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(72) Inventors:
• **HOSHINO, Hiroki**
Kiryu-shi Gunma, 3768555 (JP)
• **KIUCHI, Yuto**
Kiryu-shi Gunma, 3768555 (JP)

(74) Representative: **2K Patentanwälte Blasberg Kewitz & Reichel Partnerschaft mbB Schumannstrasse 27 60325 Frankfurt am Main (DE)**

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(71) Applicant: **Mitsuba Corporation**
Kiryu-shi, Gunma 376-8555 (JP)

(54) **HORN DEVICE**

(57) A horn device (A), which is capable of preventing production of abnormal noise is provided. The horn device (A) which resonates, by a resonator (1), sound produced by vibrating a diaphragm (21) and comprises: a control part (34), which vibrates the diaphragm (21); a temperature measurement part (30), which measures the temperature inside the horn device (A); and a voltage measurement part (31), which measures the voltage value used to vibrate the diaphragm (21); wherein the control part (34) deviates a vibration frequency which vibrates the diaphragm (21) from a resonance frequency (f_c) according to at least any of the temperature measured by the temperature measurement part (30) and the voltage value measured by the voltage measurement part (31).

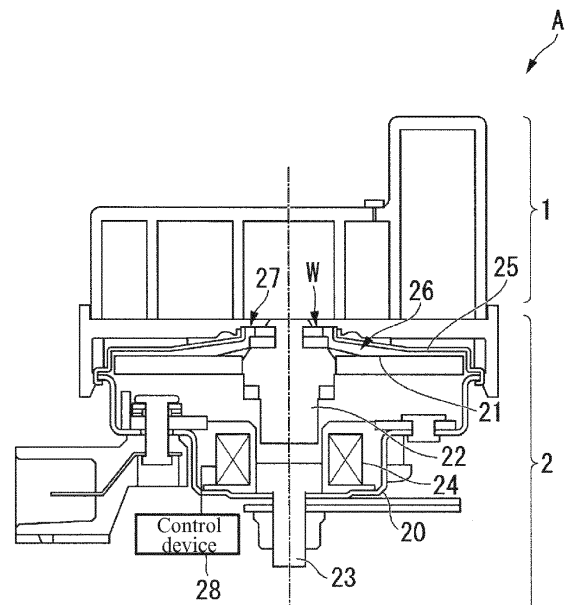


FIG. 1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a horn device.

2. Description of Related Art

[0002] In patent literature 1, a horn device is disclosed which vibrates a diaphragm at a predetermined vibration frequency by magnetic force of an electromagnet generated by energization, and resonate by a resonator the sound produced by the vibration to produce sound.

[Literature of Prior Art]

[Patent Literature]

[0003] [Patent Literature 1] Japanese Patent Application Laid-Open No. 2017-9624

SUMMARY OF THE INVENTION

[Problems to be Solved by the Invention]

[0004] By the way, in the conventional horn device, when the temperature is low, resistance value of the coil constituting the electromagnet decreases, and plenty of current flows through the coil. Accordingly, attraction force of the electromagnet increases. Therefore, a fixed iron core may collide with a movable iron core, causing the generation of abnormal noise.

[0005] The present invention is accomplished in view of such situation, and aims at providing a horn device which is capable of preventing the produce of abnormal noise.

[Means to Solve the Problems]

[0006] One of the embodiments of the present invention is a horn device, which is configured to resonate, by a resonator, sound produced by vibrating a diaphragm, comprising: a control part configured to vibrate the diaphragm; a temperature measurement part configured to measure a temperature inside the horn device; and a voltage measurement part configured to measure the voltage value used to vibrate the diaphragm; wherein the control part deviates a vibration frequency which vibrates the diaphragm from a resonance frequency according to at least any of the temperature measured by the temperature measurement part and the voltage value measured by the voltage measurement part.

[0007] One of the embodiments of the present invention is the aforementioned horn device, wherein the control part reduces the vibration frequency which vibrates the diaphragm for only a predetermined value according

to at least any of the temperature measured by the temperature measurement part and the voltage value measured by the voltage measurement part.

[0008] One of embodiments of the present invention is the aforementioned horn device, wherein the control part reduces the vibration frequency which vibrates the diaphragm for only the predetermined value in at least any of situations when the temperature measured by the temperature measurement part is determined to be within a temperature range of low temperature, and when the voltage value measured by the voltage measurement part is determined to be within a voltage range of high voltage. Low temperature is -30°C or below for example. High voltage is 15V or above for example.

[Effect of the Invention]

[0009] As described above, according to the present invention, production of abnormal noise can be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is a drawing showing one example of a schematic structure of a horn device A according to one embodiment of the present invention.

Fig. 2 is an external view of a resonator 1 according to one embodiment of the present invention.

Fig. 3 is a drawing showing one example of a schematic structure of a control device 28 according to one embodiment of the present invention.

Fig. 4 is a flow chart of an operation of energization control of a coil 24 according to one embodiment of the present invention.

Fig. 5 is a drawing illustrating the change of vibration frequency of a diaphragm according to a voltage value measured by a voltage measurement part of one embodiment of the present invention.

Figs. 6(a) and 6(b) are drawings illustrating the change of vibration frequency of the diaphragm according to a temperature measured by a temperature measurement part of one embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0011] In the following part, the present invention is described through embodiments of the invention, but the following embodiments do not limit the invention. Besides, not all the combinations of characteristics described in the embodiments are necessary to the solving method of the invention. In addition, in the drawings, the same or similar parts are marked with the same symbols and repeated description is omitted sometimes. Moreover, shapes, sizes and the like of the elements in the drawings may be exaggeratedly shown for a clearer de-

scription.

[0012] In the whole specification, as long as no opposing description exists, the expression that a certain part "include(s)", "has/have" or "comprise(s)" a certain structural element means that other structural elements can be further included instead of being excluded.

[0013] In the following part, a horn device according to one embodiment of the present invention is described with reference to drawings. The horn device according to one embodiment of the present invention is, for example, a horn device which is mounted on a front side of a vehicle such as an automobile and produces a warning sound.

[0014] Fig. 1 is a drawing showing one example of a schematic structure of a horn device A according to one embodiment of the present invention. As shown in Fig. 1, the horn device A comprises a resonator 1 and a horn body part 2.

The resonator 1 is mounted on the horn body part 2. The resonator 1 resonates the sound produced by the horn body part 2 and produces sound outside.

[0015] Fig. 2 is an external view of the resonator 1 according to one embodiment of the present invention. As shown in Fig. 2, the resonator 1 comprises a sound guide 10.

The sound guide 10 is spirally shaped. The sound guide 10 comprises a wall 11 and a sound outlet 12.

[0016] The wall 11 is an enclosure wall with an approximately U-shaped cross section and a predetermined thickness. On an internal side of the wall 11, a path is formed. The path is formed for the sound produced in the horn body part 2 to pass through.

In the central part of the spiral shape in the sound guide 10, a sound inlet (not shown) for the sound produced in the horn body part 2 to get into is arranged.

The sound outlet 12 is a bugle-shaped opening part arranged on an outlet side of the sound guide 10.

[0017] According to the aforementioned structure, the sound produced in the horn body part 2 resonates from the sound inlet of the resonator 1 through the sound guide 10 and is amplified to a predetermined sound pressure level. Then, the amplified sound is produced outside from the sound outlet 12 of the resonator 1.

[0018] Back to Fig. 1, the structure of the horn body part 2 according to the first embodiment is described.

The horn body part 2 comprises a case 20, a diaphragm 21, a movable iron core 22, a fixed iron core 23, a coil 24, a cover 25, an air vibration chamber (chamber) 26, an airflow path 27 and a control device 28.

[0019] In the case 20, the diaphragm 21, the movable iron core 22, the fixed iron core 23, the coil 24, the cover 25, the air vibration chamber (chamber) 26, the airflow path 27 and the control device 28 are accommodated.

[0020] The diaphragm 21 is arranged to infill the opening part of the case 20. The diaphragm 21 is, formed to an approximate disk shape by stamping a thin steel plate for example. In the central part of the diaphragm 21, the movable iron core 22 is fixed. For example, the dia-

phragm 21 is fixed to the resonator 1 by being fastened with a washer W.

[0021] The movable iron core 22 is formed to a cylinder shape by magnetic material. One end of the movable iron core 22 is fixed to the diaphragm, and the other end is disposed facing the fixed iron core 23. Here, the shaft center of the movable iron core 22 corresponds with the shaft center of the fixed iron core 23. That is, the movable iron core 22 and the fixed iron core 23 are disposed coaxially with each other.

[0022] The fixed iron core 23 is disposed on the center of the coil 24. That is, the fixed iron core 23 and the coil 24 are formed as an electromagnet. Besides, the fixed iron core 23 is fixed to the case 20.

[0023] The coil 24 is formed by conductive material, and is wound with a predetermined number of turns. The coil 24 is electrically connected with the control device 28. The cover 25 is fixed to the case 20. The periphery section of the cover 25 is fastened to both the periphery section of the case 20 and the periphery section of the diaphragm 21.

[0024] An air vibration chamber 26 is formed between the cover 25 and the diaphragm 21.

The airflow path 27 is formed between the cover 25 and the washer W. The airflow path 27 is configured to let the air from the air vibration chamber 26 pass through, accompanied by the vibration of the diaphragm 21.

[0025] By energizing the coil 24, the control device 28 turns the fixed iron core 23 disposed on the center of the coil 24 to an electromagnet and produces magnetic force.

[0026] In the following part, a sound producing method according to one embodiment of the present invention is described.

By the magnetic force generated by the energization control performed to the coil 24 at a predetermined frequency f_{out} , the control device 28 moves the movable iron core 22 back and forth to vibrate the diaphragm 21. Accordingly, a volume of the ring-shaped air vibration chamber 26, which is formed between the cover 25 and the diaphragm 21, increases or decreases. Accordingly, air flowing is generated in the airflow path 27. In this way, the diaphragm 21 vibrates at a predetermined frequency f_{out} , and the vibration becomes sound and is produced from the airflow path 27. In addition, when the predetermined frequency f_{out} is approximately the same as the resonance frequency f_c , the sound pressure is the largest. Moreover, the resonance frequency f_c is a value determined by the shape of material of the resonator 1. However, the resonance frequency f_c varies in accordance with the ambient temperature of the horn device A.

[0027] In the following part, the structure of the control device 28 according to one embodiment of the present invention is described with reference to Fig. 3.

As shown in Fig. 3, the control device 28 comprises a temperature measurement part 30, a voltage measurement part 31, a power supply device 32, a driving part 33, a control part 34 and a memory part 35.

The temperature measurement part 30 measure the am-

bient the temperature T of the horn device A. For example, the temperature measurement part 30 is arranged inside the control device 28. Then, the temperature measurement part 30 measures the temperature T inside the control device 28. The temperature measurement part 30 outputs the measured temperature T to the control part 34.

[0028] The voltage measurement part 31 measures the voltage value V_b which is used to vibrate the diaphragm 21. For example, the voltage measurement part 31 measures the voltage value V_b output from the power supply device 32. Here, the voltage value V_b may also be the voltage applied to the coil 24. The voltage measurement part 31 outputs the measured voltage V_b to the control part 34.

[0029] The power supply device 32 supplies power to each part of the control device 28. For example, the power supply device 32 is a battery. For example, secondary batteries such as a nickel-hydrogen battery or a lithium-ion battery can be used as the power supply device 32. Besides, instead of secondary batteries, an electric double layer capacitor (condenser) can also be used.

[0030] Based on a PWM (Pulse Width Modulation) signal output from the control part 34, the driving part 33 converts the direct-current power from the power supply device 32 to an alternating-current power, and outputs the converted alternating-current power to the coil 24. In this way, the coil 24 is energized.

[0031] By outputting the PWM signal to the driving part 33, the control part 34 energizes the coil 24 and vibrates the diaphragm 21 at a predetermined frequency. In this case, the control part 34 changes the frequency which vibrates the diaphragm 21 according to the temperature T measured in the temperature measurement part 30. Here, the frequency at which the diaphragm 21 vibrates (referred to as "vibration frequency" hereinafter) is the frequency f_{out} of the PWM signal. Here, a characteristic of the control part 34 is that when the temperature T measured by the temperature measurement part 30 is within the temperature range of low temperature, the control part 34 deviates the vibration frequency which vibrates the diaphragm 21 from the resonance frequency f_c at which the amplitude of the diaphragm 21 is the greatest.

[0032] To be specific, when the temperature T measured by the temperature measurement part 30 is within a normal temperature range (ranging from the first temperature threshold T_{th1} to the second temperature threshold T_{th2}), the control part 34 sets the frequency f_{out} to the frequency f_0 which is the initial value of the frequency of PWM signals. Here, the frequency f_0 is the resonance frequency f_c in the normal temperature range. On the other hand, when the temperature T measured by the temperature measurement part 30 is within a temperature range of low temperature (lower than the first temperature threshold), the control part 34 sets the frequency f_{out} to a value ($f_0 - f_x$) obtained by subtracting a predetermined frequency f_x from the frequency f_0 .

[0033] In this way, when the current value flowing through the coil 24 increases because the ambient temperature of the horn device A becomes a low temperature, the control part 34 inhibits the amplitude of the diaphragm 21 by deviating the vibration frequency from the resonance frequency f_c . Accordingly, the control part 34 can prevent the collision of the movable iron core 22 and the fixed iron core 23, and can prevent the production of abnormal noise.

[0034] Besides, the control part 34 changes the frequency which vibrates the diaphragm 21 according to the voltage value V_b measured by the voltage measurement part 31. Here, a characteristic of the control part 34 is that when the voltage value V_b measured by the voltage measurement part 31 is within a voltage range of high voltage, the control part 34 deviates the vibration frequency which vibrates the diaphragm 21 from the resonance frequency f_c .

[0035] To be specific, when the voltage value V_b measured by the voltage measurement part 31 is within a normal voltage range (ranging from the first voltage threshold V_{th1} to the second voltage threshold V_{th2}), the control part 34 sets the frequency f_{out} to the frequency f_0 which is the initial value of the frequency of PWM signals.

On the other hand, when the voltage value V_b measured by the voltage measurement part 31 is within a voltage range of high voltage (higher than the second temperature threshold T_{th2}), the control part 34 sets the frequency f_{out} to a value ($f_0 - f_x$) obtained by subtracting the predetermined frequency f_x from the frequency f_0 .

[0036] In this way, when the current value flowing through the coil 24 increases because the voltage output from the power supply device 32 is within the voltage range of high voltage, the control part 34 inhibits the amplitude of the diaphragm 21 by deviating the vibration frequency from the resonance frequency f_c . Accordingly, the control part 34 can prevent the collision of the movable iron core 22 and the fixed iron core 23, and can prevent the production of abnormal noise. Moreover, when the current value flowing through the coil 24 increases because the ambient temperature (for example, the temperature T) of the horn device A becomes a low temperature, the control part 34 may also prevent the amplitude of the diaphragm 21 by deviating the vibration frequency from the resonance frequency f_c .

[0037] In the following part, the operation of the energization control of the coil 24 according to this embodiment is described with reference to Fig. 4.

First, the control part 34 sets the frequency f_{out} to the frequency f_0 which is the initial value. Besides, the control part 34 sets the duty ratio D_{out} to the duty ratio D_0 which is the initial value (step S101). Here, when a warning signal is obtained from outside, the control part 34 generates PWM signals of the set frequency f_{out} and duty ratio D_{out} , and outputs the generated PWM signals to the driving part 33. In this way, the control part 34 energizes the coil 24 and vibrates the diaphragm 21 at the frequency f_0 , by which sound is produced from the sound outlet 12

of the resonator 1 to outside.

[0038] Next, the control part 34 obtains the temperature T from the temperature measurement part 30 (step S102).

The control part 34 determines whether the obtained temperature T is within the temperature range of low temperature (step S103). For example, when the obtained temperature T is determined to be lower than the first temperature threshold T_{th1} , the control part 34 determines that the obtained temperature T is within the temperature range of low temperature. On the other hand, when the obtained temperature T is determined to be higher than the first the temperature threshold T_{th1} , the control part 34 determines that the temperature T is not within the temperature range of low temperature. In addition, the first the temperature threshold T_{th1} is set according to the temperature of the coil 24 when the current value, which is capable of producing the attraction force that collides the fixed iron core with the movable iron core when PWM signals are output to the coil 24, flows through the coil 24.

[0039] When the obtained temperature T is not within the temperature range of low temperature, the control part 34 obtains the voltage value V_b from the voltage measurement part 31 (step S104).

[0040] The control part 34 determines whether the obtained voltage value V_b from the voltage measurement part 31 is within the voltage range of high voltage (step S105). For example, when the obtained voltage value V_b is determined to be higher than the second voltage threshold V_{th2} , the control part 34 determines that the obtained voltage value V_b is within the voltage range of high voltage. On the other hand, when the obtained voltage value V_b is lower than the second voltage threshold V_{th2} , the control part 34 determines that the voltage value V_b is not within the voltage range of high voltage. In addition, the second voltage threshold V_{th2} is set according to the voltage applied to the coil 24 or the output voltage of the power supply device 32 when the current value, which is capable of producing the attraction force that collides the fixed iron core with the movable iron core in the electromagnet, flows through the coil 24.

[0041] When the obtained voltage value V_b is determined not to be within the voltage range of high voltage, the control part 34 sets the frequency f_{out} which is approximately equal to the resonance frequency f_c to the frequency f_0 (step S106).

On the other hand, when the obtained voltage value V_b is determined to be within the voltage range of high voltage, as shown in Fig. 5, the control part 34 sets the frequency f_{out} to the value $(f_0 - f_x)$ obtained by subtracting the predetermined frequency f_x from the frequency f_0 (step S107). Accordingly, when the voltage value V_b is determined to be within the voltage range of high voltage, the control part 34 can inhibit the amplitude of the diaphragm 21 by deviating the vibration frequency from the resonance frequency f_c and prevent abnormal noise. In addition, as shown in Fig. 5, when the voltage value V_b

becomes high, the resonance frequency f_c becomes high.

[0042] In the treatment of step S103, when the obtained temperature T is determined to be within the temperature range of low temperature, the control part 34 sets the frequency f_{out} to the value $(f_0 - f_x)$ obtained by subtracting the predetermined frequency f_x from the frequency f_0 (step S108). Accordingly, when the temperature T is determined to be within the temperature range of low temperature, the control part 34 can inhibit the amplitude of the diaphragm 21 and prevent abnormal noise by deviating the vibration frequency from the resonance frequency f_c . In addition, when the frequency property of the diaphragm 21 at room temperature shown in Fig. 6(a) is compared with the frequency property of the diaphragm 21 at low temperature shown Fig. 6(b), the resonance frequency f_c at low temperature is higher than the resonance frequency f_c at room temperature.

[0043] As mentioned above, the horn device A according to one embodiment of the present invention is characterized in deviating the vibration frequency which vibrates the diaphragm 21 from the resonance frequency f_c according to at least any of the temperature T measured by the temperature measurement part 30 and the voltage value V_b measured by the voltage measurement part 31. Accordingly, the horn device A can prevent the production of abnormal noise caused by the collision of the fixed iron core 23 and the movable iron core 22 due to the increase of attraction force of the electromagnet.

[0044] To be specific, in at least any situation of the situation when the temperature T measured by the temperature measurement part 30 is determined to be a low temperature, and the situation when the voltage value V_b measured by the voltage measurement part 31 is determined to be a high voltage, the control part 34 of the horn device A reduces the vibration frequency (f_{out}) which vibrates the diaphragm 21 for only a predetermined value f_x .

[0045] The control part 34 of the aforementioned embodiment may also be realized by a computer. In this situation, a program used to realize the function may be recorded in a computer-readable recording medium, and the function may be realized by making a computer system read in the program recorded in the recording medium and implementing the program. In addition, the "computer system" mentioned here includes a hardware such as OS or peripheral device. Besides, the "computer-readable recording medium" is a memory device such as a movable medium like a flexible disk, a magnetic optical disk, a ROM and a CD-ROM, and a built-in hard disk in the computer system. Further, the expression of "computer-readable recording medium" means a recording medium which dynamically keeps programs for a short time like a communication wire that transmits programs via a network such as the Internet or via a communication line such as a telephone line, including a recording medium which keeps programs for a specific time like a volatile memory within the computer system which

becomes a server or client in this situation. Moreover, the programs may be programs which are used to realize a part of the functions, may be programs realized by a further combination with programs which already record the functions in the computer system, or may be programs which are realized by using programmable logic arrays such as a FPGA (Field Programmable Gate Array).

[0046] In the aforementioned part, the embodiment of the present invention is described in detail with reference to the drawings, but the specific structure is not limited to the embodiment, and the designs in a scope not departing from the spirit of the present invention are also included.

[0047] The fact should be noticed that the devices, systems and programs shown in the scope of the specification and the drawings, as well as the implementation sequence of each treatment of the operations, procedures, steps and stages in the method can be performed in any sequence as long as there is no particular description such as "before ...", "in advance of ..." and so on, and the result of the former treatment is not used in the latter treatment. As for the operation flow in the scope of the specification and the drawings, even if the expressions of "first", "next" and so on are used in the description for convenience, it is not necessary to follow this sequence.

[Description of the Symbols]

[0048]

A	Horn device	
1	resonator	
2	Horn body part	
20	Case	35
21	Diaphragm	
22	Movable iron core	
23	Fixed iron core	
24	Coil	
25	Cover	40
26	Air vibration chamber (chamber)	
27	Airflow path	
28	Control device	
30	Temperature measurement part	
31	Voltage measurement part	45
32	Power supply device	
33	Driving part	
34	Control part	
35	Memory part	50

Claims

1. A horn device (A), which is configured to resonate, by a resonator (1), sound produced by vibrating a diaphragm (21), comprising:

a control part (34) configured to vibrate the dia-

phragm;

a temperature measurement part (30) configured to measure a temperature inside the horn device (A); and

a voltage measurement part (31) configured to measure a voltage value used to vibrate the diaphragm (21); wherein

the control part (34) deviates a vibration frequency which vibrates the diaphragm (21) from a resonance frequency (f_c) according to at least any of the temperature measured by the temperature measurement part (30) and the voltage value measured by the voltage measurement part (31).

2. The horn device (A) according to claim 1, wherein the control part (34) reduces the vibration frequency which vibrates the diaphragm for only a predetermined value according to at least any of the temperature measured by the temperature measurement part (30) and the voltage value measured by the voltage measurement part (31).
3. The horn device (A) according to claim 2, wherein the control part (34) reduces the vibration frequency which vibrates the diaphragm (21) for only the predetermined value in at least any of situations when the temperature measured by the temperature measurement part (30) is determined to be within a temperature range of low temperature, and when the voltage value measured by the voltage measurement part (31) is determined to be within a voltage range of high voltage.

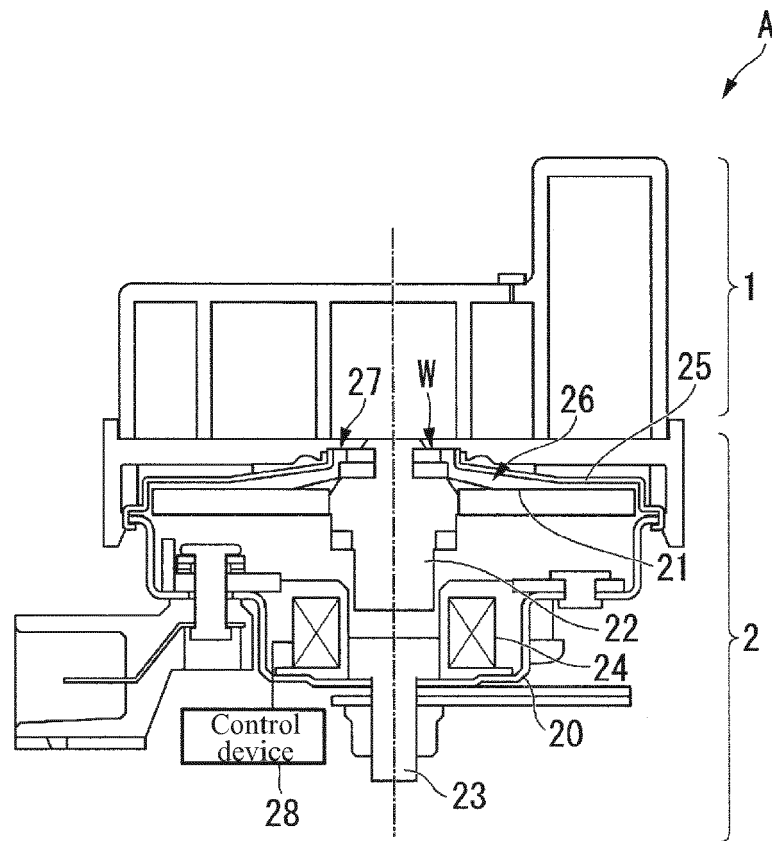


FIG. 1

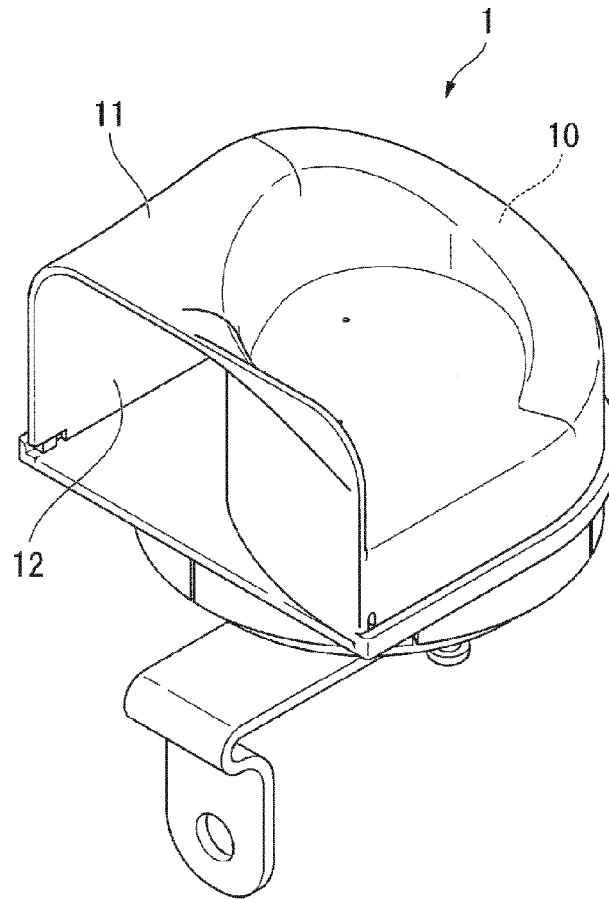


FIG. 2

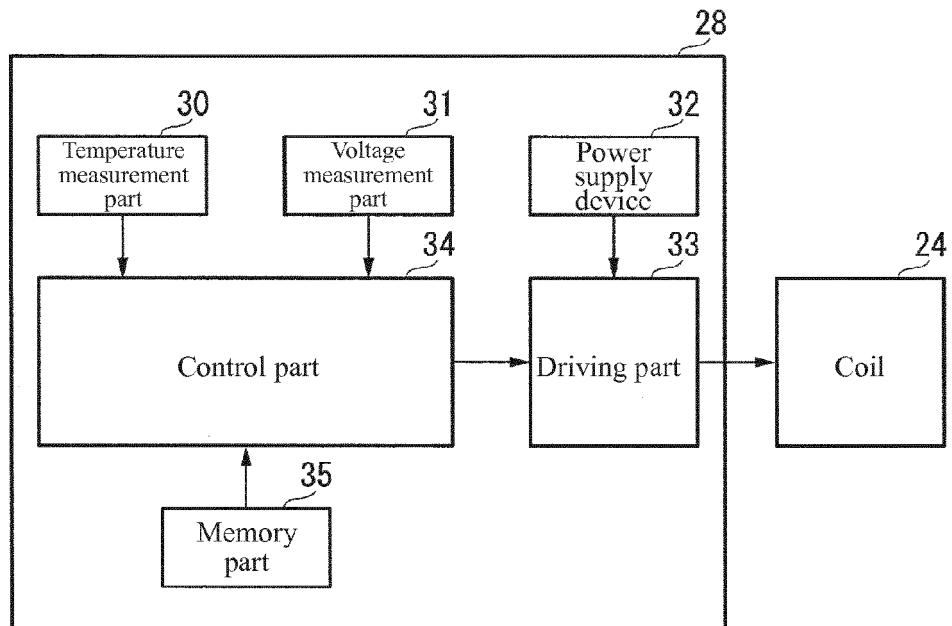


FIG. 3

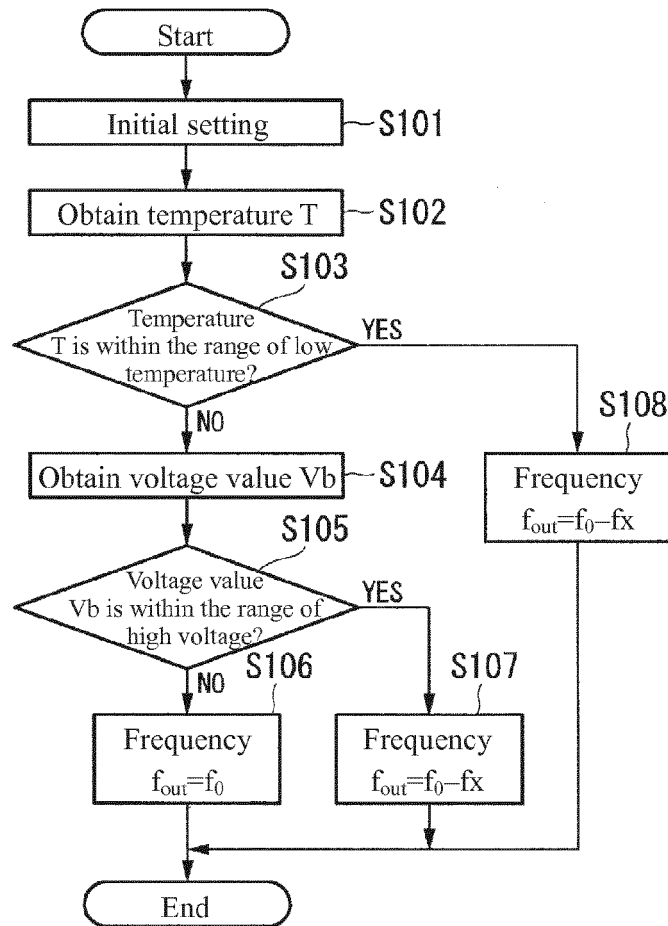


FIG. 4

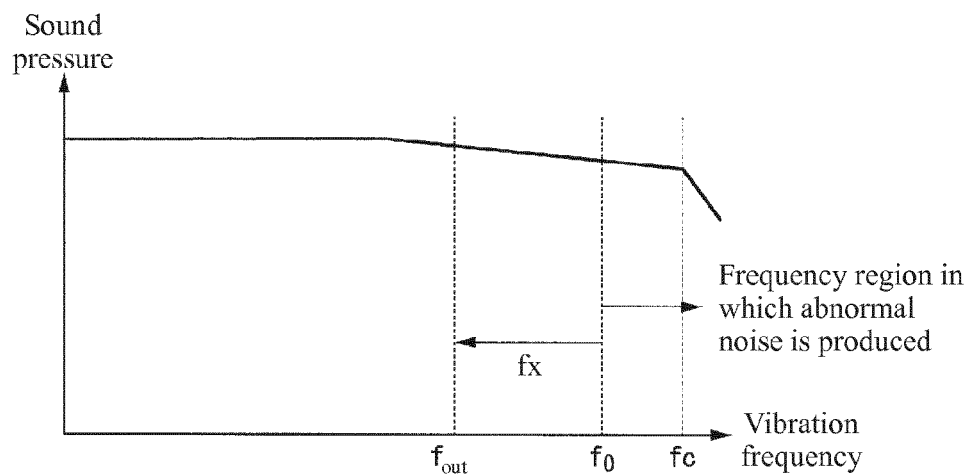


FIG. 5

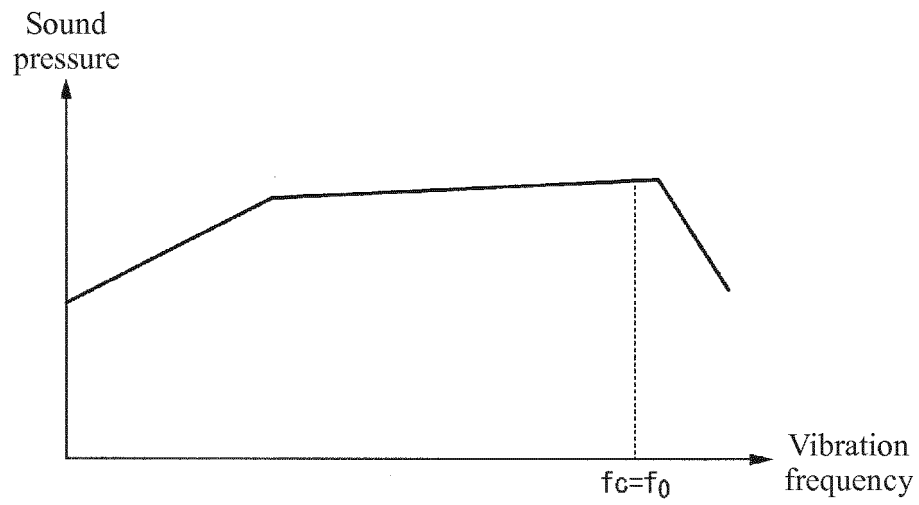


FIG. 6(a)

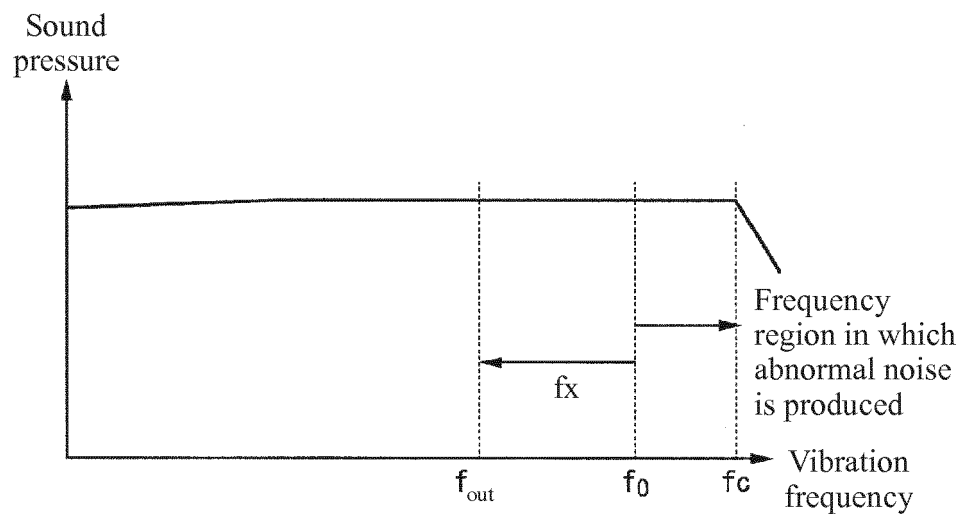


FIG. 6(b)



EUROPEAN SEARCH REPORT

Application Number
EP 18 16 3396

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Place of search The Hague		Date of completion of the search 31 July 2018	Examiner Tympel, Jens
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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The members are as contained in the European Patent Office EDP file on
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