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(54) **SILENCER AND ELECTRONIC EQUIPMENT**

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Publication Classification

(51) **Int. Cl.**[7] **F01N 7/00**; E04F 17/04

(52) **U.S. Cl.** **181/225**; 181/224

(57) **ABSTRACT**

A silencer is disclosed that includes a housing having a flat enclosing shape and having formed therein a passage for silencing; and pores, being formed at the housing so as to be communicatively connected with the passage, into which a sound wave to be noise is introduced. The pores, being formed close to the periphery of the housing, are configured so that the sound wave travels in the planar direction of the housing.

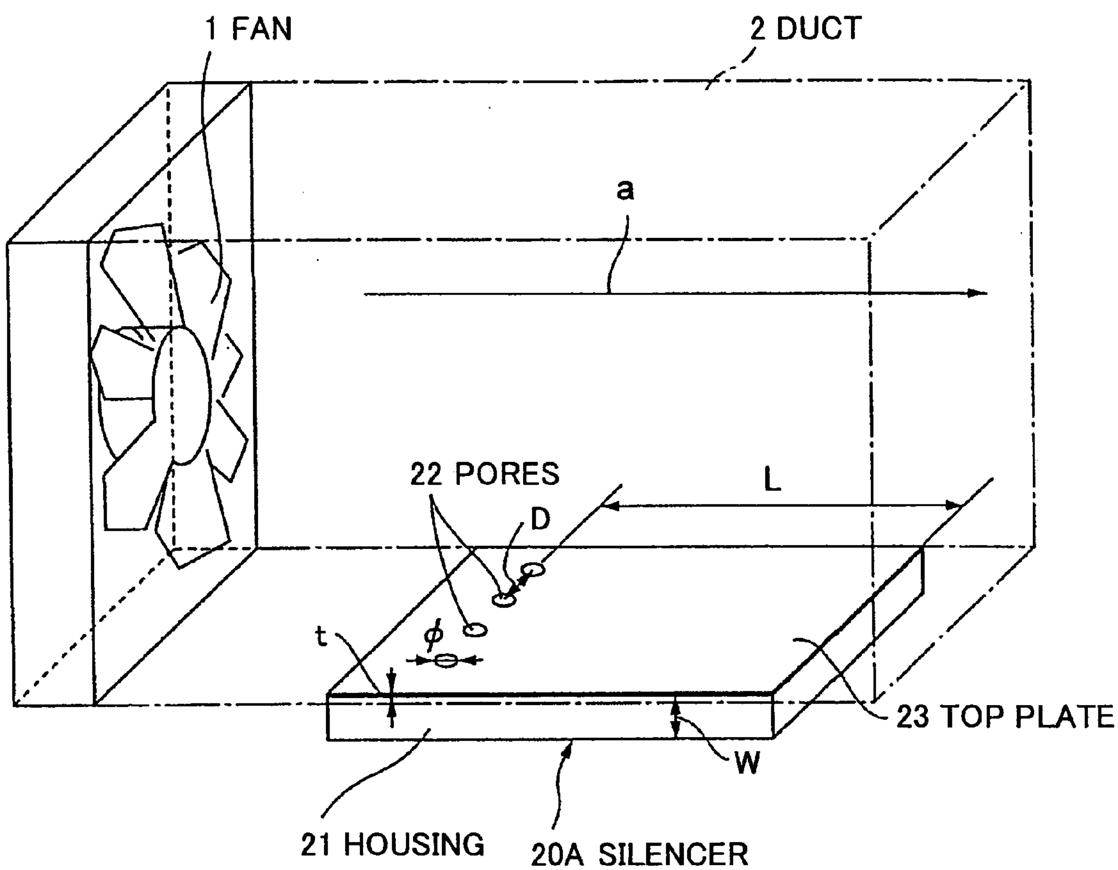


FIG.1

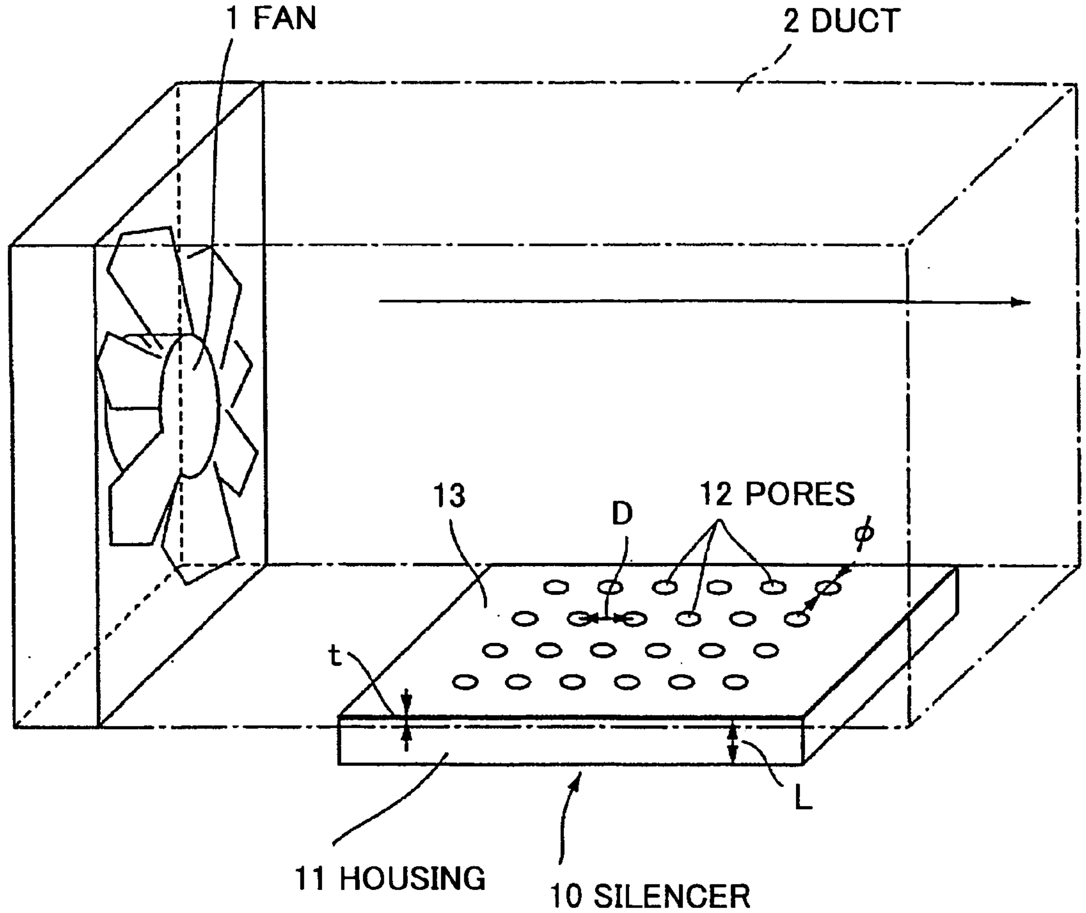


FIG.2

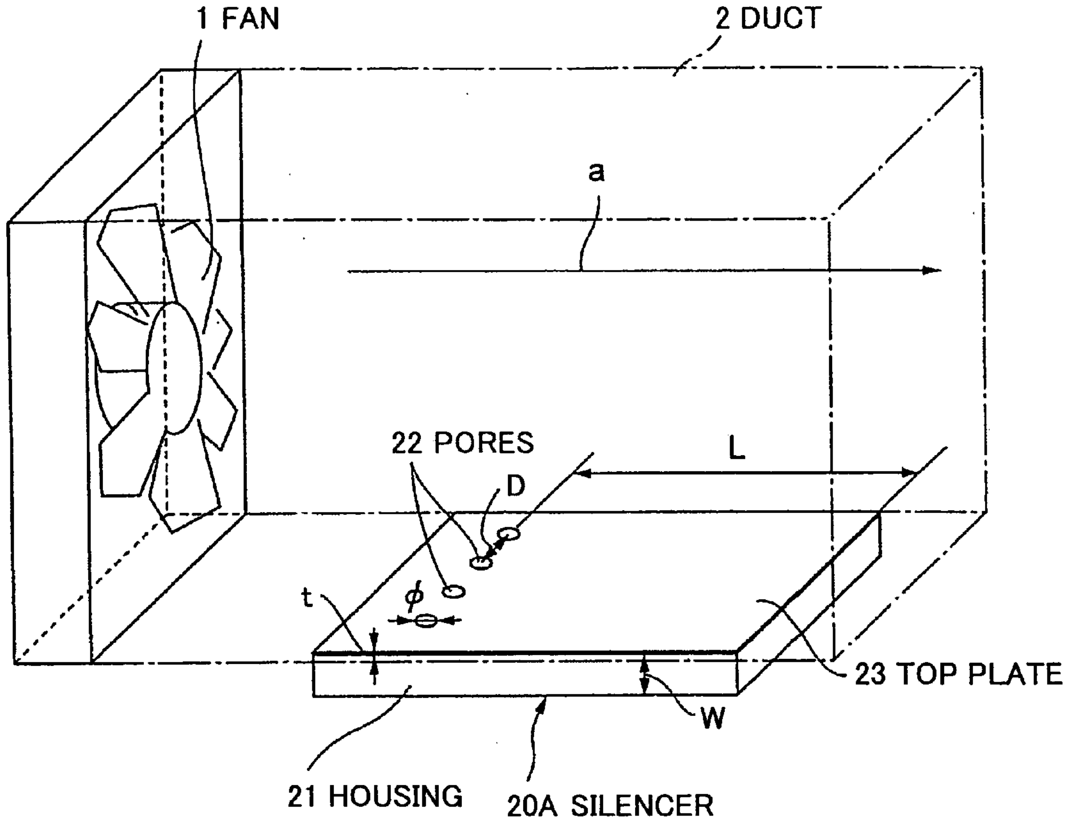

1 FAN
2 DUCT
a
22 PORES
L
D
t
ϕ
23 TOP PLATE
W
21 HOUSING
20A SILENCER

FIG.3

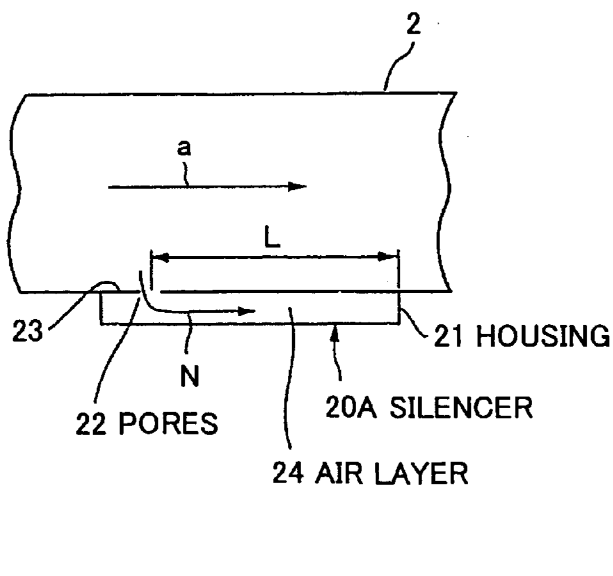

2
a
L
23
21 HOUSING
N
22 PORES
20A SILENCER
24 AIR LAYER

FIG.4A

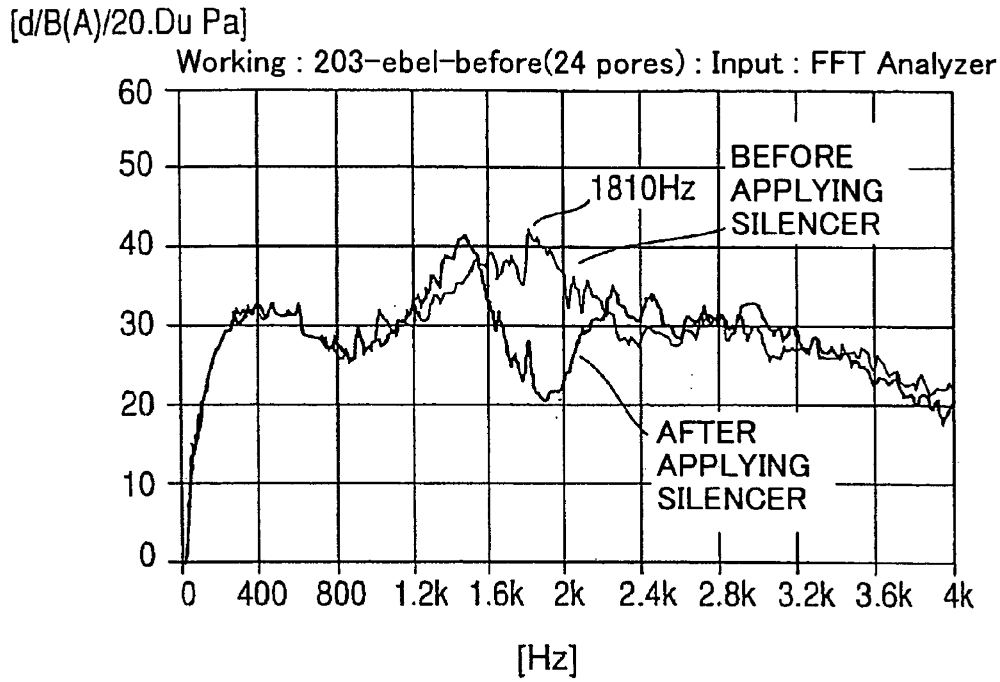

[d/B(A)/20.Du Pa]
Working : 203-ebel-before(24 pores) : Input : FFT Analyzer
60
50
40
30
20
10
0
0
400
800
1.2k
1.6k
2k
2.4k
2.8k
3.2k
3.6k
4k
[Hz]
1810Hz
BEFORE APPLYING SILENCER
AFTER APPLYING SILENCER

FIG.4B

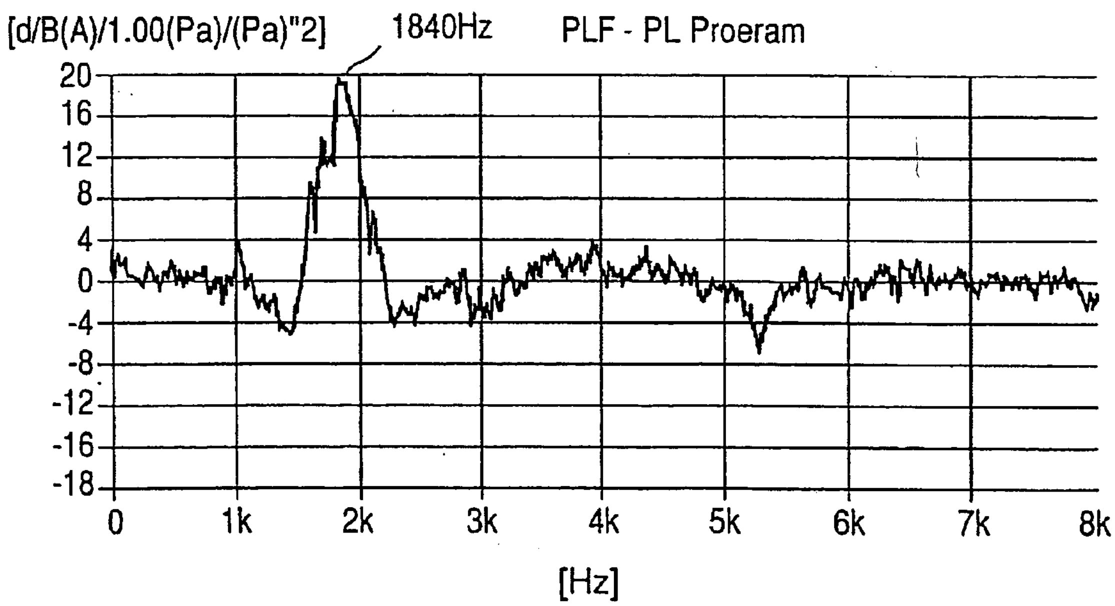

[d/B(A)/1.00(Pa)/(Pa)"2]
1840Hz
PLF - PL Proeram
20
16
12
8
4
0
-4
-8
-12
-16
-18
0
1k
2k
3k
4k
5k
6k
7k
8k
[Hz]

FIG.5A

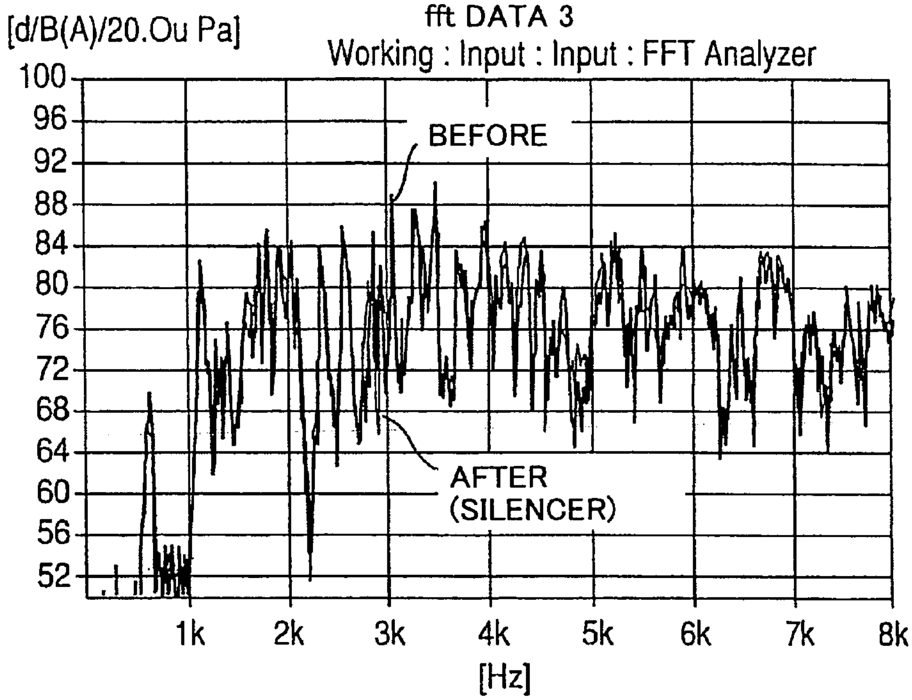

fft DATA 3
Working : Input : Input : FFT Analyzer
[d/B(A)/20.Ou Pa]
100
96
92
88
84
80
76
72
68
64
60
56
52
BEFORE
AFTER
(SILENCER)
1k
2k
3k
4k
5k
6k
7k
8k
[Hz]

FIG.5B

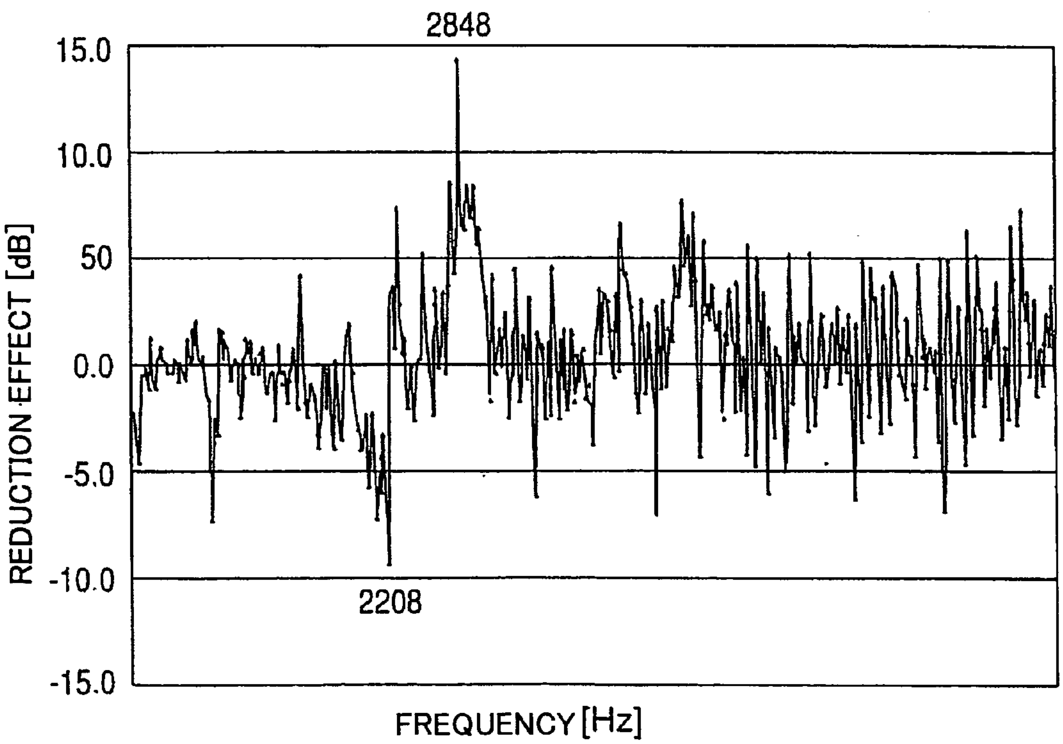

2848
15.0
10.0
50
0.0
-5.0
-10.0
-15.0
2208
REDUCTION·EFFECT [dB]
FREQUENCY [Hz]

FIG.6

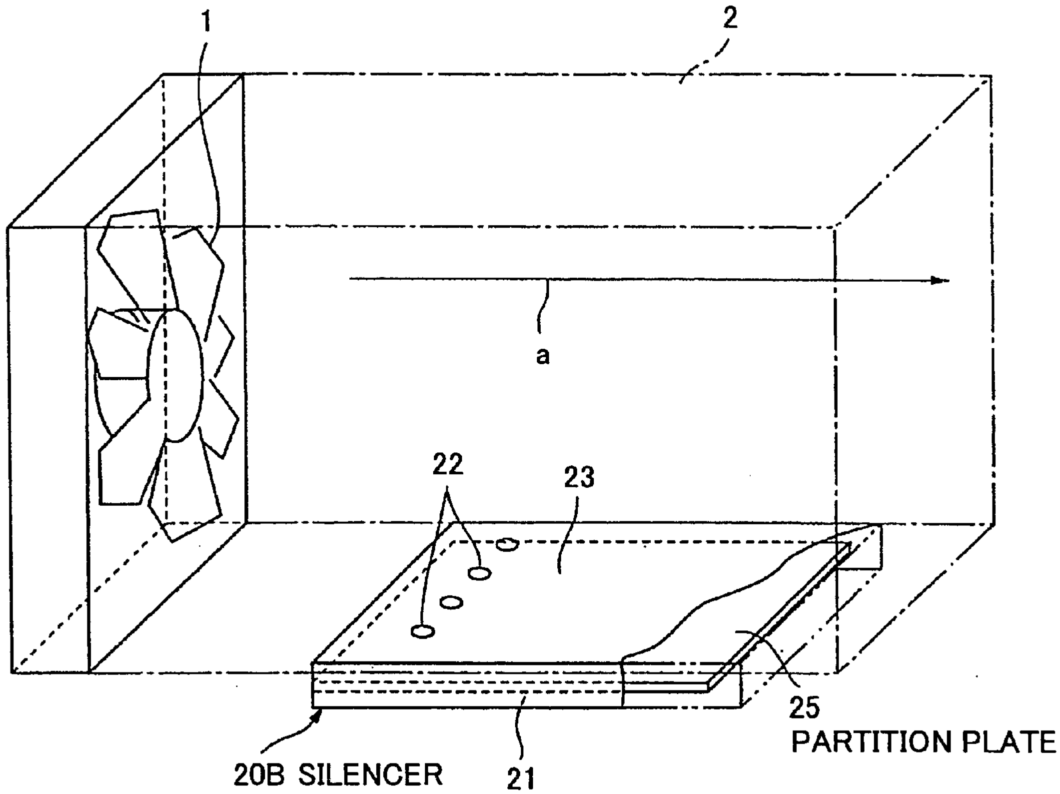


FIG.7

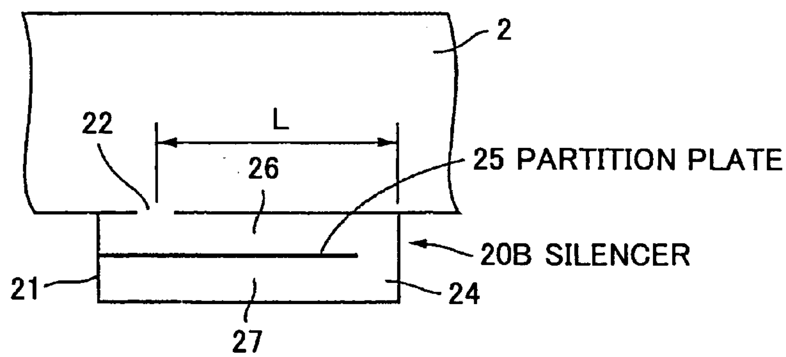


FIG.8

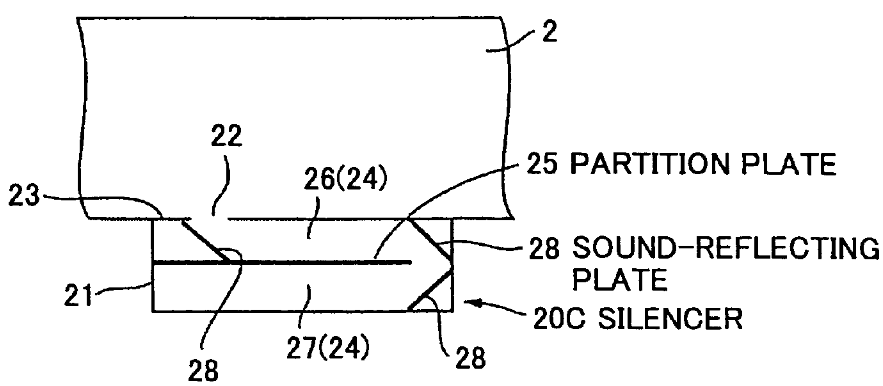


FIG.9

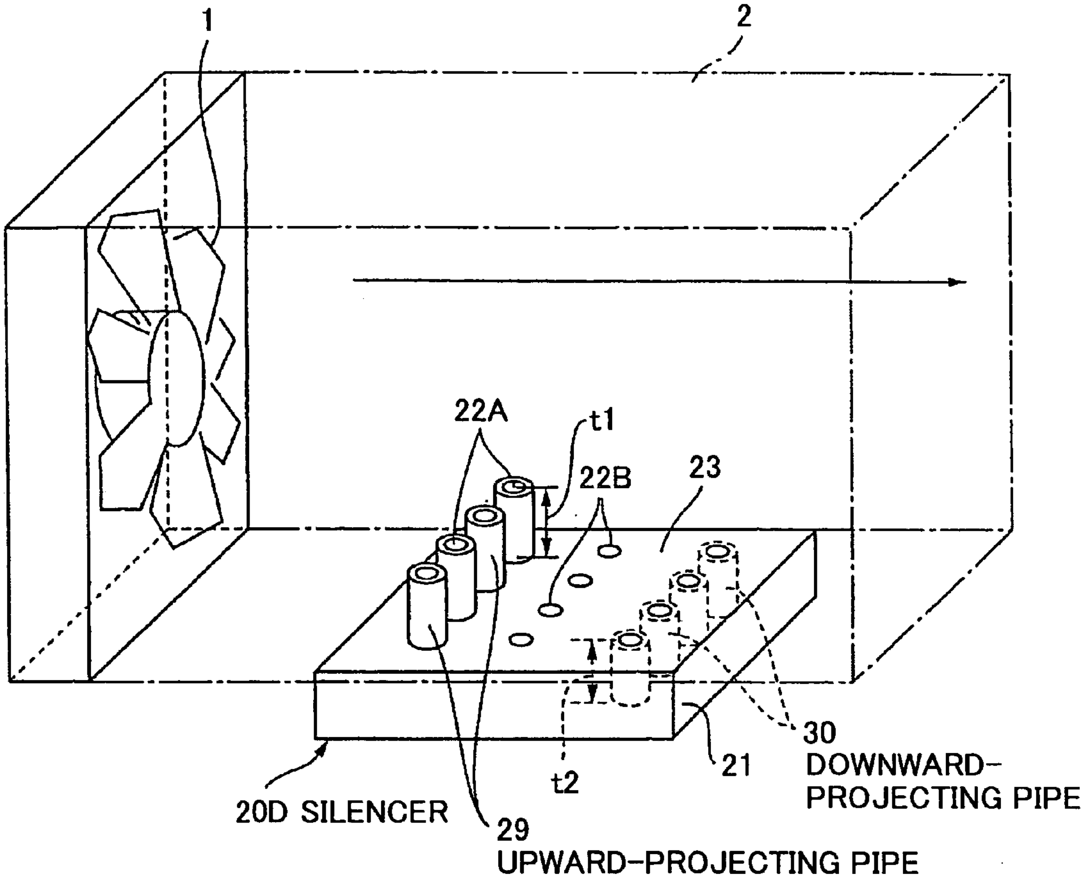

1
2
22A
t1
22B
23
30
DOWNWARD-PROJECTING PIPE
21
t2
20D SILENCER
29
UPWARD-PROJECTING PIPE

FIG.10

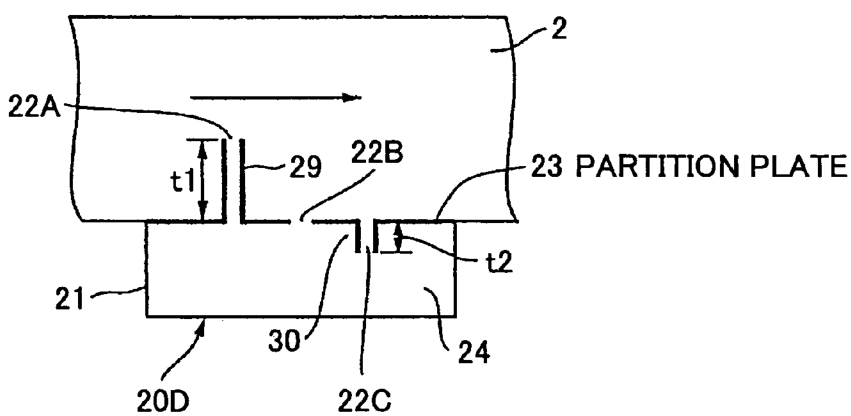

2
22A
29
22B
23 PARTITION PLATE
t1
t2
21
30
24
20D
22C

FIG.11

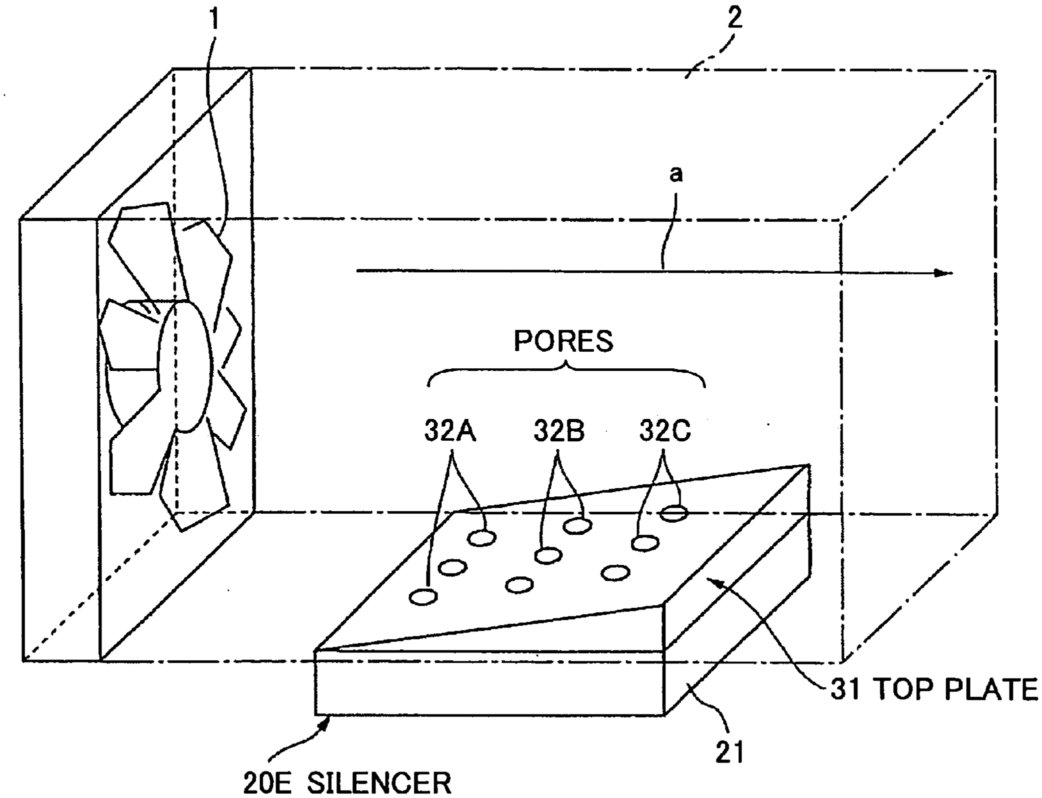

1
2
a
PORES
32A
32B
32C
31 TOP PLATE
21
20E SILENCER

FIG.12

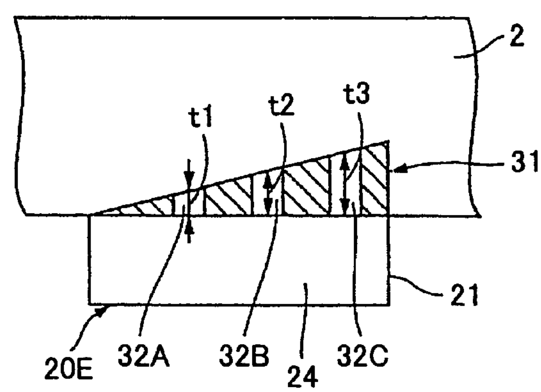

2
t1
t2
t3
31
21
20E
32A
32B
24
32C

FIG.13

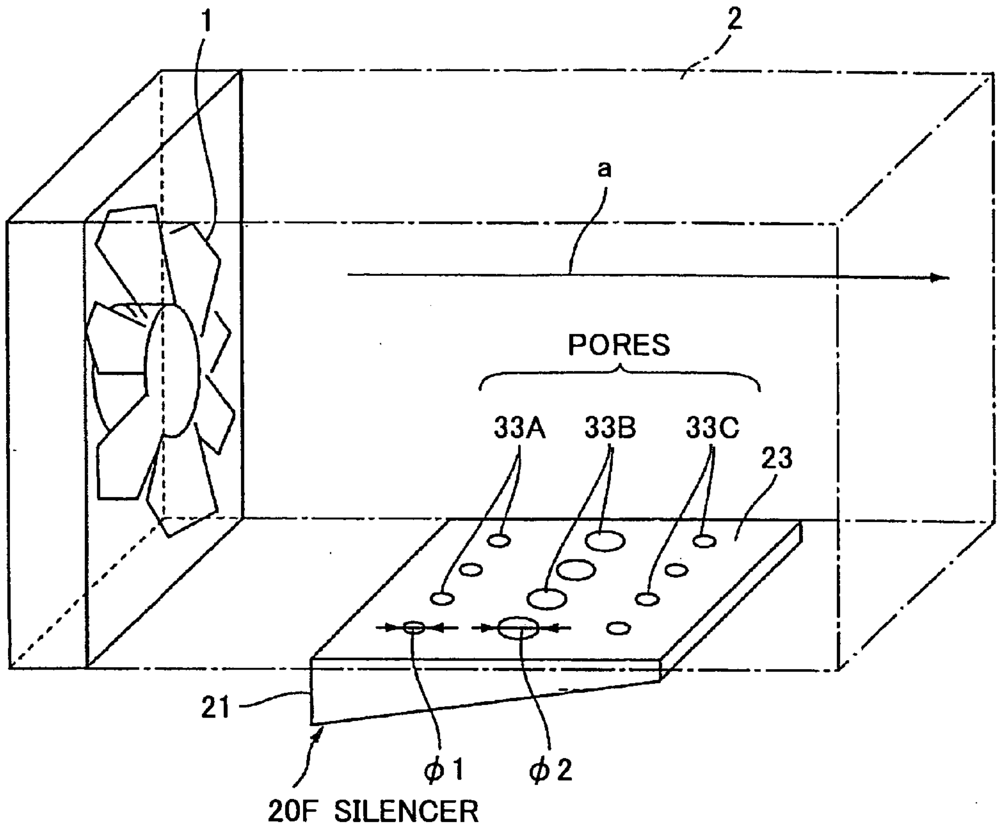

1
2
a
PORES
33A
33B
33C
23
21
φ1
φ2
20F SILENCER

FIG.14

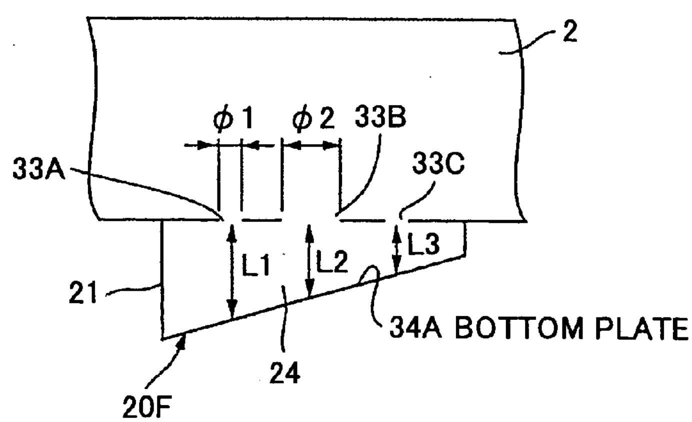

2
φ1
φ2
33B
33A
33C
L1
L2
L3
21
34A BOTTOM PLATE
24
20F

FIG.15

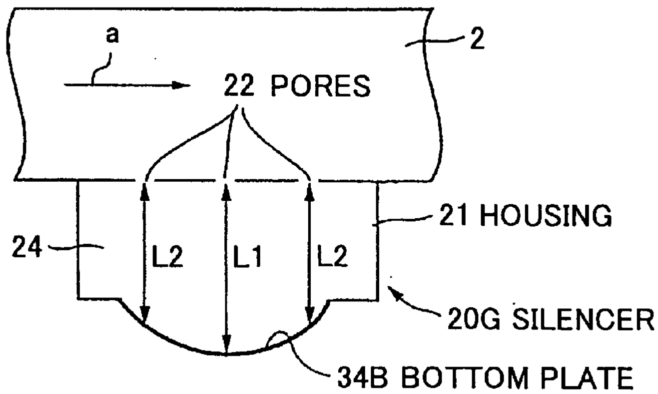


FIG.16

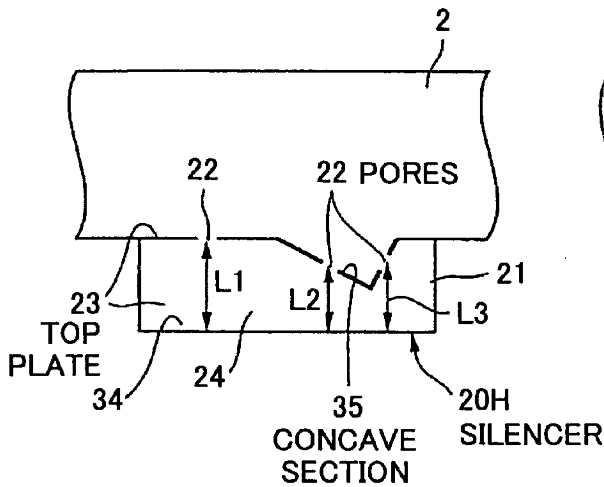


FIG.17

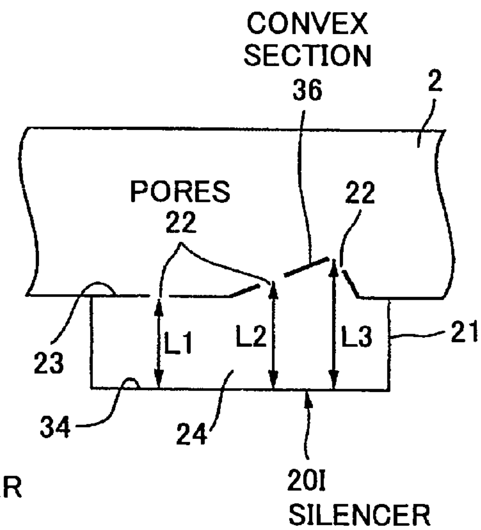


FIG.18

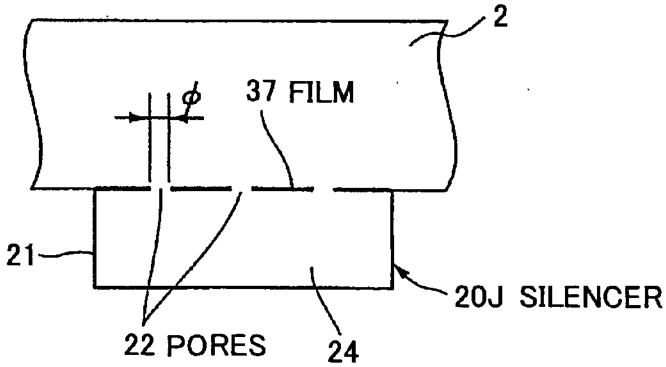


FIG.19

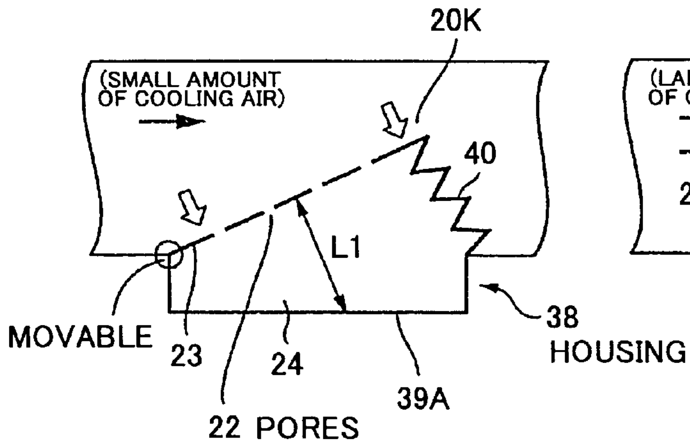


FIG.20

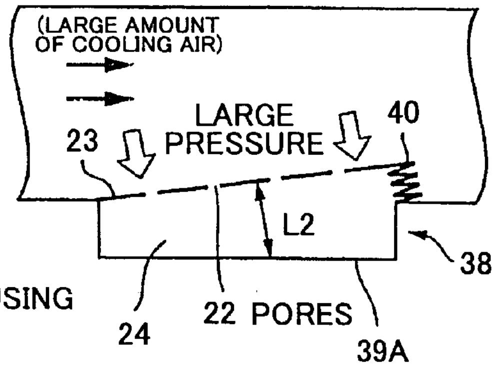


FIG.21

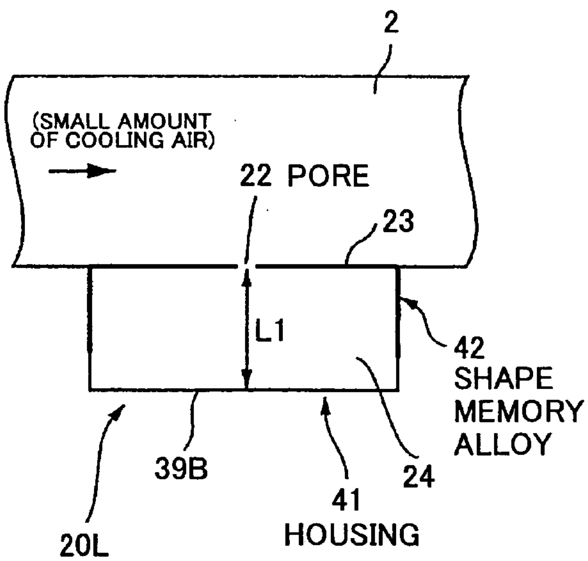


FIG.22

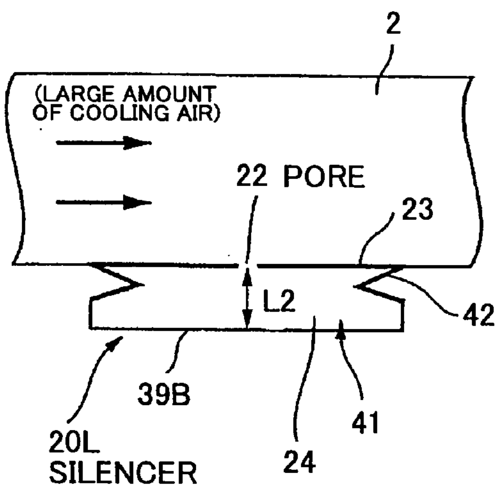


FIG.23

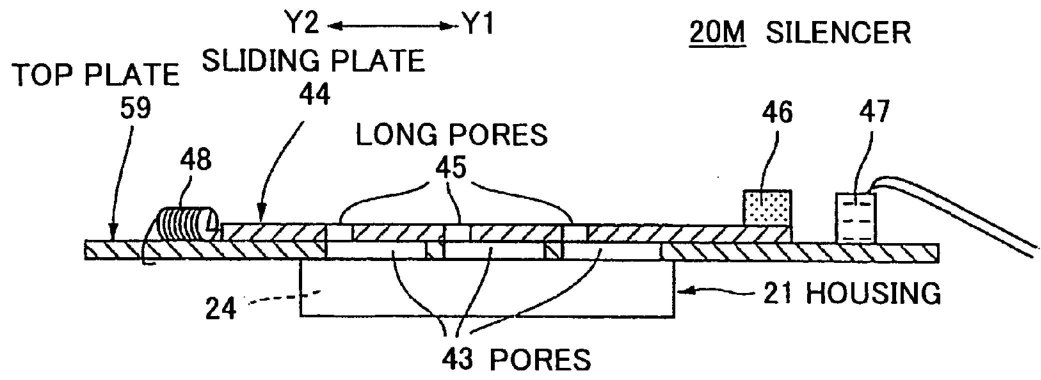


FIG.24

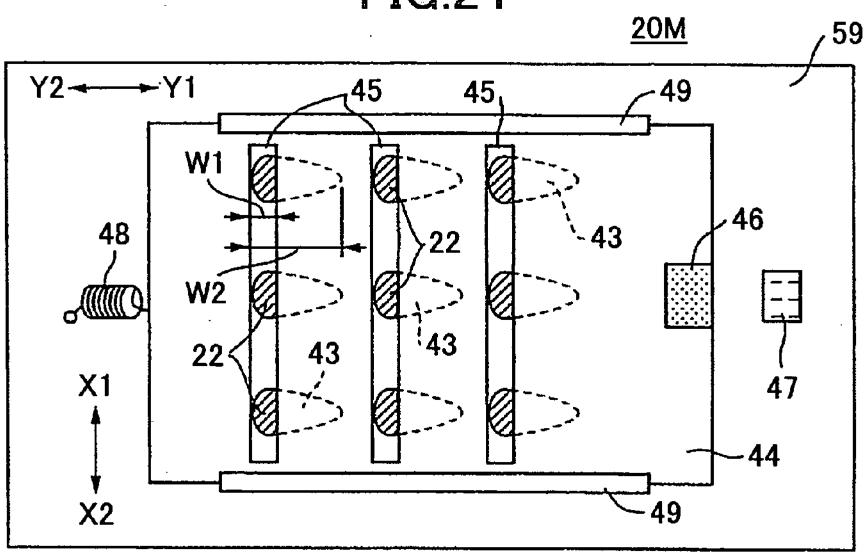


FIG.26

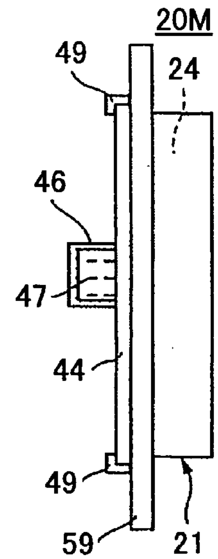


FIG.25

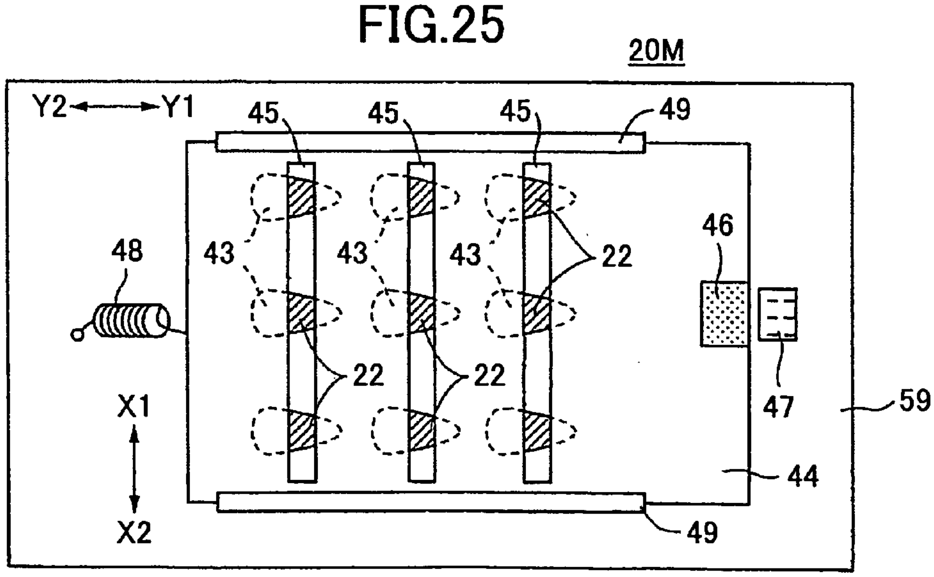


FIG.27

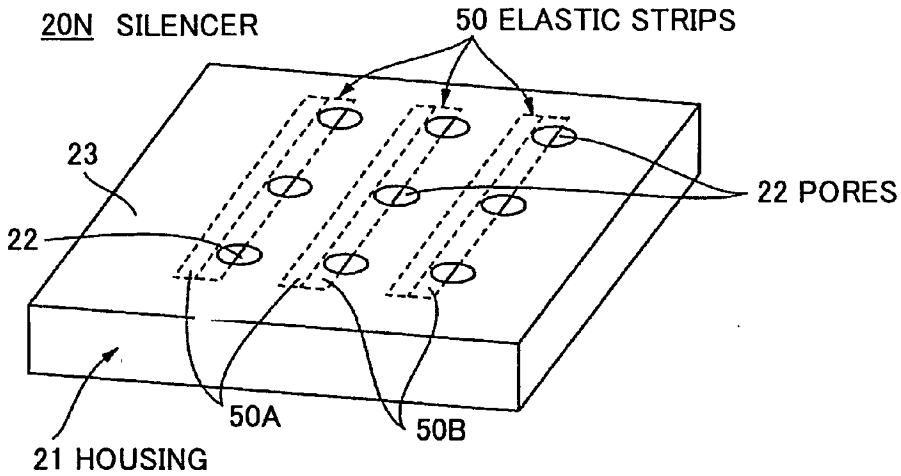


FIG.28

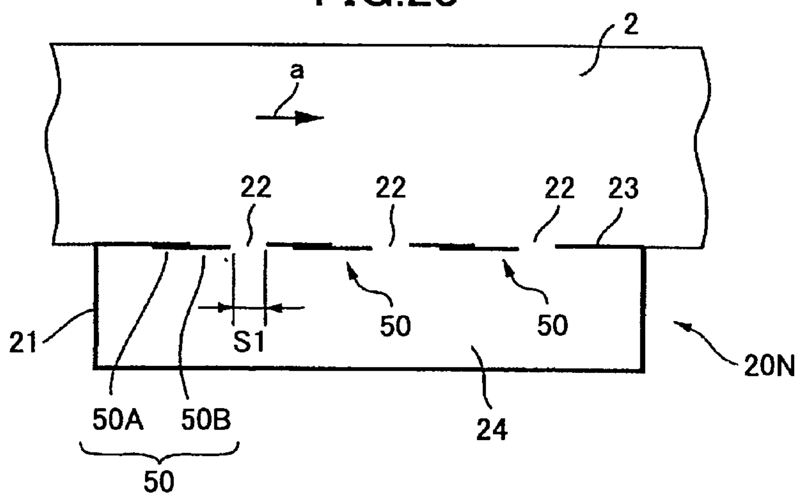


FIG.29

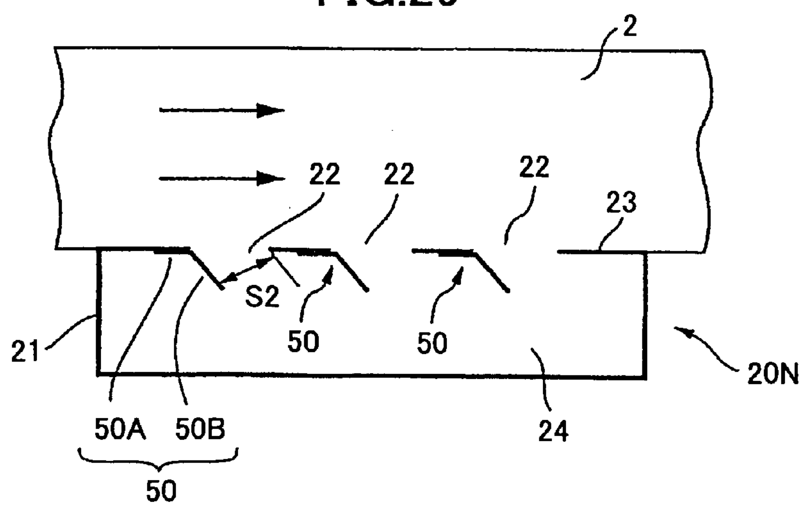


FIG.30

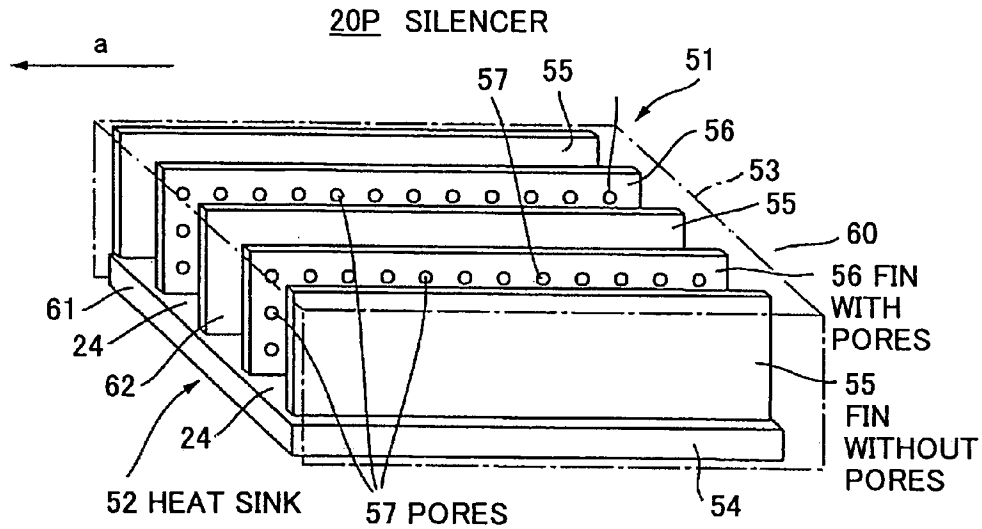


FIG.31

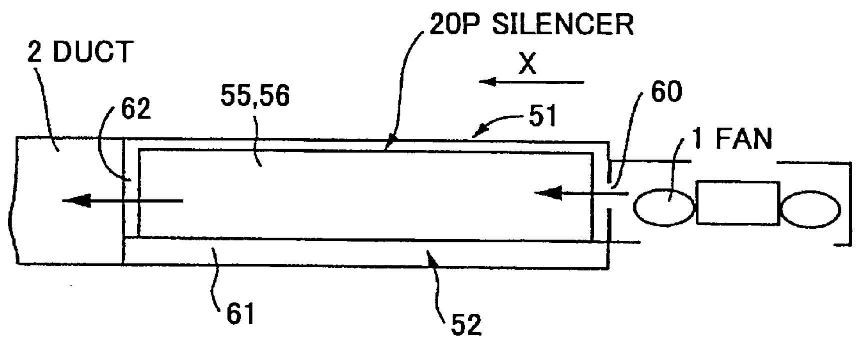


FIG.32

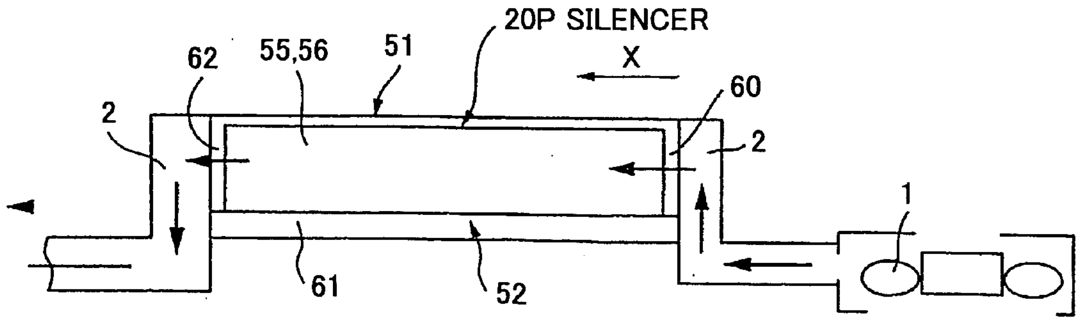


FIG.33

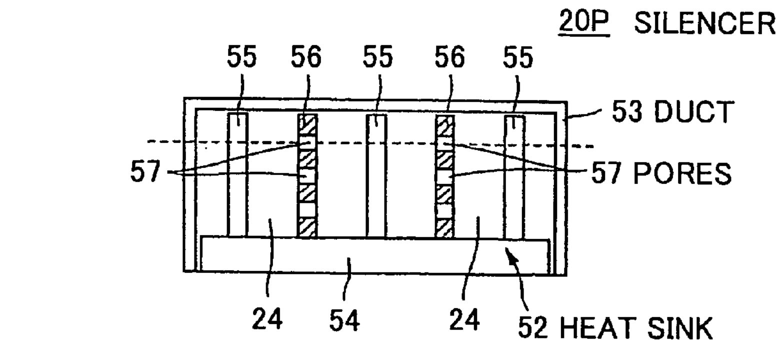


FIG.34

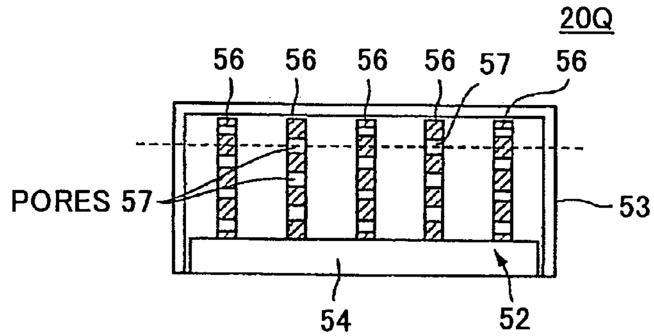


FIG.35

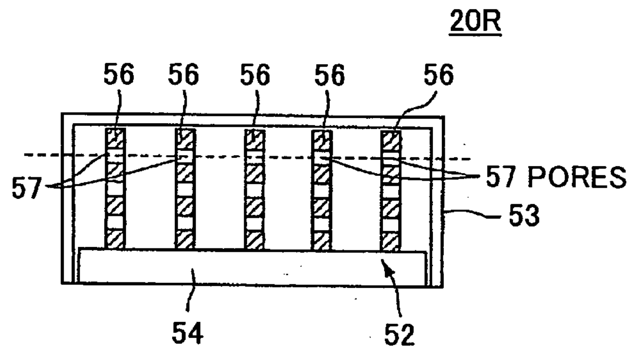


FIG.36

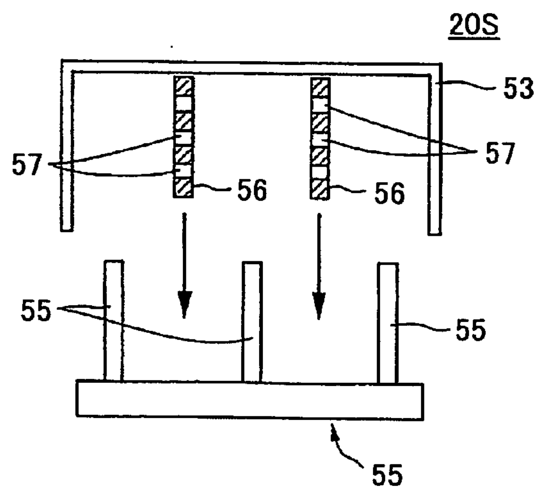


FIG.37

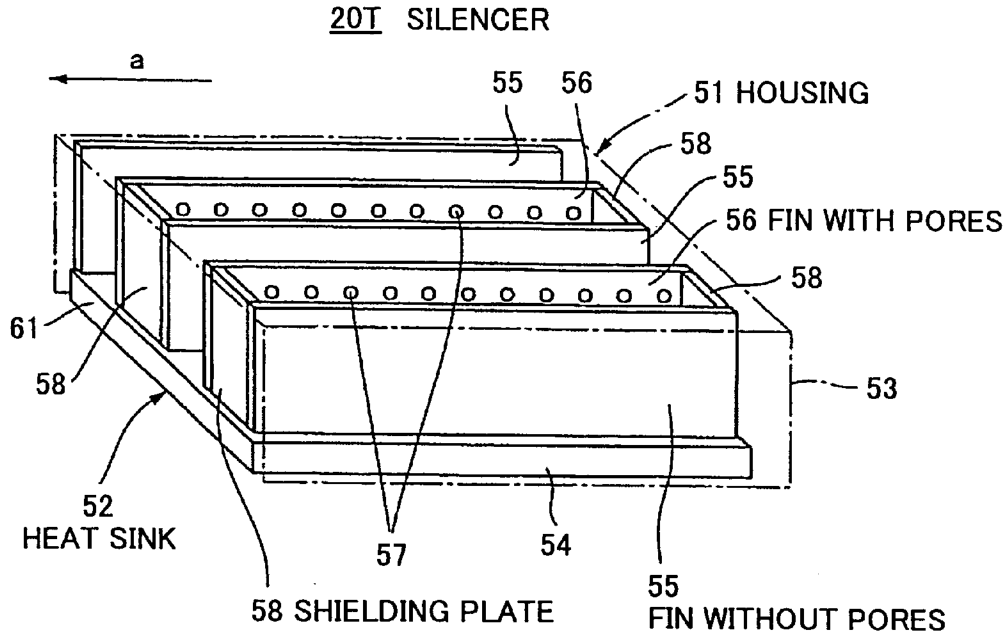
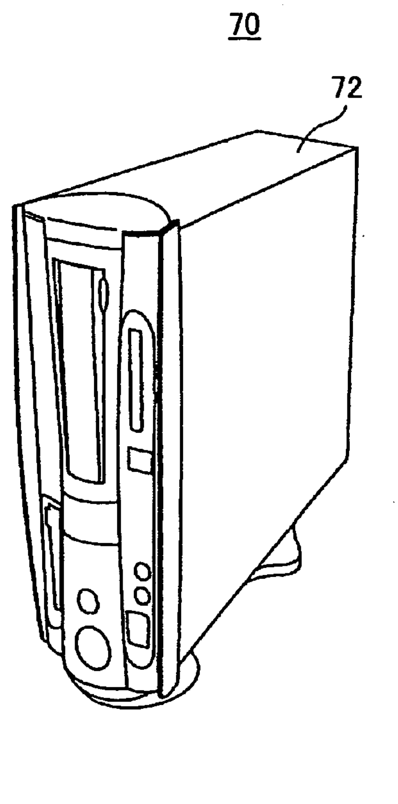

20T SILENCER
a
55
56
51 HOUSING
58
55
56 FIN WITH PORES
58
61
58
53
52
HEAT SINK
57
54
58 SHIELDING PLATE
55
FIN WITHOUT PORES

FIG.38


70
72

SILENCER AND ELECTRONIC EQUIPMENT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a U.S. continuation application filed under 35 USC 111(a) claiming benefit under 35 USC 120 and 365(c) of PCT application JP02/13679, filed Dec. 26, 2002, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention generally relates to a technology for silencing fan noise, and particularly relates to a silencer suitable for use in a fan-noise silencing process and electronic equipment having provided therein the silencer.

[0004] 2. Description of the Related Art

[0005] In recent years and continuing, as small-sized electronic equipment such as a notebook PC and a desk-top PC is made smaller and faster, the amount of heat dissipation required for a semiconductor apparatus (such as a CPU) set up inside is on the increase. It is possible to air-cool using a fan as means for cooling the semiconductor apparatus.

[0006] However, with the method of cooling using the fan, there is a problem such that increasing the number of rotations of the fan in order to increase the cooling efficiency results in increased fan noise. Moreover, while only a small-sized fan can be fit into the downsized electronic equipment as described above, it is known that with the same air amount, the smaller the fan the larger the fan noise.

[0007] On the other hand, in order to reduce the fan noise without degrading the cooling performance, methods are possible such as cooling using cooling water as in water-cooling, and by means of temperature control, decreasing the number of rotations of the fan when the temperature of the CPU is low.

[0008] However, with the water-cooling, the structure of the apparatus becomes complicated so as to cause an increased product cost, and the enlarged apparatus runs counter to the demand for downsizing. Moreover, a problem arises such that an increased number of components leads to an increased failure rate, so as to cause decreased reliability of the electronic equipment into which the water-cooled cooling apparatus is fit.

[0009] With temperature control being configured to sense with a sensor an increase in the amount of heat dissipation of the CPU and to subsequently activate the fan for ventilation, the fan noise fluctuates depending on the change in the CPU operating state and room temperature. Such fluctuating is recognized by a human being as annoying noise. Moreover, when the CPU continues to operate for more than or equal to a certain time period, there is a case such that the number of rotations of the fan becomes the maximum so that there is no longer any advantage in controlling the number of rotations.

[0010] Thus, in the method of reducing the noise generated at the fan, the noise cannot be suppressed effectively. Therefore, a method is possible that uses a silencer for silencing the noise generated at the fan rather than decreasing the noise generated at the fan. However, conventionally, such method of using a silencer is used in a relatively large apparatus such as an air-conditioning apparatus but not in smaller-sized electronic equipment such as a PC. This is due to the following reasons:

[0011] 1) It is considered that a large space for the silencer is needed in order to silence the low-frequency fan noise of approximately 500 Hz to 2 kHz;

[0012] 2) The frequency characteristics of the fan noise are such that the fan noise consists of multiple peak frequencies and a wide-bandwidth component so that an adequate silencing effect cannot be obtained with a conventional silencer with which a single frequency can be silenced.

[0013] **FIG. 1** illustrates the state in which a silencer **10** being configured conventionally is set up at a duct **2** of a fan **1**. Cooling air generated at the fan **1** travels within the duct **2** in the direction of the arrow illustrated and cools a CPU, etc., as material to be cooled. This fan **1** operates at all times, or stops/rotates depending on the temperature of the materials to be cooled as in the temperature control described above.

[0014] The silencer **10** is configured such that multiple pores **12** are formed at a housing **11**. As this silencer **10** is to be fit into small-sized electronic equipment such as a notebook PC and a desktop PC, the housing **11** has a flat enclosing shape. Moreover, a top plate **13** of the housing **11** is being exposed to the duct **2**, and the multiple pores **12** (**24** in the illustrated example) are formed at this top plate **13**.

[0015] As the housing **11** has the enclosing shape as described above, an air layer for silencing is being formed. Thus, the noise that is generated by the fan **1** and that penetrates into the housing **11** from the pores **12** is silenced by attenuation through resonance and expansion at the air layer within this housing **11**.

[0016] Now each parameter of the silencer **10** is set as follows while illustrating each of these parameters in **FIG. 1**:

[0017] c: the speed of sound (m/s)

[0018] t: the plate thickness of the top plate **13** (mm);

[0019] ϕ: the diameter of the pores **12** (mm);

[0020] L: the length of the noise passage (mm);

[0021] D: the interval between the pores **12** (mm);

[0022] P: the intermediate value;

[0023] f: the silencing frequency (Hz)

[0024] When specifying each parameter as described above, the silencing frequency f (Hz) silenceable at the silencer **10** and the intermediate value P may be represented by the following equations (1) and (2):

$$f=c/2\pi\sqrt{P/(t}+0.8\phi)L \quad (1)$$

$$P=\pi\phi^2/4D^2 \quad (2)$$

[0025] Now, there is more demand for downsizing the silencer to be fit into small-sized electronic equipment relative to the conventional silencer fit in large-sized equipment such as an air-conditioning apparatus so that the constraint on the size of the silencer to be fit into the small-sized electronic equipment is severe. More specifically, the thickness of the housing **11** may be constrained to be within 0.5 mm. Then, the length L of the noise passage in equation (1) as described above is equivalent to the distance from the pores **12** to the bottom of the housing **11**, or in other words, the thickness of the housing **11**.

[**0026**] Now, assuming the speed of sound c as 346.3 m/s, the plate thickness t of the top plate **13** as 0.5 mm, the diameter ϕ of the pores **12** as 0.8 mm, the length L of the noise passage (or the thickness of the housing **11**) as 0.5 mm, and the interval D between the pores **12** as 10 mm; according to the equations (1) and (2), the silencing frequency f ends up high at f=5176 Hz such that the fan noise (at approximately 1.5 to 2 kHz) actually generated at the fan **1** cannot be silenced.

[**0027**] Thus, in the conventional silencer **10**, when it is fit into small-sized electronic equipment such as a notebook PC and a desktop PC, the length L of the noise passage cannot be increased so that the fan noise generated at the fan **1** cannot be silenced. Moreover, when the configuration is made such that the fan noise generated at the fan **1** is reliably eliminated, there is a problem in that the silencer **10** ends up being large such that a further demand for downsizing the small-sized electronic equipment cannot be met.

SUMMARY OF THE INVENTION

[**0028**] It is a general object of the present invention to provide a technology for silencing fan noise that substantially obviates one or more problems caused by the limitations and disadvantages of the related art.

[**0029**] It is a more particular object of the present invention to provide a silencer for use in a fan-noise silencing process and electronic equipment having provided the silencer that achieves silencing reliably while achieving downsizing.

[**0030**] According to the invention, a silencer includes a housing having a flat enclosing shape and having formed therein a passage for silencing, and one or a plurality of pores, being formed at the housing so as to be communicatively connected with the passage, into which a sound wave to be noise is introduced, wherein the pores, being formed close to the periphery of the housing, are configured so that the sound wave to be noise travels in the planar direction of the housing.

[**0031**] The silencer as described above enables achieving silencing reliably while achieving downsizing.

[**0032**] According to another aspect of the invention, in electronic equipment including within the apparatus mainframe a fan for cooling and a silencer for silencing noise generated at the fan, the silencer includes a housing having a flat enclosing shape and having formed therein a passage for silencing, and one or more pores, being formed at the housing so as to be communicatively connected with the passage, into which a sound wave to be noise is introduced, and the pores, being formed close to the periphery of the housing, are configured so that the sound wave to be noise travels in the planar direction of the housing.

[**0033**] The electronic equipment as described above enables achieving silencing reliably while achieving downsizing.

[**0034**] Other objects and further features of the present invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0035**] **FIG. 1** is a diagram for describing a configuration of an exemplary conventional silencer and a theoretical equation regarding the silencing frequency;

[**0036**] **FIG. 2** is a block diagram of a silencing apparatus being a first embodiment of the present invention;

[**0037**] **FIG. 3** is a cross-sectional view of the silencing apparatus being the first embodiment of the present invention;

[**0038**] **FIG. 4A** is a diagram illustrating the silencing performance of the silencer being the first embodiment of the present invention relative to the silencing performance of a conventional silencer;

[**0039**] **FIG. 4B** is a diagram illustrating the silencing effect of the silencer being the first embodiment of the present invention;

[**0040**] **FIG. 5A** is a diagram illustrating the silencing performance of a silencer not being enclosed;

[**0041**] **FIG. 5B** is a diagram illustrating the silencing effect of the silencer not being enclosed;

[**0042**] **FIG. 6** is a block diagram of a silencing apparatus being a second embodiment of the present invention;

[**0043**] **FIG. 7** is a cross-sectional view of the silencing apparatus being the second embodiment of the present invention;

[**0044**] **FIG. 8** is a cross-sectional view of a silencing apparatus being a third embodiment of the present invention;

[**0045**] **FIG. 9** is a block diagram of a silencing apparatus being a fourth embodiment of the present invention;

[**0046**] **FIG. 10** is a cross-sectional view of the silencing apparatus being the fourth embodiment of the present invention;

[**0047**] **FIG. 11** is a block diagram of a silencing apparatus being a fifth embodiment of the present invention;

[**0048**] **FIG. 12** is a cross-sectional view of the silencing apparatus being the fifth embodiment of the present invention;

[**0049**] **FIG. 13** is a block diagram of a silencing apparatus being a sixth embodiment of the present invention;

[**0050**] **FIG. 14** is a cross-sectional view of a silencing apparatus being the sixth embodiment of the present invention;

[**0051**] **FIG. 15** is a cross-sectional view of a silencing apparatus being a seventh embodiment of the present invention;

[**0052**] **FIG. 16** is a cross-sectional view of a silencing apparatus being an eighth embodiment of the present invention;

[0053] **FIG. 17** is a cross-sectional view of a silencing apparatus being a variant of the eighth embodiment of the present invention;

[0054] **FIG. 18** is a cross-sectional view of a silencing apparatus being a ninth embodiment of the present invention;

[0055] **FIG. 19** is a cross-sectional view illustrating the state before operating a silencing apparatus being a tenth embodiment of the present invention;

[0056] **FIG. 20** is a cross-sectional view illustrating the state after operating the silencing apparatus being the tenth embodiment of the present invention;

[0057] **FIG. 21** is a cross-sectional view illustrating the state before operating a silencing apparatus being an eleventh embodiment of the present invention;

[0058] **FIG. 22** is a cross-sectional view illustrating the state after operating the silencing apparatus being the eleventh embodiment of the present invention;

[0059] **FIG. 23** is a cross-sectional view of a silencing apparatus being a twelfth embodiment of the present invention;

[0060] **FIG. 24** is a plan view illustrating the state before operating the silencing apparatus being the twelfth embodiment of the present invention;

[0061] **FIG. 25** is another plan view illustrating the state after operating the silencing apparatus being the twelfth embodiment of the present invention;

[0062] **FIG. 26** is a cross-sectional view from the right-hand side of the silencing apparatus being the twelfth embodiment of the present invention;

[0063] **FIG. 27** is a perspective view of the silencing apparatus being a thirteenth embodiment of the present invention;

[0064] **FIG. 28** is a cross-sectional view illustrating the state before operating the silencing apparatus being the thirteenth embodiment of the present invention;

[0065] **FIG. 29** is a cross-sectional view illustrating the state after operating the silencing apparatus being the thirteenth embodiment of the present invention;

[0066] **FIG. 30** is a perspective view of a silencing apparatus being a fourteenth embodiment of the present invention;

[0067] **FIG. 31** is a (first) diagram for describing a mounting structure of the silencing apparatus being the fourteenth embodiment of the present invention;

[0068] **FIG. 32** is a (second) diagram for describing the mounting structure of the silencing apparatus being the fourteenth embodiment of the present invention;

[0069] **FIG. 33** is a cross-sectional view of the silencing apparatus being the fourteenth embodiment of the present invention;

[0070] **FIG. 34** is a cross-sectional view of the silencing apparatus being a first variant of the fourteenth embodiment of the present invention;

[0071] **FIG. 35** is a cross-sectional view of the silencing apparatus being a second variant of the fourteenth embodiment of the present invention;

[0072] **FIG. 36** is a cross-sectional view of the silencing apparatus being a third variant of the fourteenth embodiment of the present invention;

[0073] **FIG. 37** is a perspective view of the silencing apparatus being a fifteenth embodiment of the present invention; and

[0074] **FIG. 38** is a perspective view of electronic equipment into which each of the silencing apparatuses corresponding to each of the embodiments of the present invention is fit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0075] In the following, embodiments of the present invention are described with reference to the accompanying drawings.

[0076] **FIGS. 2 and 3** illustrate a silencer **20A** being a first embodiment of the present invention. It is noted that the same elements in **FIGS. 2, 3**, and each of the subsequent figures used in describing each embodiment as the elements illustrated in **FIG. 1** have applied the same letters.

[0077] The silencer **20A** in the present embodiment is configured from a housing **21** and pores **22** being formed at a top plate **23** of this housing **21**. The housing **21** has a flat enclosing shape and is configured to be enclosed except for the pores **22**. Therefore, a space (below referred to this space as an air layer **24**) is formed within the housing **21**. This housing **21** is set up at a duct **2** of a fan **1** generating cooling air.

[0078] The fan **1** and the duct **2** are set up within an apparatus mainframe **72** of electronic equipment **70** such as a desktop PC as illustrated in **FIG. 38** so that materials to be cooled such as a CPU, etc., are cooled by cooling air generated at the fan **1**. It is noted that applying the present invention is not to be limited to a desktop PC such that the present invention may be applied to a further-downsized notebook PC or a large-sized server.

[0079] The housing **21** is mounted onto the duct **2** such that the top plate **23** is exposed within the duct **2**. Thus, the sound wave to be noise generated at the fan **1** penetrates from the pores **22** into the housing **21**. It is noted that the arrow represented by the letter N illustrates the penetrating of the sound wave to be noise into the housing **21**.

[0080] The pores **22** for introducing the sound wave to be noise into the housing **21** are formed close to the periphery of the housing **21**. More specifically, a multiple number (4 in the present embodiment) of pores are formed along the short side of one end which is upstream relative to the direction (represented as arrow "a" in **FIG. 2**) of flow of the cooling air generated at the fan **1**. It is noted that while the pores **22** are formed along the short side on the one upstream end relative to the direction of the flow of the cooling air in the present embodiment, the configuration may be such that the pores **22** are formed along the short side of the other downstream end relative to the direction "a" of the flow of the cooling air.

[0081] Thus, having formed the pores **22** close to the periphery of the housing **21** causes the sound wave to be noise that has penetrated from the pores **22** to travel in the planar direction (the direction parallel to the direction "a" of the flow of the cooling air) in the air layer **24** that is formed within the housing **21** and that is to be the passage for the sound wave. Then, the distance that the sound wave to be noise travels within the housing **21** becomes the distance represented by the arrow "L" in **FIGS. 2 and 3** so as to be a larger distance relative to the thickness dimension W of the housing **21** (L>W).

[0082] Now focusing on equation (1) as described above, out of the various parameters, the length L of the noise passage in the present embodiment becomes the distance L that the sound wave to be noise travels within the housing **21**. The length L of this noise passage is a value in the denominator so that as the value L gets larger the silencing frequency f becomes smaller. Therefore, according to the silencer **20**A of the present embodiment, even making the thickness W of the housing **21** smaller to achieve downsizing, or in other words even achieving downsizing of the silencer **20**A enables decreasing the silencing frequency f, enabling effectively silencing the noise generated at the fan **1** that is of low frequency.

[0083] Next, a calculation is made by substituting specific parameter values into equation (1). Now, each of the parameter values in equation (1) is set equal to the parameter values used when deriving the silencing frequency f of the silencer **10** previously illustrated in **FIG. 1**. More specifically, the parameters are set with the speed of sound c as 346.3 m/s, the plate thickness t of the top plate **13** as 0.5 mm, the diameter ϕ of the pores **12** as 0.8 mm, the interval D between the pores **12** as 10 mm, and the length L of the noise passage as 4 mm in the present embodiment (L=0.5 mm in the example illustrated in **FIG. 1**).

[0084] As a result, the silencer **20**A in the present embodiment, without changing to a large extent the shape relative to the silencer **10** as illustrated in **FIG. 1**, or in other words while achieving downsizing of the silencer **20**A, a large reduction from the previous f=5176 Hz to f=1830 Hz is enabled. This silencing frequency f=1830 Hz (below referred to as the theoretical frequency value) becomes the roughly-center frequency of the fan noise (approximately 1.5 to 2 kHz) actually generated at the fan **1**. Therefore, with the silencer **20**A of the present embodiment, effectively silencing the fan noise generated at the fan **1** is enabled.

[0085] **FIG. 4A** illustrates the silencing performance of the silencer **20**A in the present embodiment in relation to the silencing performance of the conventional silencer as illustrated in **FIG. 1**. Moreover, **FIG. 4B** is a diagram illustrating the silencing effect of the silencer being the first embodiment of the present invention, and more specifically represents the result of having subtracted the value after applying the silencer from the value before applying the silencer as illustrated in **FIG. 4A**.

[0086] According to these figures, the silencing frequency f of the silencer **20**A in the present embodiment is 1810 Hz to 1840 Hz so as to roughly correspond to 1830 Hz being the theoretical frequency value derived from equation (1). More specifically, as illustrated in **FIG. 4B**, it can be understood that, as a large noise-reducing effect of approximately 20 dB (A) centered at 1840 Hz is obtained, an effective silencing is performed on the noise of the fan **1**.

[0087] On the other hand, **FIG. 5A** illustrates the silencing performance of the silencer **20**A when there is a gap at a portion of the housing **21** so that the air layer **24** is communicatively connected to outer air. The silencing performance of the conventional silencer as illustrated in **FIG. 1** is also illustrated in this figure as well. Furthermore, **FIG. 5B** illustrates the silencing effect of the silencer **20**A having formed the gap.

[0088] According to **FIG. 5A, 5B**, with the silencer **20**A that has the gap in the housing **21** so that the airproofness of the housing **21** is reduced, the peak of the silencing frequency f is 2848 Hz so as not to coincide with the theoretical frequency value of f=1830 Hz.

[0089] Thus, it can be understood that effectively silencing the noise of the fan **1** requires enclosing the air layer **24** formed within the housing **21**. Having to enclose the housing **21** except at the positions at which the pores **22** are formed, enables suppressing the so-called noise leakage, thus enabling to reliably absorb resonance within the housing **21**.

[0090] Next, a second embodiment of the present invention is described.

[0091] **FIGS. 6 and 7** illustrate a silencer **20**B being the second embodiment. The silencer **20**B in the present embodiment is characterized in that a partition plate **25** is provided within the housing **21** in the silencer **20**A in the first embodiment. It is noted that in each of the diagrams for use in describing the second and the subsequent embodiments, the same elements as the elements illustrated in **FIGS. 1 and 2** have applied the same letters so as to omit the explanations for the elements.

[0092] This partition plate **25** is being set up so as to be roughly parallel to the direction "a" of flow of the cooling air generated at a fan **1** and also to be roughly parallel to a top plate **23**. Also, the partition plate **25** has the edge of the side which is upstream relative to the direction of the flow of the cooling air (the left-hand side in **FIG. 7**) fixed to the inner wall of the housing **21**.

[0093] By configuring as described above, an air layer **24** formed within the housing **21** is partitionally formed into upper and lower sections so that two passages consisting of an upper passage **26** and a lower passage **27** are formed. Then, the sound wave to be the noise introduced from pores **22** travels through the upper-section passage **26** so as to further travel into the lower-level passage **27**.

[0094] Thus, in the silencer **20**B in the present embodiment, even the housing **21** having the same shape as that of the silencer **20**A in the first embodiment enables providing a longer distance for the sound wave to be noise to travel relative to the configuration of the silencer **20**A in the first embodiment which is not provided a partition plate. More specifically, the distance for the sound wave to be noise to travel within the housing **21** may be roughly doubled from L with the silencer **20**A in the first embodiment to 2×L according to the present embodiment. Hereby, further decreasing the silencing frequency f while maintaining the small size of the silencer **20**B is enabled.

[0095] It is noted that while an example of having provided one partition plate **25** within the housing **21** is described, the number of the partition plates **25** provided within the housing **21** is not limited to one so that a configuration of having provided multiple partition plates is possible. Moreover, it is possible to change the length of each of the partition plates **25**. Thus, appropriately setting the number of partition plates **25** to be set up and the length of the partitioning plates enables implementing a silencer having a random silencing frequency f.

[**0096**] Next, a third embodiment of the present invention is described.

[**0097**] **FIG. 8** illustrates a silencer **20**C being the third embodiment. The silencer **20**C in the present embodiment is characterized in that sound-reflecting plates **28** are provided at the upper passage **26** and the lower passage **27** that are divided by the partition plate **25** in the silencer **20**B being the second embodiment.

[**0098**] These sound-reflecting plates **28**, being provided at the position at which the sound wave to be noise that is introduced from a pore **22** is reflected within a housing **21**, perform a function of guiding at this reflecting position the direction of the reflecting to the direction to which each of the passages **26** and **27** extends. Therefore, each of the sound-reflecting plates **28** is set up so as to have approximately a 45-degree angle relative to a top plate **23** and the partition plate **25**.

[**0099**] Thus, having provided within the housing **21** the sound-reflecting plates **28** for guiding the sound wave to be noise enables efficient guiding of the sound wave to be noise to each of the passages **26** and **27**, enabling improving the silencing efficiency. Moreover, with it being necessary to provide within the housing **21** only the sound-reflecting plates which are merely plate materials, there is no need to cause the size of the silencer **20**C to increase as a result.

[**0100**] Now a fourth embodiment of the present invention is described.

[**0101**] **FIGS. 9 and 10** illustrate a silencer **20**D being a fourth embodiment. The silencer **20**D in the present embodiment is characterized by having formed multiple pores **22** in a housing **21** while having made the height positions from a surface of the housing **21**, from which the pores **22** are exposed, to differ.

[**0102**] Out of a total of 12 pores **22** of which are formed in the silencer **20**D in the present embodiment, four pores **22**A being close to a fan **1** are configured such that upward-projecting pipes **29** are upwardly erected from a top plate **23** so that the pores **22**A are exposed at the top end of these upward-projecting pipes **29**.

[**0103**] Moreover, four pores **22**C being farthest from the fan **1** are configured such that downward-projecting pipes **30** are downwardly erected from the top plate **23** so that the pores **22**C are exposed at the bottom end of these downward-projecting pipes **30**. Furthermore, the pores **22**B set up between the pores **22**A and the pores **22**C are configured such that the pores are directly formed on the top plate **23**.

[**0104**] Now assuming the height of the upward-projecting pipe **29** in the upward direction from the top plate **23** to be t**1** and the height of the downward-projecting pipe **30** in the downward direction from the top plate **23** to be t**2**, each of these heights t**1** and t**2** become equivalent to the plate thickness t of the top plate **13** in the equation (1) as described above.

[**0105**] In the equation (1), as the plate thickness t of the top plate **13** is in the denominator, the larger the plate thickness t the smaller the silencing frequency f. Thus, changing the heights t**1** and t**2** of the projecting pipes **29**, **30**, respectively, enables adjusting the value of the silencing frequency f. Hereby, silencing noises of various frequencies is enabled, enabling wide-bandwidth silencing. Moreover using pipes **29**, **30** for making the height positions from the surface of the housing **21**, from which the pores **22** are exposed, to differ, enables easy and inexpensive adjusting of the silencing frequency f.

[**0106**] Furthermore, it is known that the noise generated at the fan **1** is greatest at the center position of the duct **2** and less towards the periphery. In the present embodiment, the upward-projecting pipes **29** are configured such that they extend into the duct **2** so that the pores **22** being positioned at the tip of the upward-projecting pipes **29** are exposed at the positions at which the noise within the duct **2** is great. Thus, compared with the pores **22**B and the pores **22**C, efficiently introducing noise within the duct **2** into the housing **21** (the air layer **24**) is enabled, enabling increasing the silencing efficiency.

[**0107**] Next a fifth embodiment of the present invention is described.

[**0108**] **FIGS. 11 and 12** illustrate a silencer **20**E being the fifth embodiment. The silencer **20**E in the present embodiment is configured such that varying the wall thickness of a housing **21** varies the depths of pores **32**A through **32**C formed in this housing **21**.

[**0109**] More specifically, in the present embodiment, a top plate **31** configuring the housing **21**, as illustrated in **FIG. 12**, is arranged such as to have a sectionally-triangular shape, and to have the thickness to gradually increase toward the end which is downstream relative to the direction "a" of the flow of cooling air. Then, as illustrated, at the top plate **31**, pores are made that consist of 3 pores **32**A having the depth t**1**, 3 pores **32**B having the depth t**2**, and 3 pores **32**C having the depth t**3** (where t**1**<t**2**<t**3**).

[**0110**] The thicknesses t**1** through t**3** of these pores **32**A through **32**C, respectively, become equivalent to the plate thickness t of the top plate **13** in the equation (1) as described above. As described previously, as the plate thickness t of the top plate **13** in the equation (1) is in the denominator, the larger the plate thickness t the smaller the silencing frequency f.

[**0111**] Thus, changing the depths t**1** through t**3** of each of the pores **32**A through **32**C by changing the tilt angle of the top plate **31** enables adjusting the value of the silencing frequency f. Hereby, silencing the noise of various frequencies is enabled, enabling wide-bandwidth silencing.

[**0112**] Next a sixth embodiment of the present invention is described.

[**0113**] **FIGS. 13 and 14** illustrate a silencer **20**F being a sixth embodiment. The silencer **20**F in the present embodiment is configured such that having to tilt a bottom plate **34**A of a housing **21** varies the distances L**1** through L**3** to a bottom plate **34**A from pores **33**A through **33**C, respectively, formed at this housing **21** (L**3**<L**2**<L**1**).

[**0114**] Furthermore, in the silencer **20**F in the present embodiment, it is configured such that the diameter $\phi 2$ of the pores **33**B positioned at the center relative to the direction "a" of flow of cooling air is made larger than the diameter $\phi 1$ of the pores **33**A and **33**C positioned on both sides of the pores **33**B ($\phi 2>\phi 1$).

[**0115**] The distances L**1** through L**3** to the bottom plate **34**A from these pores **33**A through **33**C, respectively, become equivalent to the length L of the noise passage in the equation (1). As described previously, the length L of the noise passage in the equation (1) is in the denominator, so the larger the noise passage L the smaller the silencing frequency f.

[**0116**] Thus, changing the tilt angle of the bottom plate **34**A so as to change the distances L**1** through L**3** enables adjusting the value of the silencing frequency f. Hereby, silencing noises of various frequencies is enabled, enabling wide-bandwidth silencing.

[**0117**] Moreover in the present embodiment, the diameter $\phi 2$ of the pores **33**B is set larger than the diameter $\phi 1$ of the pores **33**A and **33**C ($\phi 2>\phi 1$). According to equations (1), (2) as described above, the larger the diameter of the pore the larger the silencing frequency f. Thus, even changing the diameters $\phi 1$, $\phi 2$ of the pores **33**A through **33**C enables adjusting the value of the silencing frequency f, enabling wide-bandwidth silencing.

[**0118**] **FIG. 15** illustrates a silencer **20**G being a seventh embodiment of the present invention. The shape of a bottom plate **34** is not limited to a tilted plane as in the sixth embodiment, but may be spherically shaped as in the present embodiment.

[**0119**] Next an eighth embodiment of the present invention is described.

[**0120**] **FIG. 16** illustrates a silencer **20**H being an eighth embodiment of the present invention. Moreover, **FIG. 17** illustrates a silencer **20I** being a variant of the eighth embodiment. The silencer **20**H in the eighth embodiment is characterized by having formed a concave section **35** at a portion of a top plate **23** of a housing **21**, while the silencer **20I** being the variant is characterized by having formed a convex section **36** at a portion of the top plate **23** of the housing **21**.

[**0121**] As in each of the embodiments, having to form the concave section **35** or the convex section **36** at the top plate **23** enables causing the distances L**2** and L**3** between a pore **22** formed at either the concave section **35** or the convex section **36** and a bottom plate **34** of the housing **21**, and the distance L**1** between a pore **22** formed at the top plate **23** and the bottom plate **34** of the housing **21**, to differ.

[**0122**] The distances L**1** through L**3** to the bottom plate **34** from the corresponding pores **22** are equivalent to the length L of the noise passage in the equation (1) as described above. Thus as in the present embodiment, even forming the concave section **35** or the convex section **36** at the top plate **23** enables adjusting the value of the silencing frequency f.

[**0123**] Next a ninth embodiment of the present invention is described.

[**0124**] **FIG. 18** illustrates a silencer **20J** being the ninth embodiment. While a plate material such as a metal plate is used as the top plate **23** in each of the embodiments as described above, the silencer **20J** in the present embodiment is characterized in that a face of a housing **21** that is being exposed into a duct **2** is configured from a film **37**. As this film **37**, a polyimide film may be used, for example.

[**0125**] As in the present embodiment, using the film **37** in lieu of the top plate **23** made of the plate material such as the metal plate enables making the diameter ϕ of pores **22** being formed at the film **37** smaller than the diameter of the pores being formed at the top plate **23** in other embodiments. In other words, it is known that, when attempting to form a pore at a certain substrate, the diameter of this pore correlates with the thickness of the substrate at which the attempt is made to form the pore, so that the thicker the substrate the larger the minimum diameter of the pore. Moreover, forming a fine pore at a thick substrate requires large-scale facilities resulting in an increased machining cost.

[**0126**] The film **37** may be made thinner than the top plate **23** being used in the other embodiments. Thus according to the present embodiment, easy and inexpensive forming at the film **37** of the pores **22** having the diameter ϕ smaller than those of the pores in the other embodiments is enabled.

[**0127**] As described above, the silencing frequency f becomes larger the larger the diameter ϕ of the pores **22** according to equations (1), (2). Thus, being able to make the diameter ϕ of the pores **22** smaller as in the present embodiment enables making the value of the silencing frequency f smaller, enabling effective silencing of specifically the low frequency range.

[**0128**] Now a tenth embodiment of the present invention is described.

[**0129**] **FIGS. 19 and 20** illustrate a silencer **20**K being the tenth embodiment. In each of the embodiments as described above, the housing **21** is configured to have an enclosing shape and to not deform from the enclosing shape. On the other hand, the silencer **20**K in the present embodiment is configured such that a housing **38** consists of a mainframe **39**A and an elastic material **40**.

[**0130**] The mainframe **39**, being configured so as to be exposed in a duct **2**, has formed at its top plate **23** pores **22** in the present embodiment. This elastic material **40**, being formed with a rubber material, for example, is configured so as to be elastically deformed by air pressure within the duct **2**.

[**0131**] The silencer **20**K having the configuration as described above is in a state such that, when the air speed of cooling air flowing in the duct **2** is low, the elastic material **40** is extended as illustrated in **FIG. 19**. On the other hand, with higher air speed of cooling air resulting in higher air pressure, the elastic material **40** is elastically deformed to decrease the volume of an air layer **24**.

[**0132**] **FIG. 20** illustrates a state such that the elastic material **40** is elastically deformed with an increase in air pressure. As illustrated, with higher speed of the cooling air generated at the fan **1**, the elastic material **40** is elastically deformed to reduce the air layer **24** so that the thickness of the housing **38** is decreased. As a result, the distance L**2** to the elastic material **40** from the pores **22** becomes shorter compared to the distance L**1** to the elastic material **40** from the pores **22** prior to being elastically deformed as illustrated in **FIG. 19** ($L2<L<L1$), enabling increasing the silencing frequency f of the silencer **20**K based on equation (1) as described above.

[0133] Now, the peak frequency of the noise generated at the fan **1** depends on such factors as the number of rotations of the fan **1** and the number of blades provided at the fan **1**. Then, assuming the peak frequency of the noise generated at the fan **1** as fp, the number of rotations of the fan **1** as Q, and the number of blades as M, it may be represented that: fp=Q×M×n (where n is an integer). Or as the number of rotations M of the fan **1** and/or the number of blades provided at the fan **1** change, or in other words as the speed of cooling air generated at the fan **1** changes, the peak frequency fp of the noise changes as well (the higher the fan speed, the higher the peak frequency fp).

[0134] However, the silencer **20**K in the present embodiment is such that, even when the peak frequency fp of the noise generated at the fan **1** changes, a change in the speed of the cooling air resulting from the change in the peak frequency as described above is followed by a change in the silencing frequency f of the silencer **20**K. Thus, the silencer **20**K enables automatically optimizing the silencing effect, enabling effectively silencing the noise generated at the fan **1**.

[0135] Next an eleventh embodiment of the present invention is described.

[0136] **FIGS. 21 and 22** illustrate a silencer **20**L being the eleventh embodiment. In the tenth embodiment as described previously, the configuration is such that the housing **38** is deformed using the elastic material **40**, thereby enabling varying the thickness of the housing **38** (the length L of the noise passage). On the other hand, the silencer **20**L in the present embodiment is characterized by having provided a shape memory alloy **42** (illustrated with bold lines) at a housing **41**.

[0137] The shape memory alloy **42**, having a bellows shape at room temperature as illustrated in **FIG. 21**, is set up between a top plate **23** having formed a pore **22** and a mainframe **39**B shaped to have a bottom. This shape memory alloy **42** has a characteristic such that the bellow portion shrinks by being heated as illustrated in **FIG. 22**.

[0138] The silencer **20**L being configured as described above is in a state such that the shape memory alloy **42** is extended in a bellows shape as illustrated in **FIG. 21** when the duct **2** is at room temperature, or in other words when the material to be cooled by the fan **1** is adequately cooled. On the other hand, as the temperature of the duct **2** increases, the shape memory alloy **42** is heated so that the shape memory alloy **42** shrinks as illustrated in **FIG. 22** and the volume of the air layer **24** within the housing **41** decreases.

[0139] The fact that the temperature of the duct **2** increases indicates that the cooling of the material to be cooled by the fan **1** is not performed adequately. Then, a control apparatus (not illustrated) for performing driving control of the fan **1** performs a control such that it detects when the temperature of the material to be cooled becomes higher than a predetermined value so as to increase the number of rotations of the fan **1** and to increase the speed of cooling air. This control enables preventing the temperature of the material to be cooled from becoming high.

[0140] As described previously, the peak frequency of the noise generated at the fan **1** depends on the number of rotations of the fan **1**. Thus, when the temperature of the material to be cooled rises so as to increase the number of rotations of the fan **1**, the peak frequency of the noise generated at the fan **1** increases.

[0141] However, the silencer **20**L in the present embodiment is such that when the temperature of the material to be cooled rises so as to result in a rise in the temperature of the duct **2**, a shrinking deformation occurs in the shape memory alloy **42** as illustrated in **FIG. 22**. Hereby, the distance L2 to the elastic material **40** from the pore **22** becomes shorter than the distance L1 to the elastic material **40** from the pore **22** prior to deformation as illustrated in **FIG. 21** (L2>L1), thereby enabling increasing the silencing frequency f based on equation (1). Thus, even with the silencer **20**L in the present embodiment, automatic optimizing of the silencing effect is enabled, enabling effective silencing of the noise generated at the fan **1**.

[0142] Now a twelfth embodiment of the present invention is described.

[0143] **FIGS. 23 through 26** illustrate a silencer **20**M as the twelfth embodiment. **FIG. 23** is a vertical cross-sectional view of the silencer **20**M, **FIG. 24** is a plan view of the silencer **20**M, **FIG. 25** is a plan view illustrating the state after operating the silencer **20**M, and furthermore **FIG. 26** is a cross-sectional view from the right-hand side of the silencer **20**M.

[0144] The silencer **20**M in the present embodiment is configured such that area-varying means varies the opening area of pores **43** being formed at top plate **59**. This area-varying means is configured from such elements as a sliding plate **44**, a permanent magnet **46**, an electromagnet **47**, a coil spring **48**, and a top plate **59**.

[0145] The top plate **59**, as illustrated in **FIGS. 24 and 25**, has formed water-droplet shaped multiple pores **43**. This top plate **59** is fixed to a housing **21** and all of the multiple pores **43** are configured so as to communicatively connect to an air layer **24** being formed within the housing **21**. Moreover, the electromagnet **47** is set up at a predetermined position of the top plate **59**.

[0146] The sliding plate **44** is mounted onto the center of the top of this top plate **59** so as to be movable in the direction as illustrated with an arrow between **Y1** and **Y2**. More specifically, a pair of guides **49** for guiding the sliding plate **44** are set up at the top plate **59** so that the sliding plate **44** is guided by this pair of guides **49** so as to move in the direction as illustrated with the arrow between **Y1** and **Y2**.

[0147] This sliding plate **44** has formed multiple long pores **45** extending in the direction (the direction as illustrated with the arrow between X1 and X2) orthogonal to the direction of the arrow between **Y1** and **Y2**. The length **W1** (below referred to as the width dimension **W1**) relative to the direction of the arrow between **Y1** and **Y2** of these long pores **45** is set to be smaller than the length **W2** (below referred to as the width dimension **W2**) relative to the direction of the arrow between **Y1** and **Y2** of the pores **43** (W2>W1).

[0148] Moreover, the permanent magnet **46** is provided at one edge (the edge in the **Y1** direction) of the sliding plate **44** such that the position of the permanent magnet is set facing the electromagnet **47** being provided at the top plate **59**. Moreover, a coil spring **48** is set up between the edge of the sliding plate **44**, that is set up with the permanent magnet **46**, and the top plate **59**.

[0149] As this coil spring **48** is elastically energized in the direction of shrinking, when there is no magnetic force generated at the electromagnet **47** as illustrated in **FIG. 24**, due to the elasticity of the coil spring **48**, the sliding plate **44** is moved in the direction towards **Y2** of the arrow illustrated (below referred to this state as the state prior to operating). Moreover, in the state prior to operating as illustrated in **FIG. 24**, the long pores **45** are overlapping with predetermined ranges at the side of the pores **43** that is in the direction towards **Y2**. Then, these overlapping portions configure the pores **22** for introducing the noise into the housing **21** (these pores **22** are illustrated as hatched).

[0150] In the configuration as described above, once current is supplied to the electromagnet **47**, magnetic force is generated at the electromagnet **47**. As the permanent magnet **46** is set up to face the electromagnet **47**, with the permanent magnet **46** generating magnetic force, the sliding plate **44** moves in the direction toward **Y1** of the arrow illustrated in opposition to the force of the coil spring **48**. Then, the amount of movement of the sliding plate **44** in the direction towards **Y1** may be controlled with the value of current supplied to the electromagnet **47** (or the magnetic force generated at the electromagnet **47**), assuming the elastic energizing of the coil spring **48** to be constant.

[0151] Moreover, as described above, the pores **43** are made to be water-droplet shaped (or a shape such that the length of the pores **43** relative to the direction of the arrow between X1 and X2 as illustrated changes gradually when proceeding in the direction of the arrow between Y1 and Y2) and that the width dimension W1 of the long pores **45** is shorter than the width dimension W2 of the pores **43**. Thus, the sliding plate **44** moving in the direction of the arrow between **Y1** and **Y2** changes the area of the portions overlapping between the pores **43** and the long pores **45**, or the area of the pores **22**.

[0152] According to equations (1) and (2) as described above, the larger the diameter ϕ of the pores, the larger the silencing frequency f. Moreover, as in the present embodiment, changing the area of the pores **22** where the pores **43** and the long pores **45** overlap is equivalent to changing the diameter ϕ of the pores in equations (1) and (2).

[0153] Thus, according to the silencer **20**M in the present embodiment, moving the sliding plate **44** enables adjusting the value of the silencing frequency f, enabling wide-bandwidth silencing. Moreover, randomly varying the diameter of the opening of the pores enables, even when the frequency of noise changes, reliably responding to the change so as to perform silencing.

[0154] It is noted that the shape of these pores **43** is not limited to the water-droplet shape so that other shapes are possible as long as the area of the opening formed as a result of the overlapping of the pores **43** and the long pores **45** is shaped such that it changes as the sliding plate **44** moves. Moreover, it may be configured such that the area of the opening pores **22** increases as the sliding plate **44** moves with an increased speed of cooling air and as the sliding plate **44** moves with an increased supply voltage of the fan.

[0155] Next a thirteenth embodiment of the present invention is described.

[0156] **FIGS. 27 through 29** illustrate a silencer **20**N being the thirteenth embodiment. **FIG. 27** is a perspective view of the silencer **20**N, while **FIGS. 28 and 29** are vertical cross-sectional views for describing the operation of the silencer **20**N.

[0157] The silencer **20**N in the present embodiment is also configured to provide area-varying means for varying the opening area of pores **22** being formed at a top plate **59**. In the present embodiment, this area-varying means is configured only from elastic strips **50**. Thus, compared to the silencer **20M** in the twelfth embodiment described previously, simplified structure and low cost are achieved.

[0158] The elastic strips **50**, being formed with an elastic material such as rubber, for example, are configured to integrally form a fixed section **50**A and a movable section **50**B. These elastic strips **50** are configured such that the movable section **50**B makes a roughly-straight line with the fixed section **50**A when there is no cooling air flowing within a duct **2** as illustrated in **FIG. 28**. Moreover, the elastic strips **50** are fixed at the positions close to the pores **22**. More specifically, the elastic strips **50** are fixed to the bottom of a top plate **23** as the fixed sections **50**A are adhered to the edges of the pores **22** that are on the side upstream relative to the direction "a" of flow of cooling air.

[0159] The silencer **20**N being configured as described above is such that the elastic strips **50** as illustrated in **FIG. 28** have the movable sections **50**B making a roughly-straight line with the fixed sections **50**A when the air speed of the cooling air flowing in the duct **2** is low (the speed of the noise flowing in the duct **2** is low). It is noted that the opening area of the pores **22** then is set as S1.

[0160] **FIG. 29** illustrates the state in which the air speed of the cooling air flowing in the duct **2** is high (the speed of noise flowing in the duct **2** is high). As the air speed of the cooling air increases, the wind force acts on the movable sections **50**B so as to cause the movable sections **50**B to deflect toward the bottom side of a housing **24**, resulting in a larger opening area of the pores **22**. Then, when a predetermined air speed is reached, the moveable sections **50**B are caused to be extended in a direction that is obliquely downward relative to the fixed sections **50**A such that the opening areas of the pores **22** become the maximum area S2 (See **FIG. 29**).

[0161] According to equations (1) and (2) as described above, the larger the diameter ϕ of the pores, the larger the silencing frequency f. Moreover, as in the present embodiment, the fact that the area of the pores **22** changes is equivalent to changing the diameter ϕ of the pores according to the equations (1), (2).

[0162] Thus, according to the silencer **20**N of the present embodiment, as the value of the silencing frequency f changes depending on the air speed of cooling air flowing in the duct **2**, or the peak frequency of noise generated at the fan **1**, performing a silencing process that follows a wide range of frequencies is enabled. Moreover, the silencing performance of the silencer **20**N, being enabled to be changed by adjusting the elasticity coefficient of the elastic strip and the area of the pores **22** covered by the movable sections **50**B, may be set to be a performance suitable for silencing noise generated at the fan **1**. Thus, according to the silencer **20**N, efficient silencing of the noise generated at the fan **1** is enabled.

[0163] Next a fourteenth embodiment of the present invention is described.

[0164] **FIG. 30** illustrates a silencer **20**P being the fourteenth embodiment. The silencer **20**P in the present embodiment is characterized by having to configure a housing **51** with a heat sink **52** and a duct **53** (illustrated with a long-dashed short-dashed line).

[0165] The heat sink **52**, for cooling such apparatuses as a semiconductor apparatus being provided in electronic equipment into which the silencer **20**P is fit, is configured such that multiple fins **55**, **56** are erected at the top of a base **61**. The heat sink **52** in the present embodiment is configured such that a fin-without-pores **55** that has not formed pores **57** and a fin-with-pores **56** that has formed pores **57** are alternately juxtaposed.

[0166] Moreover, the duct **53**, formed of a plate material in a horseshoe shape, is mounted onto the base **61** so as to cover each of the fins **55** and **56**. Thus, with the duct **53** being mounted onto the heat sink **52**, an air layer **24** being partitionally formed by an adjacent pair of the fins **55** and **56** is formed within the silencer **20**P (See **FIG. 33**). Hereby, when the sound wave to be noise is introduced into the silencer **20**P, this noise is silenced within the air layer **24** formed between an adjacent pair of the fins **55** and **56**.

[0167] **FIGS. 31 and 32** illustrate one example of a connecting structure for connecting the silencer **20**P to a fan **1**. In the example illustrated in **FIG. 31**, the silencer **20**P is directly connected to the fan **1** so as to make a straight line with the fan. This connecting structure enables achieving reducing the total thickness of the fan **1** and the silencer **20**P. Moreover, in an example illustrated in **FIG. 32**, a gap is provided between the position at which the fan **1** is set up and the position at which the silencer **20**P is set up.

[0168] In either of the connecting structures, the cooling air generated at the fan **1** is introduced into a housing **51** from an inlet section **60** of the silencer **20**P so as to be discharged into a duct **2** from a discharging section **62**. Then, the cooling air passing within adjacent pairs of the fins **55**, **56** causes dissipation of heat that is transferred to the heat sink **52** from a material to be cooled. On the other hand, the noise generated at the fan **1**, being introduced into the silencer **20**P from the inlet **60** with the cooling air, is silenced within the air layer **24** being formed between adjacent pairs of the fins **55**, **56**.

[0169] Thus in the silencer **20**P in the present embodiment, as the housing **51** is configured with the duct **53** and the heat sink **52** that configure a cooling apparatus, the silencer **20**P may be used for the cooling apparatus. Thus, achieving reducing the space of the electronic equipment in which the silencer **20**P is provided, relative to the configuration such that a silencer and a cooling apparatus are provided separately, is enabled.

[0170] **FIGS. 34 through 36** illustrate variants of the silencer **20**P illustrated in **FIGS. 30 through 33**. As illustrated in **FIG. 33**, the silencer **20**P as described previously is configured such that a fin-without pores **55** and a fin-with-pores **56** are alternately set up.

[0171] On the other hand, a silencer **20**Q in a first variant as illustrated in **FIG. 34** is configured such that all fins set up within a duct **53** are set to be the fins-with-pores **56** and that pores **57** are not communicatively connected (see the dashed line) between neighboring fins-with-pores **56**. A silencer **20**R in a second variant as illustrated in **FIG. 35** is configured such that all fins set up within a duct **53** are set to be fin-with-pores **56** and that pores **57** are communicatively connected (see the dashed line) between neighboring fins-with-pores **56**.

[0172] Moreover, a silencer **20**S in a third variant as illustrated in **FIG. 36** is characterized by having set up fins-without-pores **55** and fins-with-pores **56** alternately and having set up fins with pores **56** in a duct **53**. Thus, randomly setting the way of setting up each of the fins **55**, **56** and the position at which the pores **57** are formed are enabled, thereby enabling varying the silencing performance.

[0173] Next a fifteenth embodiment of the present invention is described.

[0174] **FIG. 37** illustrates a silencer **20**T being the fifteenth embodiment. The silencer **20**T in the present embodiment is configured such that fins-without-pores **55** and fins-with-pores **56** are alternately juxtaposed as in the silencer **20**P in the fourteenth embodiment as illustrated in **FIG. 30**. Furthermore, the silencer **20**T in the present embodiment **20**T is characterized by having provided a shielding plate **58** at each end of a mutually-facing pair of fins-without-pores **55** and fins-with-pores **56**.

[0175] This shielding plate **58** is airproof fixed to a heat sink **52** and is configured so as to cause the space between the duct **53** and the shielding plate **58** to be airproof when the duct **53** is mounted onto the heat sink **52**. Thus, the space (air layer **24**) formed between the fins-without-pores **55**, the fins-with-pores **56**, a base **61**, and the duct **53** is configured such that only pores **57** are communicatively connected to the outside while the other portions are airproof.

[0176] As described previously using **FIGS. 5A and 5B**, increasing the airproofness of the air layer **24** improves the silencing performance. Thus, as in the silencer **20**T in the present embodiment, having provided the shielding plate **58** at both ends of mutually-facing pairs of the fins **55**, **56** so as to increase the airproofness of the air layer **24** formed therein enables improving the silencing performance of the silencer **20**T.

What is claimed is:

1. A silencer, comprising:

a housing having a flat enclosing shape and having formed therein a passage for silencing; and

one or more pores, being formed at said housing so as to be communicatively connected with said passage, into which a sound wave to be noise is introduced;

wherein said pores, being formed close to the periphery of said housing, are configured so that said sound wave to be noise travels in a planar direction of said housing.

2. The silencer as claimed in claim 1,

wherein one or more partition plates for partitioning said housing in the thickness direction are provided so as to form within said housing plural of the passages in which said sound wave to be noise travels.

3. The silencer as claimed in claim 1,

wherein a reflecting plate for reflecting toward said passage said sound wave to be noise is provided at said housing.

4. The silencer as claimed in claim 1,

wherein said housing is made airproof except for positions at which said pores are formed.

5. A silencer, comprising:

a housing having a flat enclosing shape and having formed therein an air layer for silencing; and

a plurality of pores, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced;

wherein said pores are configured so as to make height positions from a surface of said housing from which said pores open to differ.

6. The silencer as claimed in claim 5,

wherein one or more pipes are provided at said pores so that by varying the lengths of said pipes, the height positions relative to the surface of said housing from which said pores open are varied.

7. The silencer as claimed in claim 5,

wherein varying the wall thickness of said housing varies depths of said pores being formed at said housing.

8. A silencer, comprising:

a housing having a flat enclosing shape and having formed therein an air layer for silencing; and

a plurality of pores, being formed at said housing so as to be communicatively connected with said air layer, into which sound wave to be noise is introduced;

wherein said pores are configured so as to make opening areas of said pores to differ.

9. A silencer, comprising:

a housing having a flat enclosing shape and having formed therein an air layer for silencing;

one or more pores, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced; and

area-varying means for varying opening areas of said pores.

10. The silencer as claimed in claim 9,

wherein said area-varying means is configured to vary, in order to make decreased opening areas, the opening areas of said pores when the speed of cooling air increases.

11. A silencer, comprising:

a housing having a flat enclosing shape and having formed therein an air layer for silencing;

one or more pores, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced; and

shape-varying means for varying thickness of said housing.

12. The silencer as claimed in claim 11,

wherein said shape-varying means is configured to decrease the thickness of said housing when the speed of cooling air increases.

13. A silencer, comprising:

a housing having an enclosing shape and having formed therein an air layer for silencing; and

one or more inlet sections, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced;

wherein multiple fins for cooling having formed thereon one or more pores are provided within said housing.

14. A silencer, comprising:

a housing having an enclosing shape and having formed therein an air layer for silencing; and

one or more inlet sections, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced;

wherein fins for cooling having formed one or more pores and fins for cooling not having formed one or more of the pores are juxtaposed; and

a shielding plate is provided at each end of a pair of said fin for cooling with pores and said fin for cooling without pores.

15. Electronic equipment, including within an apparatus mainframe a fan for cooling and a silencer for silencing noise generated at said fan,

wherein the silencer comprises:

a housing having a flat enclosing shape and having formed therein a passage for silencing; and

one or more pores, being formed at said housing so as to be communicatively connected with said passage, into which a sound wave to be noise is introduced;

and wherein said pores, being formed close to the periphery of said housing, are configured so that said sound wave to be noise travels in a planar direction of said housing.

16. The electronic equipment as claimed in claim 15,

wherein one or more partition plates for partitioning said housing in a thickness direction are provided so as to form within said housing plural of the passages in which said sound wave to be noise travels.

17. The electronic equipment as claimed in claim 15,

wherein a reflecting plate for reflecting toward said passage said sound wave to be noise is provided at said housing.

18. The electronic equipment as claimed in claim 15,

wherein said housing is made airproof except for positions at which said pores are formed.

19. Electronic equipment, including within an apparatus mainframe a fan for cooling and a silencer for silencing noise generated at said fan,

wherein the silencer comprises:

a housing having a flat enclosing shape and having formed therein an air layer for silencing; and a plurality of pores, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced;

and wherein said pores are configured so as to make height positions from a surface of said housing from which said pores open to differ.

20. The electronic equipment as claimed in claim 19,

wherein one or more pipes are provided at said pores so that by varying the lengths of said pipes, the height positions relative to the surface of said housing from which said pores open are varied.

21. The electronic equipment as claimed in claim 19,

wherein varying the wall thickness of said housing varies depths of said pores being formed at said housing.

22. Electronic equipment, including within an apparatus mainframe a fan for cooling and a silencer for silencing noise generated at said fan,

wherein the silencer comprises:

a housing having a flat enclosing shape and having formed therein an air layer for silencing; and

a plurality of pores, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced;

and wherein said pores are configured so as to make opening areas of said pores to differ.

23. Electronic equipment, including within an apparatus mainframe a fan for cooling and a silencer for silencing noise generated at said fan,

wherein the silencer comprises:

a housing having a flat enclosing shape and having formed therein an air layer for silencing;

one or more pores, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced; and

area-varying means for varying opening areas of said pores.

24. The electronic equipment as claimed in claim 23,

wherein said area-varying means is configured to vary, in order to decrease said opening areas, the opening areas of said pores when the speed of cooling air increases.

25. Electronic equipment, including within an apparatus mainframe a fan for cooling and a silencer for silencing noise generated at said fan,

wherein the silencer comprises:

a housing having a flat enclosing shape and having formed therein an air layer for silencing; and

one or more pores, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced; and

shape-varying means for varying thickness of said housing.

26. The electronic equipment as claimed in claim 25,

wherein said shape-varying means is configured to decrease the thickness of said housing when the speed of cooling air increases.

27. Electronic equipment, including within an apparatus mainframe a fan for cooling and a silencer for silencing noise generated at said fan,

wherein the silencer comprises:

a housing having an enclosing shape and having formed therein an air layer for silencing; and

one or more inlet sections, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced;

and wherein multiple fins for cooling having formed one or more pores are provided within said housing.

28. Electronic equipment, including within an apparatus mainframe a fan for cooling and a silencer for silencing noise generated by said fan, the silencer comprising:

a housing having an enclosing shape and having formed therein an air layer for silencing; and

one or more inlet sections, being formed at said housing so as to be communicatively connected with said air layer, into which a sound wave to be noise is introduced;

wherein fins for cooling having formed one or more pores and fins for cooling not having formed one or more of the pores are juxtaposed; and

a shielding plate is provided at each end of a pair of said fins for cooling with pores and said fins for cooling without pores.

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