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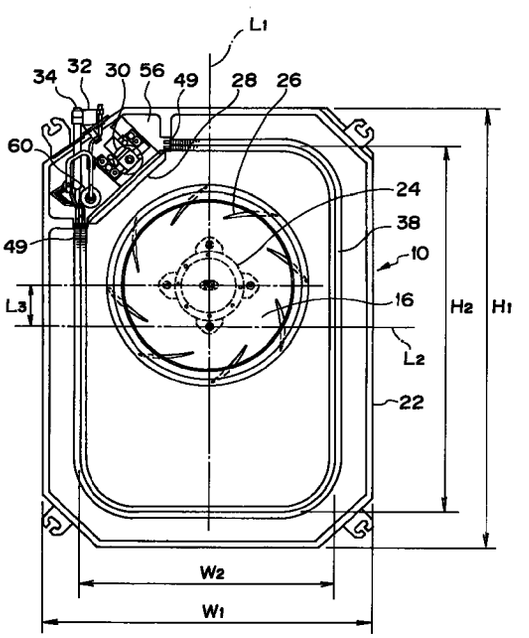
(54) Air conditioner having eccentrically-disposed fan

(57) In an air conditioner (10) which contains a fan (26) and a heat exchanger (38) in a housing, the heat exchanger (38) being bent so as to surround the fan (26), the shaft center of the fan is disposed eccentrically from the center of the heat exchanger (38) or eccentrically displaced from the center of the heat exchanger (38) toward a partition plate (28) through which the inside of the heat exchanger (38) and the outside of the heat exchanger (38) are spatially separated.

FIG. 2



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an air conditioner which is embedded and mounted in a ceiling, for example.

2. Description of Related Art

Fig. 1 shows a conventional air conditioner which is embedded and mounted in a ceiling (hereinafter referred to as "in-ceiling mount type air conditioner"). The air conditioner has a housing (hereinafter referred to as "unit body") 1, a fan 2 and a heat exchanger 3 which is formed in a substantially square shape so as to surround the fan 2. The fan 2 and the heat exchanger 3 are accommodated in the housing 1, and pipe holding plates 4 of the heat exchanger 3 are connected to each other through a partition plate 5. A drain pump 7 is further disposed in a space 6 which is spatially separated from the inside of the heat exchanger 3 by the partition plate 5. In this type of air conditioner, room air which is sucked through an air suction port 8 is subjected to heat exchange by the heat exchanger 3, and then blown out from blow-out ports 9 which are disposed so as to blow air in four directions as shown in Fig. 1. The partition plate 5 is used to prevent the heat-exchanged air from leaking from the surrounding portions of the drain pump 7, a mechanical valve 7a, etc.

In the conventional air conditioner thus constructed, the air becomes turbulent or eddy when it is blown out from the fan 2, and the turbulence or eddy of the blow-out air causes noises during the operation of the air conditioner.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide an air conditioner which can reduce noises under the operation of the air conditioner (hereinafter referred to as "operation noise").

In order to attain the above object, according to a first aspect of the present invention, an air conditioner which contains a fan and a heat exchanger in a housing, the heat exchanger being bent so as to surround the fan, is characterized in that the shaft center of the fan is disposed eccentrically from the center of the heat exchanger (i.e., is displaced from the center of the heat exchanger in any direction).

According to a second aspect of the present invention, an air conditioner which contains a fan and a heat exchanger in a housing, the heat exchanger being bent so as to surround the fan, and pipe holding plates of the heat exchanger being connected to each other through a partition plate, is characterized in that the shaft center of the fan is disposed eccentrically from the center of the heat exchanger toward the partition plate.

According to the present invention, the shaft center of the fan is disposed eccentrically from the center of the heat exchanger, or the shaft center of the fan is disposed eccentrically from the center of the heat exchanger toward the partition plate side. Therefore, the turbulence of the air is suppressed, so that the operation noise can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a bottom view showing a conventional air conditioner;

Fig. 2 is a bottom view showing an embodiment of an unit body of an air conditioner according to the present invention;

Fig. 3 is a bottom view showing a decorative panel of the unit body according to the present invention shown in Fig. 2;

Fig. 4 is a cross-sectional view showing the air conditioner shown in Fig. 3;

Fig. 5 is a graph showing noise test data according to the present invention; and

Fig. 6 is a graph showing noise test data according to the prior art.

DETAILED DESCRIPTION OF THE INVENTION

A preferred embodiment according to the present invention will be described hereunder with reference to the accompanying drawings.

Fig. 2 is a bottom view showing an unit body of an air conditioner according to the present invention, Fig. 3 is a bottom view showing the unit body to which a decorative panel is attached, and Fig. 4 is a cross-sectional view showing the unit body of Fig. 3 and the decorative panel.

Referring to Fig. 4, reference numeral 10 represents an in-ceiling mount type air conditioner. This in-ceiling mount type air conditioner is fixed while suspended in a ceiling space 11 of a house or building 40, and it is of a four-direction air blowing type. The air conditioner has an unit body 22 and a decorative panel 14. An air suction port (not shown) is formed at the center of the longitudinal direction of the decorative panel 14, and blow-out ports 18 are formed around the air suction port of the decorative panel 14 as shown in Fig. 3. Four bolts 42 are fixed to roof frames of the house 40 or the like so as to extend from the house 40 vertically downwardly, and are also fixed to hanging hooks of the unit body 22 to secure the air conditioner.

In the unit body 22 of the air conditioner 10 are disposed a fan motor 24, a turbo fan 26, a heat exchanger 38 and an electrical equipment box 36. Reference numeral 16 represents an air suction port of the turbo fan 26. The heat exchanger 38 is bent in a substantially rectangular shape so as to surround the fan motor 24 and the turbo fan 26. The pipe holding plates 49 of the heat exchanger 38 are connected through a partition

plate 28. A drain pump 30, a drain exhaust port 32, a refrigerant pipe 34, etc. are disposed in a space at the outside of the heat exchanger 38 which is spatially separated from the inside of the heat exchanger 38 by the partition plate 28. The partition plate 28 is used to prevent the sucked air from leaking out during the operation of the air conditioner, and thus allows the heat-exchanged air to be surely blow out from the four-direction air blow-out ports 18 into a room R.

According to this embodiment, the heat exchanger 38 is bent in a substantially rectangular shape, and located to surround the turbo fan 26 as shown in Fig. 2. The shaft center of the turbo fan 26 is eccentrically displaced from the center of the heat exchanger 38 toward the partition plate (i.e., the turbo fan 26 is disposed eccentrically from the center of the heat exchanger 38 toward the partition plate 28). Here, the shaft center of the turbo fan 26 means the axial center of the output shaft of the fan motor 24, and the center of the heat exchanger 38 means the intersection point between lines L1 and L2, that is, the intersection point between a longitudinal axis L1 and a lateral axis L2.

As shown in Fig. 4, an air filter 20 is also provided at the air suction port of the decorative panel 14 of the air conditioner 10.

Next, the operation of the air conditioner will be described.

In Figs. 2 to 4, upon actuation of the fan motor 24 in a body casing 22, the turbo fan 26 is rotated to suck air from the room R through the air suction port of the decorative panel and the air suction port 16 of the turbo fan 26. The sucked air is cleaned by the air filter 20, and then fed to the heat exchanger 38. The air is subjected to the heat exchange by the heat exchanger 38, and then blown out from the four blow-out ports into the room Rn in the four directions.

In this case, the room air which has been sucked from the air suction port 16 and heat-exchanged by the heat exchanger 38 is prevented from leaking from the inside of the heat exchanger 38 to the surrounding portions of the drain pump 30, the drain exhaust port 32, the in-door mechanical valve 60, etc. due to existence of the partition plate 28 located at a corner portion of the unit body 22, and thus the heat-exchanged air is allowed to be surely blow out from the four-direction blow-out ports 18 into the room R.

According to this embodiment, the shaft center of the turbo fan 26 is eccentrically displaced from the center of the heat exchanger 38 (i.e., the center of the area surrounded by the rectangular heat exchanger 38) toward the partition plate 28 side by a distance of L3 as shown in Fig. 2, so that the operation noise during the operation of the air conditioner can be more greatly reduced as compared with the conventional air conditioner, which will be described later.

The distance L3 is preferably equal to about 100mm, however, it may be varied in accordance with the size of the unit body 22. Further, it has been found out that the distance L3 is not dependent on the bending shape of the heat exchanger 38. For example, the heat exchanger 38 may be bent in a square, rectangular, elliptic or circular shape. At any rate, according to this embodiment, it is important to eccentrically displace the shaft center of the turbo fan 26 from the center of the heat exchanger 38 (i.e., to dispose the shaft center of the turbo fan 26 eccentrically from the center of the heat exchanger 38). The displacement direction of the shaft center of the turbo fan 26 is not limited to a specific one. In the embodiment shown in Fig. 2, the shaft center of the turbo fan 26 is displaced from the center of the heat exchanger 38 toward the partition plate side (in the case of Figs. 2 and 3, in a direction along the longitudinal axis L1 which approaches to one short side of the heat exchanger 38 nearer to the partition plate 28). This displacement direction is merely determined as a preferable one to reduce the operation noise, and it may be set to any direction, for example, the opposite direction to the above displacement direction (i.e., the direction opposite to the partition plate side). However, it has been clear that the latter case (i.e., the displacement in the opposite direction to the partition plate side) has a smaller noise reduction effect than the former case (the displacement toward the partition plate side).

As described above, according to the present invention, the eddy or turbulence of air which is blown out from the turbo fan 26 to the heat exchanger 38 can be reduced, so that the noises during the operation of the air conditioner can be more reduced as compared with the conventional air conditioner.

Fig. 5 is a graph showing noise test data obtained according to the present invention, and Fig. 6 is a graph showing noise test data obtained according to the prior art. In these graphs, the abscissa represents the frequency while the ordinate represents the magnitude of noises (dB). The frequency band used for the noise test data was 25Hz to 20KHz, and the histogram at the right end of each graph represents an average value in the used frequency band. Comparing these test data of Figs. 5 and 6, it is apparent from Figs. 5 and 6 that the air conditioner of the present invention can more greatly reduce the operation noise by about 2 dB as compared with the conventional air conditioner. That is, in the case of Fig. 5, the operation noise is reduced to 48.3dB whereas in the case of Fig. 6, the operation noise is equal to 50.3dB.

The actual dimension of the air conditioners used for this noise test was as follows (see Fig. 2):

dimension of the unit body 22 in the direction of the longitudinal axis L1 direction : H1 = 1050mm;
dimension of the heat exchanger 38 : H2 = 900mm;
dimension of the unit body 22 in the direction of the lateral (short) axis L2 direction : W2 = 610mm; and
displacement distance of the shaft center: L3 = 100mm.

In short, according to this embodiment, it has been found out from various noise tests that if the shaft center

of the fan is displaced in any direction, the operation noise can be reduced irrespective of the bending shape of the heat exchanger 38.

The present invention is not limited to the above embodiment, and various modifications may be made without departing from the subject matter of the present invention. For example, the above-mentioned embodiment relates to a four-direction air blow-out type air conditioner 10, however, the present invention is applicable to any other type air conditioners, such as a two-direction air blow-out type air conditioner or the like.

As described above, according to the present invention, the heat exchanger is bent so as to surround the fan, and the shaft center of the fan is eccentrically displaced from the center of the heat exchanger or displaced from the center of the heat exchanger toward the partition plate side. Therefore, the turbulence or eddy of the air which is blow out from the fan can be suppressed, so that the operation noise can be reduced.

Claims

1. An air conditioner which includes a fan and a heat exchanger in a housing, said heat exchanger being bent so as to surround said fan, characterized in that the shaft center of said fan is disposed eccentrically from the center of said heat exchanger.

2. The air conditioner as claimed in claim 1, further including a partition plate for connecting pipe holding plates of said heat exchanger therethrough and spatially partitioning the inside of said heat exchanger and the outside of said heat exchanger.

3. The air conditioner as claimed in claim 2, wherein the shaft center of said fan is displaced eccentrically from the center of said heat exchanger toward said partition plate.

4. The air conditioner as claimed in claim 1, wherein said heat exchanger is bent in a square, rectangular, elliptic or circular shape.

5. The air conditioner as claimed in claim 1, wherein the shaft center of said fan is eccentrically displaced from the center of said heat exchanger by 100mm.

6. An air conditioner including:

   a fan for sucking air from a room;
   a heat exchanger which is bent so as to surround said fan and adapted to heat-exchange the sucked air;
   a partition plate which is disposed so as to connect pipe holding plates of said heat exchanger therethrough and spatially separate the inside of said heat exchanger and the outside of said heat exchanger; and
   a decorative panel having an air suction port through which the room air is sucked, and plural air blow-out ports which are provided around said air suction port and through which the heat-exchanged air is blow out into the room in plural directions, wherein the shaft center of said fan is disposed eccentrically from the center of said heat exchanger.

7. The air conditioner as claimed in claim 6, wherein the shaft center of said fan is displaced eccentrically from the center of said heat exchanger toward said partition plate.

FIG. 1
PRIOR ART

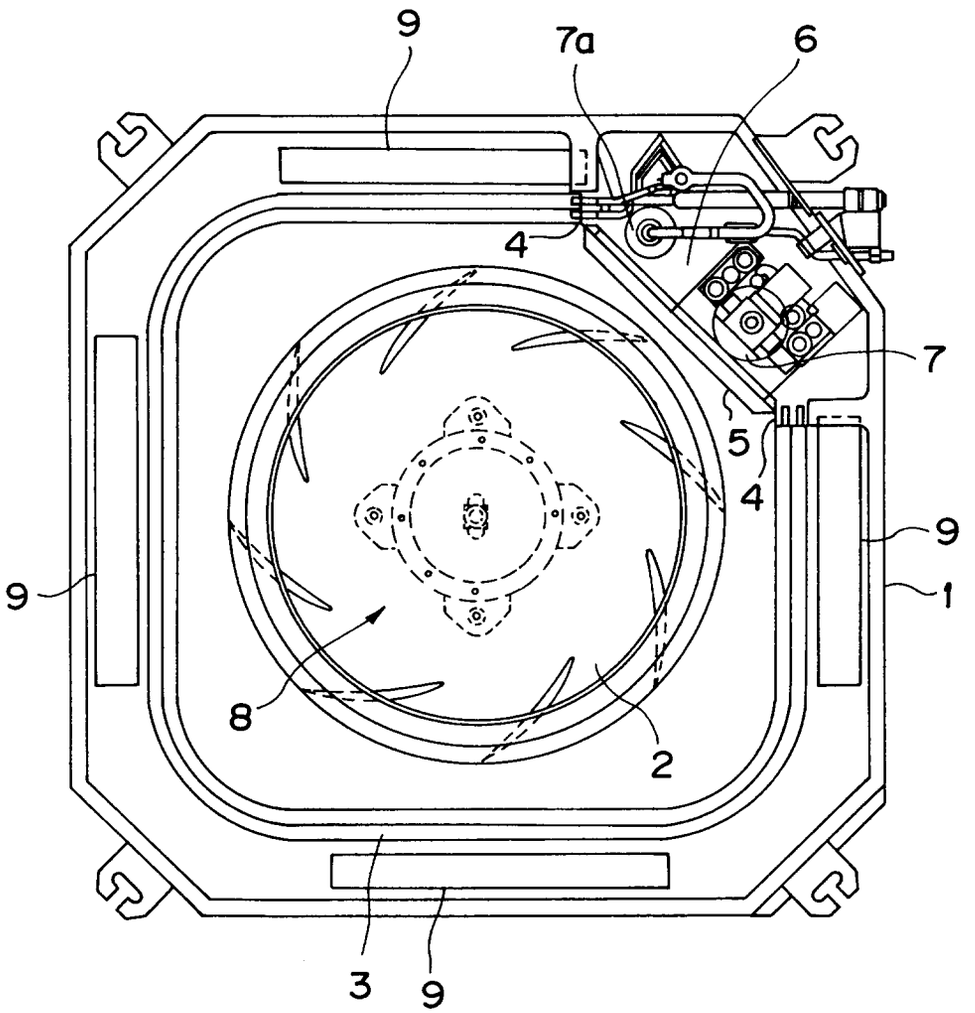

FIG. 2

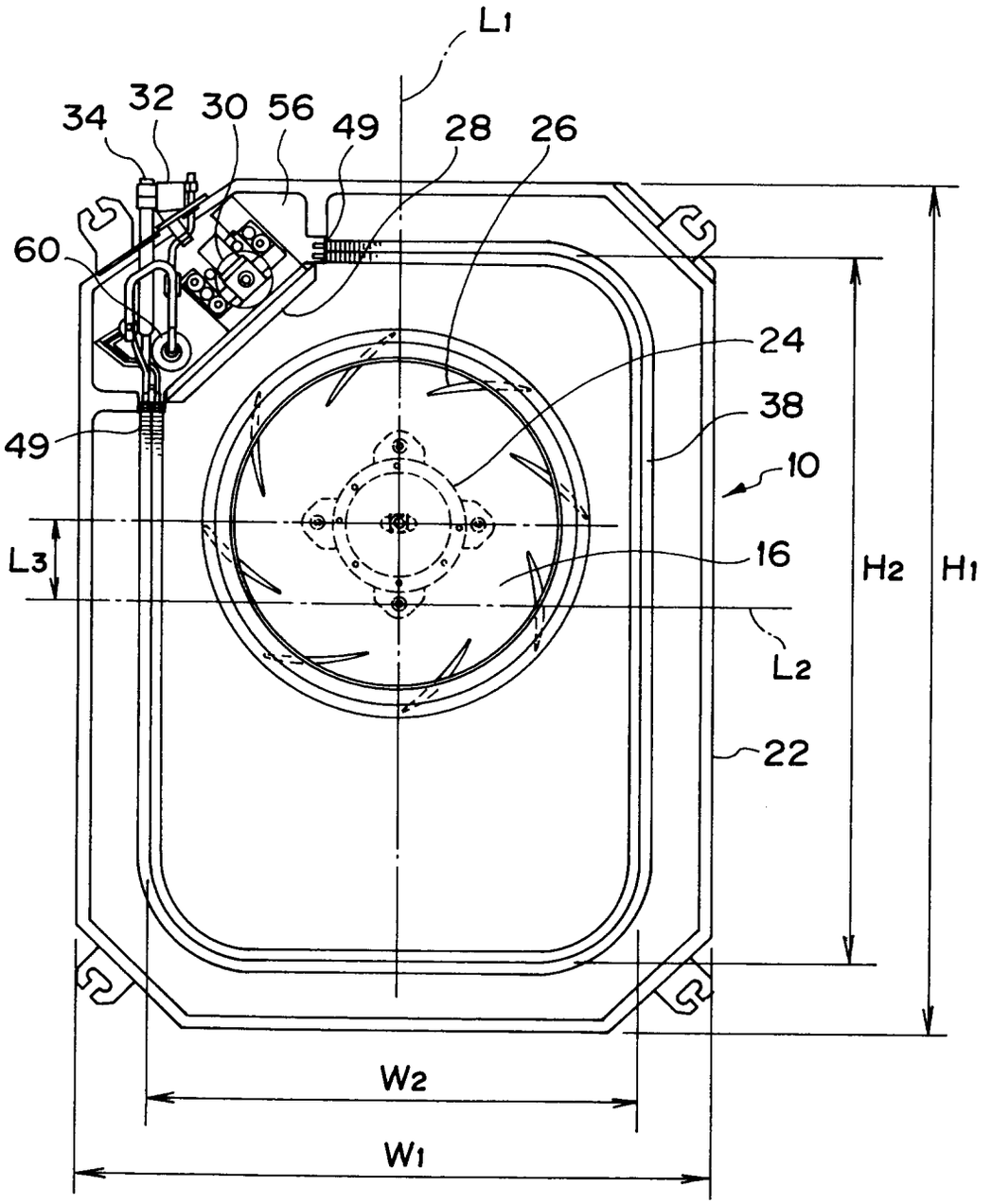

FIG. 3

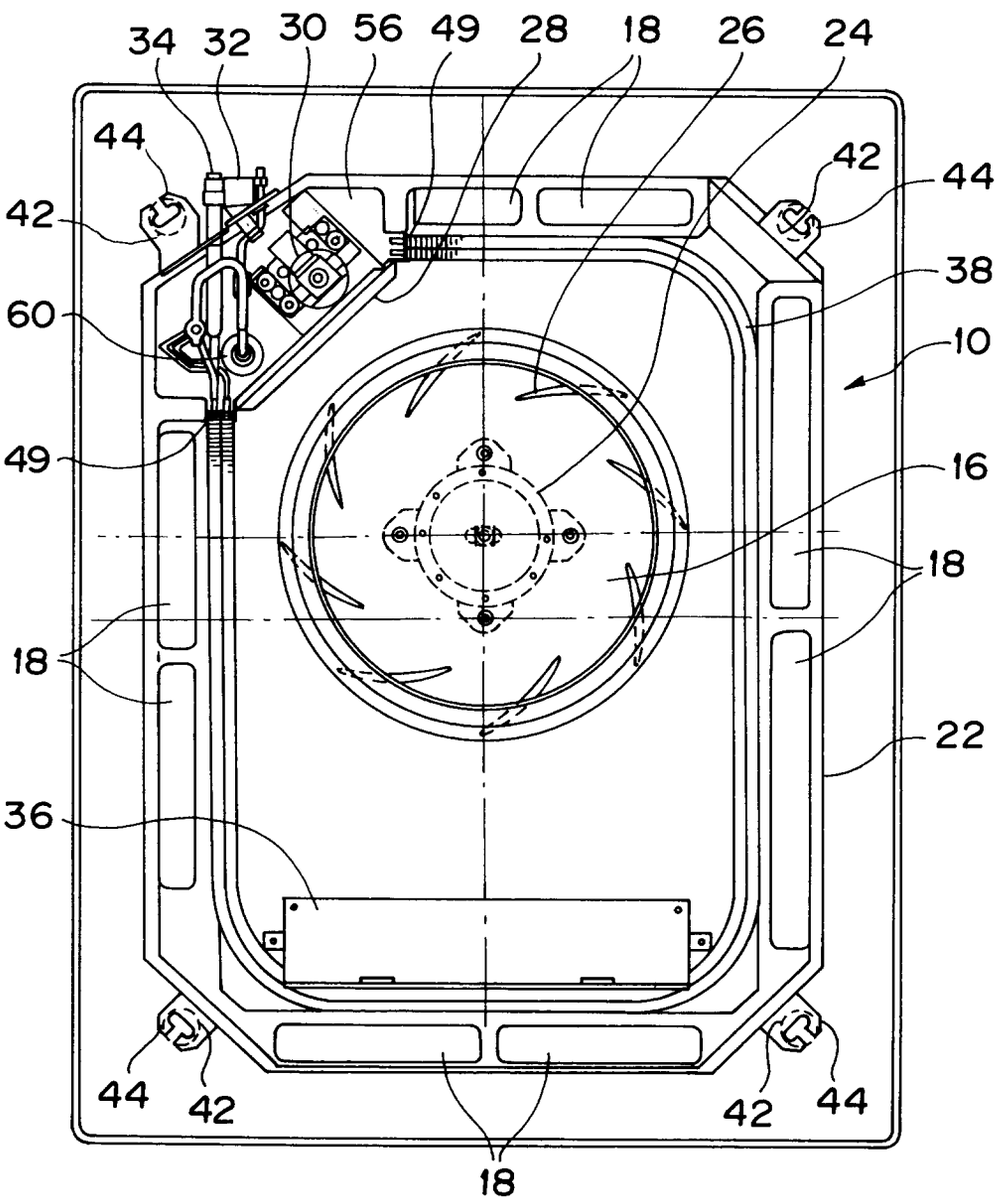
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FIG. 4

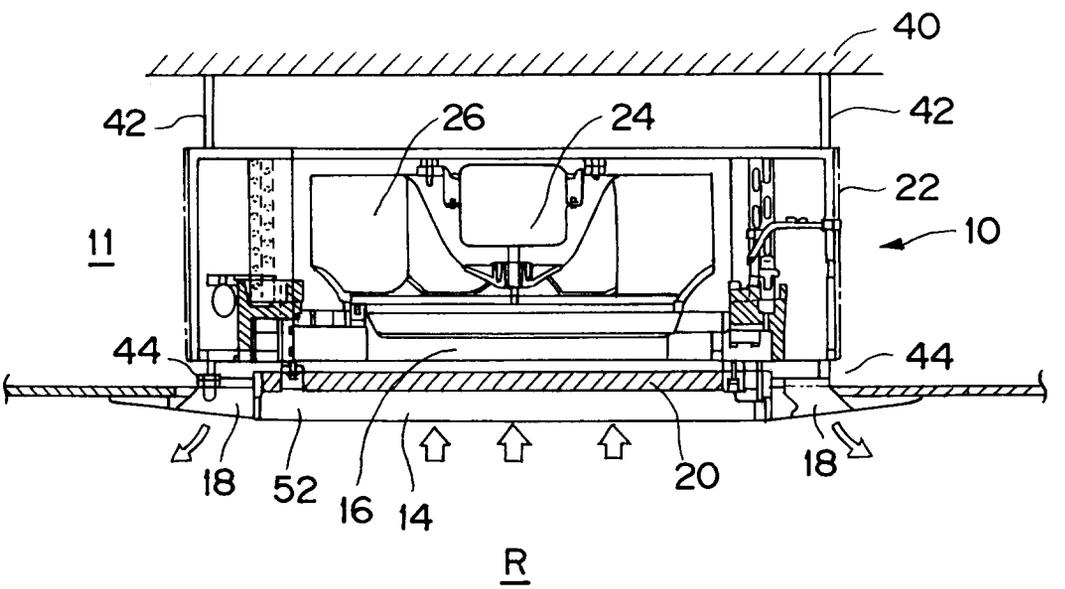
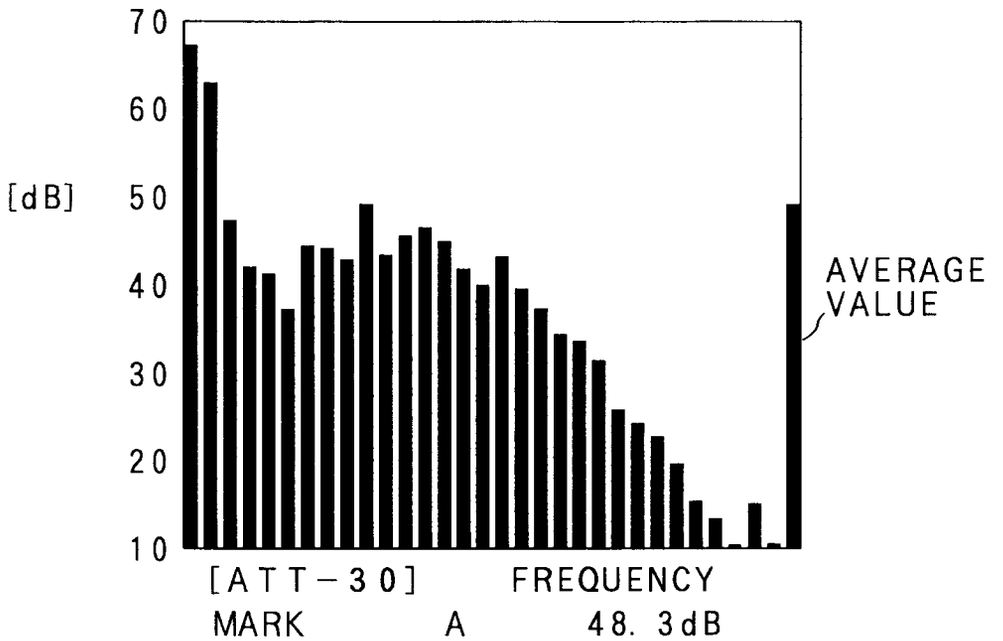


FIG. 5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20
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AVERAGE VALUE
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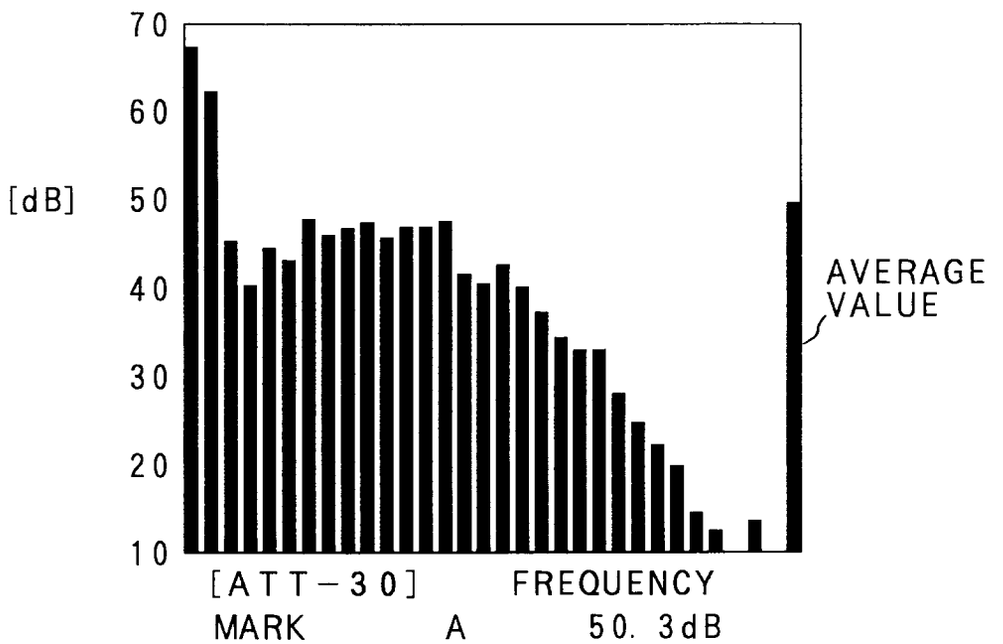
FREQUENCY
MARK A 48.3dB

FIG. 6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