The step S2300 may include forming the damping structure as a sound-through structure over the microphone inlet. For example, the sound-through structure is a cross structure over the microphone inlet.

For example, the housing and the damping structure are formed in a single molding process, using a same material, so that the processing thereof is relatively simple, which will reduce its defective rate. Alternatively, the housing and the damping structure are formed in separate molding processes, using a different material, wherein the damping structure is
5 made of a material softer than that of the outer surface.

The damping structure is formed with a height less than 2 mm above the outer surface.

The step S2300 may include forming the damping structure to include at least three ring portions around the microphone inlet, wherein the at least three ring portions include,
10 outward from the microphone inlet, a first ring portion of cylinder, a second ring portion of prism and a third portion of hemispheroid.

Although some specific embodiments of the present invention have been demonstrated in detail with examples, it should be understood by a person skilled in the art that the above examples are only intended to be illustrative but not to limit the scope of the
15 present invention.

CLAIMS

What is claimed is:

1. An audio device, comprising:

a housing for containing at least one microphone, the housing comprises:

5 an outer surface with at least one microphone inlet, wherein the microphone is to be mounted under the microphone inlet and receives sound wave through the microphone inlet;

 wherein a damping structure is formed around the microphone inlet on the outer surface and stands out of the outer surface.

10 2. The audio device according to claim 1, wherein the pattern of the damping structure is one of round, ellipse, square, triangle and polygon.

 3. The audio device according to claim 1 or 2, wherein the damping structure includes a plurality of protrusions, and the shape of each protrusion is column, cone or at least part of a
15 sphere.

 4. The audio device according to claim 3, wherein the protrusions are formed around the microphone inlet and take the microphone inlet as their center.

20 5. The audio device according to claim 3, wherein the protrusions have different or same heights; and/or,
 the protrusions have different or same shape.

 6. The audio device according to claim 3, wherein the column includes cylinder or prism,
25 the cone includes circular cone or pyramid, and the at least part of a sphere includes hemispheroid.

7. The audio device according to claim 1 or 2 or 3, wherein the damping structure includes a sound-through structure over the microphone inlet.

8. The audio device according to claim 7, wherein the sound-through structure is a cross structure over the microphone inlet.

9. The audio device according to claim 1 or 2, wherein the damping structure is made of a same material as the outer surface, or the damping structure is made of a material softer than that of the outer surface.

10. The audio device according to claim 1 or 2, wherein a height of the damping structure is less than 2 mm above the outer surface.

11. The audio device according to claim 1 or 2, wherein the damping structure includes at least three ring portions around the microphone inlet, and the at least three ring portions include, outward from the microphone inlet, a first ring portion of cylinder, a second ring portion of prism and a third portion of hemispheroid.

12. A method for manufacturing an audio device, comprising:
forming a housing with at least one microphone inlet in an outer surface of the housing;
providing at least one microphone in the housing, wherein the microphone is to be mounted under the microphone inlet and receives sound wave through the microphone inlet; and
forming a damping structure around the microphone inlet on the outer surface and stands out of the outer surface.

13. The method according to claim 12, wherein forming a damping structure further comprises:

forming the pattern of the damping structure as one of round, ellipse, square, triangle and polygon.

14. The method according to claim 12 or 13, wherein forming a damping structure further comprises:

forming the damping structure as a plurality of protrusions, and the shape of each protrusion is formed as a column, cone or at least part of a sphere;

wherein the column includes cylinder or prism, the cone includes circular cone or pyramid, and the at least part of a sphere includes hemispheroid.

15. The method according to claim 14, wherein forming a damping structure further comprises:

forming the protrusions around the microphone inlet and take the microphone inlet as their center.

16. The method according to claim 14, wherein forming a damping structure further comprises:

forming the protrusions in different or same heights; and/or,
forming the protrusions in different or same shape.

17. The method according to claim 12 or 13, wherein forming a damping structure further comprises:

forming the damping structure as a sound-through structure over the microphone inlet.
wherein the sound-through structure is a cross structure over the microphone inlet.

18. The method according to claim 12 or 13, wherein the housing and the damping structure are formed in a single molding process, using a same material,

or the housing and the damping structure are formed in separate molding processes, using a different material, wherein the damping structure is made of a material softer than that of the outer surface.

19. The method according to claim 12 or 13, wherein the damping structure is formed with a height less than 2 mm above the outer surface.

20. The method according to claim 12 or 13, wherein forming a damping structure further comprises:

forming the damping structure to include at least three ring portions around the microphone inlet, wherein the at least three ring portions include, outward from the microphone inlet, a first ring portion of cylinder, a second ring portion of prism and a third portion of hemispheroid.

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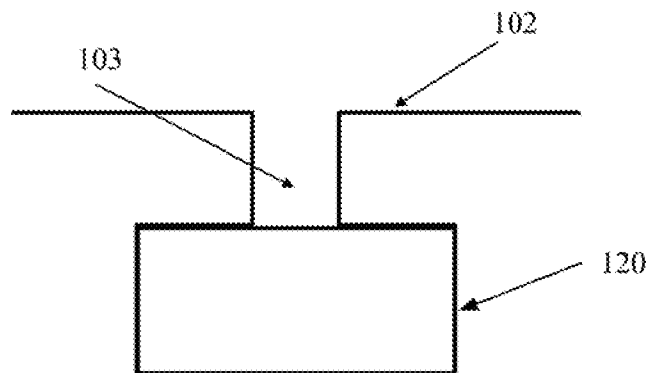


FIG. 1

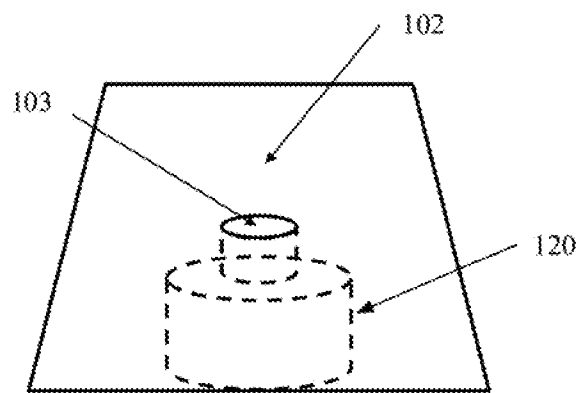


FIG. 2

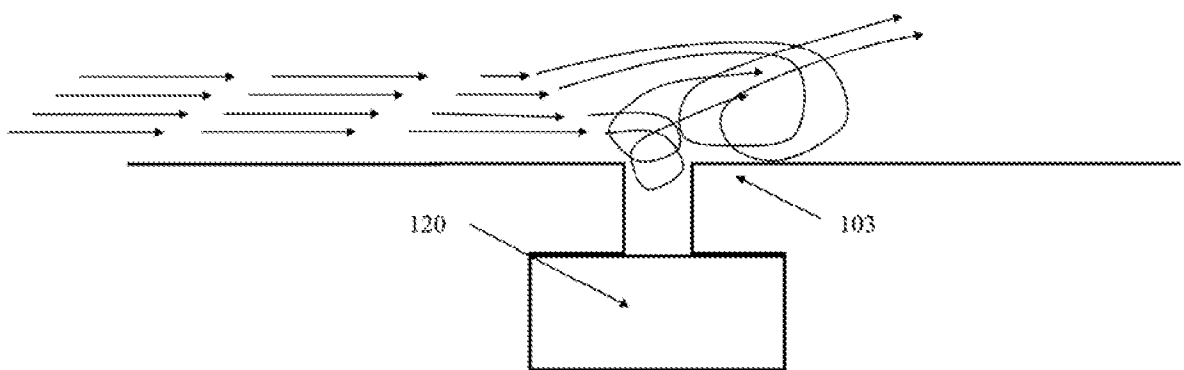


FIG. 3

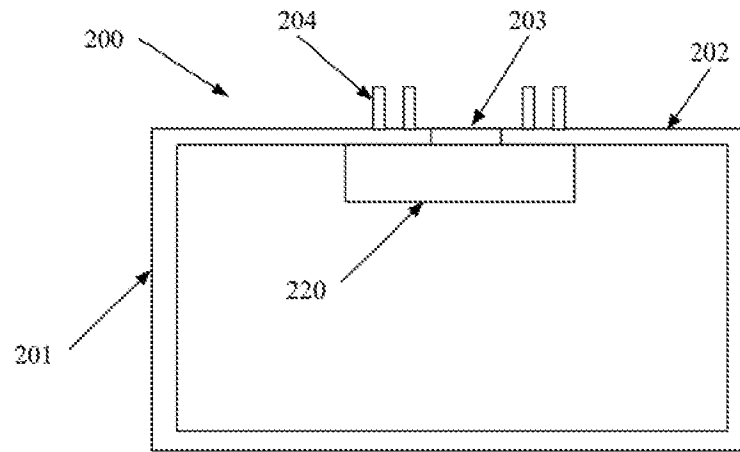


FIG. 4

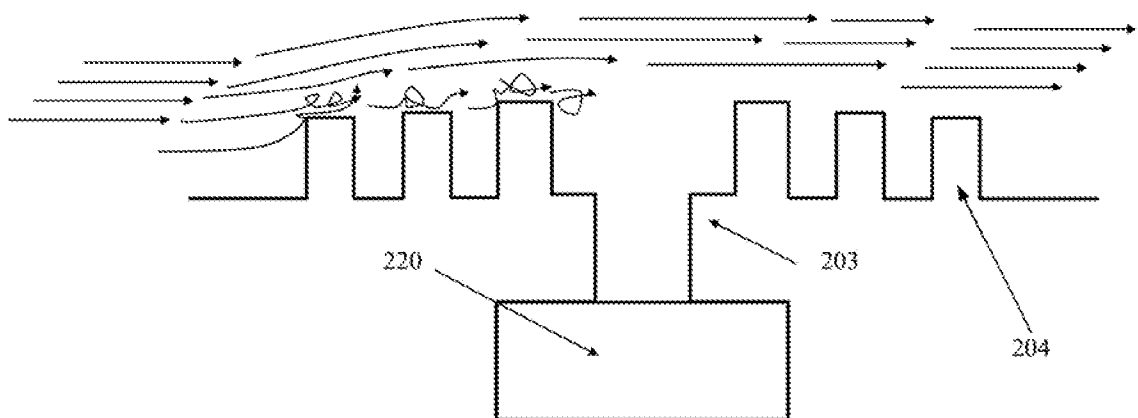


FIG. 5

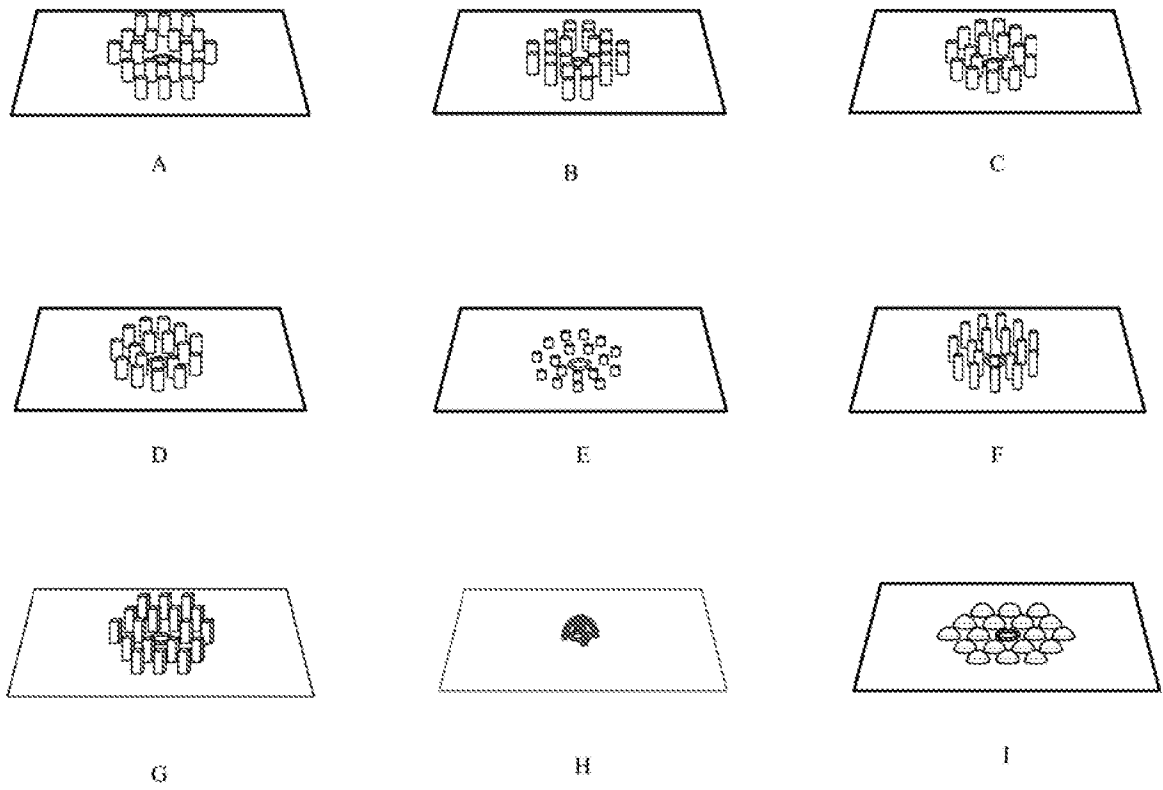


FIG. 6

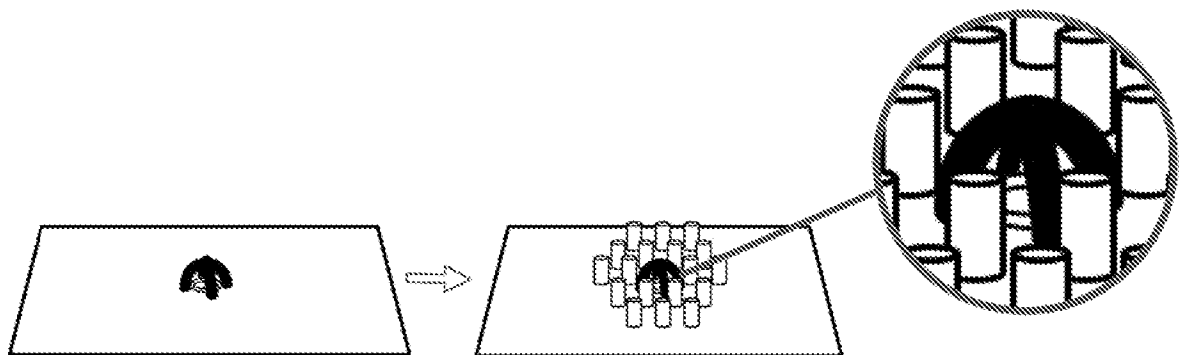


FIG. 7

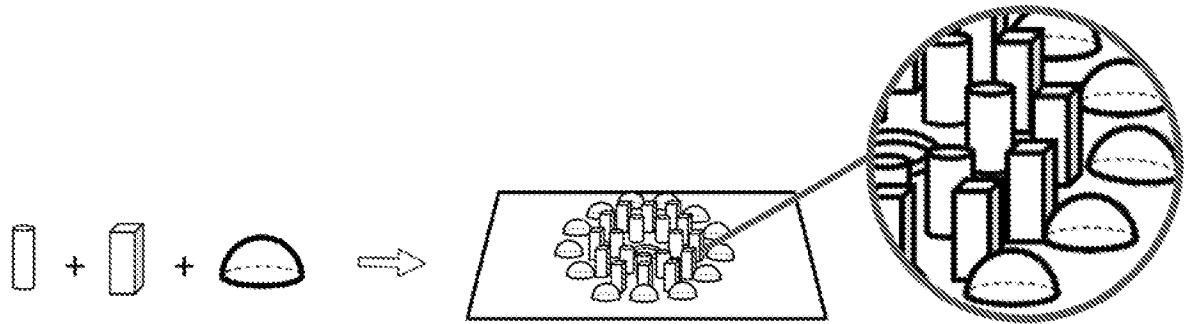


FIG. 8

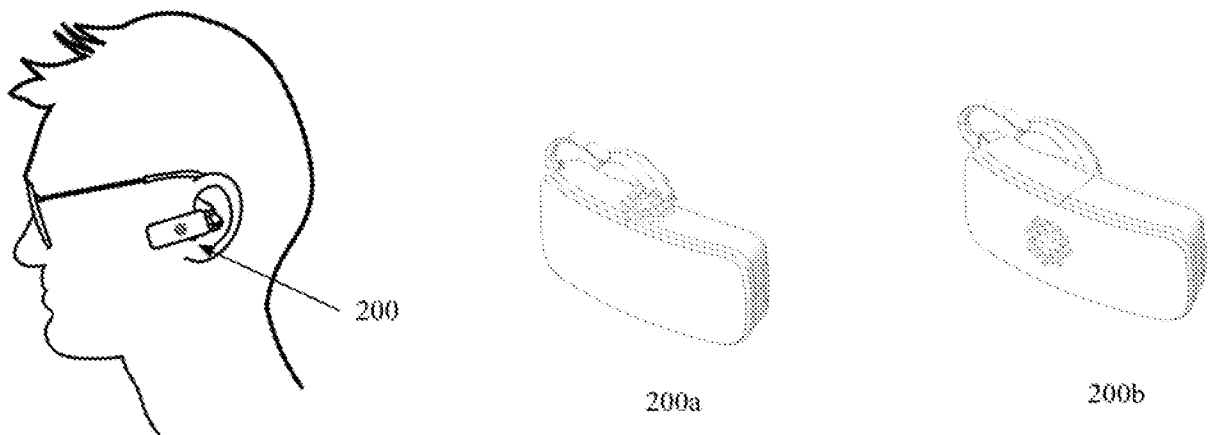


FIG. 9

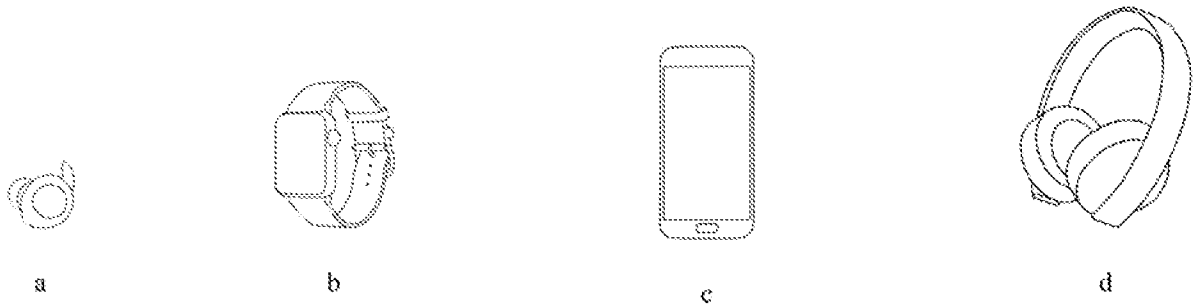


FIG. 10

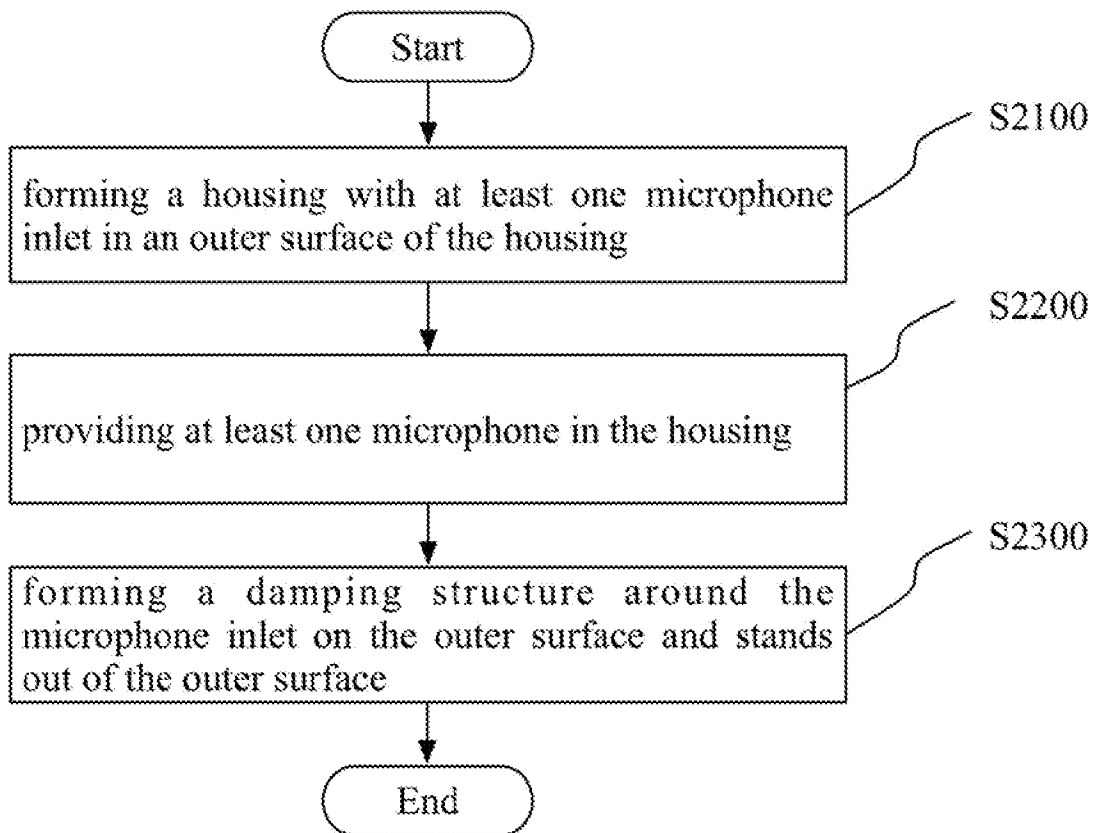


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/087532

A. CLASSIFICATION OF SUBJECT MATTER

H04R 19/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS;CNTXT;CNKI;VEN;USTXT;EPTXT;WOTXT: wind, noise, microphone, mic, damp+, column?, inlet, hole

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 207283807 U (SHENZHEN AICHEN ELECTRONICS CO., LTD.) 27 April 2018 (2018-04-27) description, paragraphs [0015]-[0018], figure 1	1, 12
X	US 2010067727 A1 (SPEEDCOM COMMUNICATIONS INC.) 18 March 2010 (2010-03-18) description, paragraphs [0031]-[0053]	1, 12
A	CN 106878842 A (SHENZHEN VOXTECH CO., LTD.) 20 June 2017 (2017-06-20) the whole document	1-20
A	CN 206602610 U (AAC TECHNOLOGIES SINGAPORE CO., LTD.) 31 October 2017 (2017-10-31) the whole document	1-20

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

13 February 2019

Date of mailing of the international search report

21 February 2019

Name and mailing address of the ISA/CN

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ZHAO,Xiaoqing

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Telephone No. 86-(010)-62411426

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/087532

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	207283807	U	27 April 2018	None			
US	2010067727	A1	18 March 2010	US	8351633	B2	08 January 2013
CN	106878842	A	20 June 2017	None			
CN	206602610	U	31 October 2017	None			