(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 791 788 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
27.08.1997 Bulletin 1997/35

(51) Int. Cl.[6]: **F24F 1/02**, F24F 1/00

(21) Application number: **97102807.1**

(22) Date of filing: **20.02.1997**

(84) Designated Contracting States:
DE ES FR GB GR IT PT

(30) Priority: **22.02.1996 JP 60100/96**

(71) Applicant: **SANYO ELECTRIC Co., Ltd.**
Moriguchi-shi, Osaka (JP)

(72) Inventors:
- **Sakaino, Kazuaki**
  Ora-gun, Gunma (JP)
- **Okawa, Kazunobu**
  Ashikaga-shi, Tochigi (JP)
- **Nawata, Yukito**
  Ota-shi, Gunma (JP)
- **Suda, Syouichi**
  Nitta-gun, Gunma (JP)
- **Abe, Kazuo**
  Nitta-gun, Gunma (JP)
- **Hiugano, Kazuhiro**
  Ashikaga-shi, Tochigi (JP)
- **Makino, Masazumi**
  Ora-gun, Gunma (JP)
- **Kogure, Hisashi**
  Ora-gun, Gunma (JP)

(74) Representative: **Glawe, Delfs, Moll & Partner**
Patentanwälte
Postfach 26 01 62
80058 München (DE)

(54) In-ceiling mount type air conditioner using the same

(57) In an air conditioner having an air blow fan 7 fixed on the top face 4a of a housing 4, and a heat exchanger 10 disposed around the air blow fan 7, air which is sucked in by the air blow fan 7 being blown out to the heat exchanger 10, a first intercepting plate 100 is interposed between the top face 4a of the housing 4 of the air conditioner and the air blow fan 7. Further, a fan nozzle 13a is disposed on the inner periphery of a shroud 7c of the air blow fan 7, and a second intercepting plate 13 is disposed on the outer periphery of the shroud 7c.

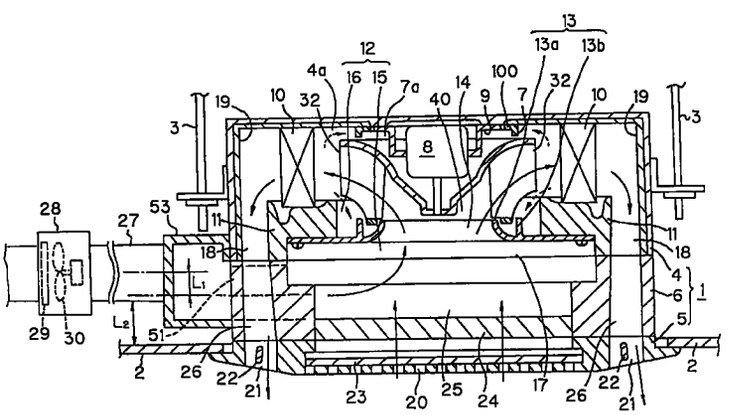


FIG. 1

EP 0 791 788 A2

Description

BACK GROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a technique for suppressing noises which occur in an in-ceiling mount type air conditioner.

2. Description of the Related Art

There has been known an in-ceiling mount type air conditioner in which an air blow fan such as a turbo fan is fixed on the top face of a hornsing of the air conditioner, a heat exchanger is disposed so as to surround the air blow fan, and air which is sucked by the turbo fan is blown toward the heat exchanger.

In this type air conditioner, a part of the air blown out from the air blow fan does no passes through the heat exchanger, but turns about and leaks into a gap between the top face of the housing and the air blow fan, that is, a so-called "air bypassing" phenomenon occurs. Further, in this type air conditioner, a part of the air blown out from the air blow fan is not blown to the heat exchanger, but leaks from the gap between the air blow fan and a fan nozzle for guiding suck-in air to the air suck-in port of the air blow fan, and a so-called "air rolling" phenomenon occurs at the air suck-in port of the air blow fan. It has been experimentally proved that these "air bypassing" and "air rolling" phenomena cause noises in the air conditioner. Various countermeasures to the noises have been conventionally taken, however, they merely reduce the noise level to about 50 dB at maximum. Therefore, from the view point of keeping the quality of the air conditioner, it has been very important to suppress the noises as much as possible.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an in-ceiling mount type air conditioner in which noises occurring when air is sucked can be suppressed as much as possible, and further noises occurring when air is blown from the air blow fan to a heat exchanger can be suppressed as much as possible.

In order to attain the above object, according to the present invention, an in-ceiling mount type air conditioner including an air blow fan which is adapted to suck in air and blow out the air and is fixed onto the top face of a housing of the air conditioner, and a heat exchanger disposed so as to surround the air blower, the air which is sucked by the air blow fan being blown to the heat exchanger, is characterized in that a first intercepting plate for intercepting flow of air is disposed at a position between the top face of the housing and the air blow fan.

In the air conditioner as described above, the first intercepting plate is designed in a ring shape.

In the air conditioner as described above, the first intercepting plate is disposed between the top face of the housing and a hub of the air blow fan so as to be located within the rotational locus of blades of the air blow fan.

According to a second aspect of the present invention, an air blowing apparatus is characterized by comprising a shroud and a second air intercepting plate which is adapted to intercept flow of air and disposed on the outer periphery of the shroud.

In the air blowing apparatus as described above, a fan nozzle for guiding suck-in air is disposed on the inner periphery of the shroud of the air blowing apparatus.

In the air blowing apparatus as described above, the second intercepting plate and the fan nozzle are formed integrally with each other.

According to the present invention, the first air intercepting plate is interposed between the top face of the housing of the air conditioner and the air blow fan. Therefore, the air which is about to flow into the gap between the top face of the housing and the air blow fan is intercepted by the first intercepting plate, so that the "air bypassing" can be prevented and the noises can be suppressed to a smaller level, as compared with the prior art.

According to the present invention, the second intercepting plate is provided on the outer periphery of the shroud of the air blow fan. Therefore, the air which is about to flow to this place can be intercepted by the second intercepting plate, so that the "air rolling" can be prevented and the noises can be suppressed to a smaller level, as compared with the prior art.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view showing the basic construction of an in-ceiling mount type air conditioner according to the present invention;

Fig. 2 is an exploded perspective view showing the surrounding of an air blow fan used in the in-ceiling mount type air conditioner shown in Fig. 1;

Fig. 3 is a graph showing noise measurement data when an intercepting plate 100 is provided;

Fig. 4 is a graph showing noise measurement data when the intercepting plate 100 is not provided;

Fig. 5 is a graph showing noise measurement data when an intercepting plate 13b is provided; and

Fig. 6 is a graph showing noise measurement data when the intercepting plate 13b is not provided.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments according to the present invention will be described hereunder with reference to the accompanying drawings.

In Fig. 1, reference numeral 1 represents an air conditioner which is mounted on the ceiling 2 of a

house, and it is generally called as "four-way cassette".

The air conditioner 1 includes a housing 4 which is suspended by suspending bolts in the ceiling 2, a decoration panel 5 which is exposed from the ceiling to the room, and a chamber (filter chamber) 6 disposed between the decoration panel 5 and the housing 4.

Reference numeral 7 represents an air blow fan (e.g., turbo fan) which is disposed substantially at the center of the housing, and reference numeral 8 represents a motor for driving the fan 7. The motor 8 is fixed to the top face 4a of the housing 4 by a fixture 9. Reference numeral 10 represents a heat exchanger which is disposed so as to surround the fan 7, and reference numeral 11 represents a drain pan which is disposed at the lower side of the heat exchanger 10. An air passage 12 is formed at the center of the drain pan. Reference numeral 13 represents an air suck-in plate which is fixed to the lower surface of the drain pan 11. An inner peripheral side tongue (hereinafter referred to as "fan nozzle") 13a and an outer peripheral side tongue 13b which corresponds to a second intercepting plate of the present invention are formed in the air suck-in plate 13, and an orifice 14 is formed in the inner peripheral portion of the fan nozzle 13a.

The orifice 14 is disposed so as to confront the air suck-in port 40 of the fan 7. The air passage 12 is sectioned into a primary space 15 and a secondary space 16 by the air suck-in plate 13, and the fan 7 is located in the air passage 12. The suck-in port 17 is located at the lower side of the primary space 15. Reference numeral 18 represents an air blow-out port, and reference numeral 19 represents an adiabatic member which is attached to the inner wall of the housing 4. An air suck-in grill 20 is provided at the center of the decoration panel 5, and an air blow-out port 21 is provided around the air suck-in grill 20.

Air blow-direction changing vanes are disposed at the air blow-out port 21, and reference numeral 23 represents a pre-filter which is disposed at the back side of the air suck-in grill 20.

The filter chamber 6 is disposed between the decoration panel 5 and the housing 4. In the chamber 6 are formed an air suck-in space (air passage) 25 where a high-performance filter 24 is provided, and four air discharge spaces 26 which are provided at the outside of the air suck-in space 25. The air suck-in port 17 of the housing 4 and the air suck-in grille 20 intercommunicate with each other through the air discharge space 26.

The filter chamber 6 is provided with an outside air supply portion (opening) 51, and the outside air portion 51 intercommunicates with a joint duct 53. The joint duct 53 intercommunicates with an outside air supply duct 27. The center axes of the outside supply duct 27 and the outside supply portion 51 are spaced from each other by a distance of L1. With this design, when the outside supply duct 27 is lined to the joint duct 53, the outside supply duct 27 is upwardly spaced from the ceiling plate 2 by a distance of L2, so that a working space is ensured to facilitate a joint work.

Reference numeral 28 represents a booster fan apparatus provided to the outside supply duct 27, and a filter 29 and a booster fan 30 are accommodated in the booster fan apparatus 28. The outside is supplied into the housing by driving the booster fan 30. The outside air supply portion 51 to which the outside air supply duct 27 is joined is disposed so as to penetrate through the side portion of the filter chamber 6 and confront the air suck-in space 25 of the filter chamber 6.

The outside air supply operation is performed by the booster fan apparatus 28. In this case, the outside air which is supplied through the outside air supply duct 27 is introduced through the air suck-in space 25 into the filter chamber 6. The outside air thus supplied joins with the indoor air which is passed through the high-performance filter 24 as described above, and sucked into the orifice 14 of the air suck-in plate 13.

According to this construction, the outside air supply duct 27 is joined to the filter chamber 6, and the outside air is supplied through the filter chamber 6. Therefore, the outside air which is supplied through the outside air supply duct 27 smoothly flows into the air suck-in port 17 of the housing 4, and thus reduction in the flow amount of the air flowing in the outside air supply duct 27 can be suppressed to a small level. Accordingly, the supply amount of the outside air can be increased. In such a case where it is unnecessary to dispose the high-performance filter 24 or supply the outside air, neither the filter chamber nor the joint duct 53 linked to the filter chamber are required. In this case, the air conditioner 1 is constructed by the housing 4 and the decoration panel.

According to the air conditioner thus constructed, the indoor air flows as indicated by a solid line of Fig. 1 to perform room cooling/heating operation. That is, the indoor air discharged from the turbo fan 7 is blown out from the outer peripheral portion of the fan 7 by centrifugal force of the fan 7, and then passed through the heat exchanger 10 to be heat-exchanged. Thereafter, the heat-exchanged air is passed through the air blow-out port 18 of the housing and the air blow-out port 21 of the decoration panel 5, and finally blown into the room.

In the air conditioner as described above, there may occur a case where a part of the indoor air discharged from the turbo fan 7 is not passed through the heat exchanger 10, but turns about and leaks into the gap between the top face 4a of the housing 4 of the air conditioner and a hub 7a of the turbo fan 7 as indicated by an arrow of dotted chain line (upwardly directed arrow of dotted chain line in Fig. 1), that is, so-called "air bypassing" occurs. This "air bypassing" phenomenon causes noises in the air conditioner.

However, according to this embodiment, a ring-shaped first intercepting plate 100 is interposed between the top face 4a of the housing 4 and the hub 7a of the turbo fan 7 as shown in Fig. 2 so that the air is prevented from leaking into the gap between the top face 4a of the housing 4 and the hub 7a of the turbo fan 7. The first intercepting plate 100 is formed by punching

an iron plate, and preferably an erecting portion 100a of the first intercepting plate 100 is disposed to be within the rotational locus of a blade 7b which is fixed to the hub 7a of the turbo fan 7. In Fig. 2, reference numeral 7c represents a shroud of the turbo fan 7.

Fig. 3 is a graph showing noise measurement data (ordinate: Magnitude of Noise, abscissa: Frequency, average value: 48.3 dB) when the first intercepting plate 100 is provided, and Fig. 4 is a graph showing noise measurement data (average value: 50.7dB) when the first intercepting plate 100 is not provided. As is apparent from Figs. 3 and 4, when the first intercepting plate 100 is provided, the "air bypassing" is prevented and thus the noise is reduced to a value which is less by about 2.4dB than when the first intercepting plate 100 is not provided. In this case, 2.4dB corresponds to the noise magnitude due to the "air bypassing".

In short, according to this embodiment, the ring-shaped first intercepting plate 100 is interposed in the gap between the top face 4a of the housing 4 and the hub 7a of the turbo fan 7 as shown in Fig. 2, whereby the "air bypassing" is prevented and thus the noise caused by the air discharge action of the turbo fan 7 can be suppressed.

The present invention is not limited to the above embodiment. For example, the shape of the first intercepting plate 100 is not limited to the ring shape, and any shape may be used insofar as it has an effect of preventing the "air bypassing".

In the air conditioner as described above, there may also occur a case where a part of the indoor air discharged from the turbo fan 7 is not passed through the heat exchanger, but turns about and leaks through the gap between the fan nozzle 13a and the hub 7a of the turbo fan 7 to the air suck-in port 40 of the fan 7 as indicated by a downwardly directing arrow of dotted line chain of Fig. 1 to thereby inducing the "air rolling" phenomenon. This air rolling phenomenon causes noises in the air conditioner.

According to a second embodiment of the present invention, in order to prevent the air from leaking to the air suck-in port 40 of the turbo fan 7 through the fan nozzle 13a of the air suck-in plate 13 and the hub 7a of the turbo fan 7, a ring-shaped outer peripheral side tongue (hereinafter referred to as "second intercepting plate") 13b extending in the direction of the shaft of the turbo fan 7 is provided on the outer periphery of the shroud 7c of the turbo fan 7 as shown in Fig. 1. The second intercepting plate 13b is formed integrally with the air suck-in plate 13 (resin molding), and preferably it has a height which is substantially equal to the height of the fan nozzle 13a.

Fig. 5 is a graph showing noise measurement data (average value: 48.4 dB) when the first intercepting plate 13b is provided, and Fig. 6 is a graph showing noise measurement data (average value: 49.6 dB) when the second intercepting plate 13b is not provided. As is apparent from Figs. 5 and 6, when the second intercepting plate 13b is provided, the noise can be reduced to a value which is less by 1.2 dB than when the second intercepting plate 13b is not provided. In this case, 1.2dB corresponds to the noise magnitude due to the "air rolling".

In short, according to the present invention, the second intercepting plate 13b which extends in the direction of the shaft of the fan is provided on the outer periphery of the shroud 7c, so that the "air rolling" can be prevented and the noise due to the air suck-in operation of the turbo fan 7 can be reduced.

The present invention is not limited to the above embodiment. For example, in the above embodiment, the second intercepting plate 13b is formed integrally with the air suck-in plate 13. However, the present invention is not limited to this mode, and the second intercepting plate 13b may be designed in any manner insofar as it prevents the "air rolling".

In the above embodiments, the present invention is applied to an in-ceiling mount type air conditioner. However, the present invention is not limited to the in-ceiling mount type air conditioner, and it may be applied to a general air blowing apparatus having a shroud.

Furthermore, if both the first and second intercepting plates 13b and 100 are provided over the upper and lower sides of the turbo fan 7, the effect of the present invention can be more enhanced.

As is apparent from the foregoing description, the first intercepting plate is interposed between the top face of the housing and the hub of the turbo fan, so that the "air bypassing" can be prevented, and the noise due to the air discharging operation of the air blow fan (turbo fan) can be reduced by the amount corresponding to the "air bypassing". In addition, the second intercepting plate is provided on the outer periphery of the shroud of the air blow fan, so that the "air rolling" can be prevented, and the noise due to the air suck-in operation of the air blow fan can be reduced by the amount corresponding to the "air rolling".

Claims

1. An in-ceiling mount type air conditioner in which a heat exchanger is disposed around an air blow fan which is adapted to suck in air and blow out the air, and fixed on the top face of a housing of the air conditioner, air which is sucked by the air blow fan being blown to the heat exchanger, characterized in that an intercepting plate for intercepting flow of air is provided at a position between the top face of the housing and said air blow fan.

2. The air conditioner as claimed in claim 1, wherein said intercepting plate is designed in a ring shape.

3. The air conditioner as claimed in claim 1,wherein said intercepting plate is disposed to be within the rotational locus of blades of said air blow fan.

4. An in-ceiling mount type air conditioner in which a

heat exchanger is disposed around an air blow fan which is adapted to suck in air and blow out the air, and fixed on the top face of a housing of the air conditioner, air which is sucked by the air blow fan being blown to the heat exchanger, characterized in that an intercepting plate is provided on the outer periphery of a shroud of said air blow fan.

5. The air conditioner as claimed in claim 4, wherein said air blow fan is provided with a fan nozzle which is disposed on the inner periphery of said shroud of said air blow fan and adapted to guide suck-in air.

6. The air conditioner as claimed in claim 5, wherein said intercepting plate and said fan nozzle are formed integrally with each other.

7. An in-ceiling mount type air conditioner in which a heat exchanger is disposed around an air blow fan which is adapted to suck in air and blow out the air, and fixed on the top face of a housing of the air conditioner, air which is sucked by the air blow fan being blown to the heat exchanger, characterized by including a first intercepting plate which is adapted to intercept flow of air and provided at a position between the top face of the housing and said air blow fan, and a second intercepting plate which is adapted to intercept flow of air and provided on the outer periphery of a shroud of said air blow fan.

8. The in-ceiling mount type air conditioner as claimed in claim 7, wherein a fan nozzle for guiding suck-in air is provided on the inner periphery of said shroud of said air blow fan.

9. The in-ceiling type air conditioner as claimed in claim 8, wherein said second intercepting plate and said fan nozzle are formed integrally with each other.

FIG. 1

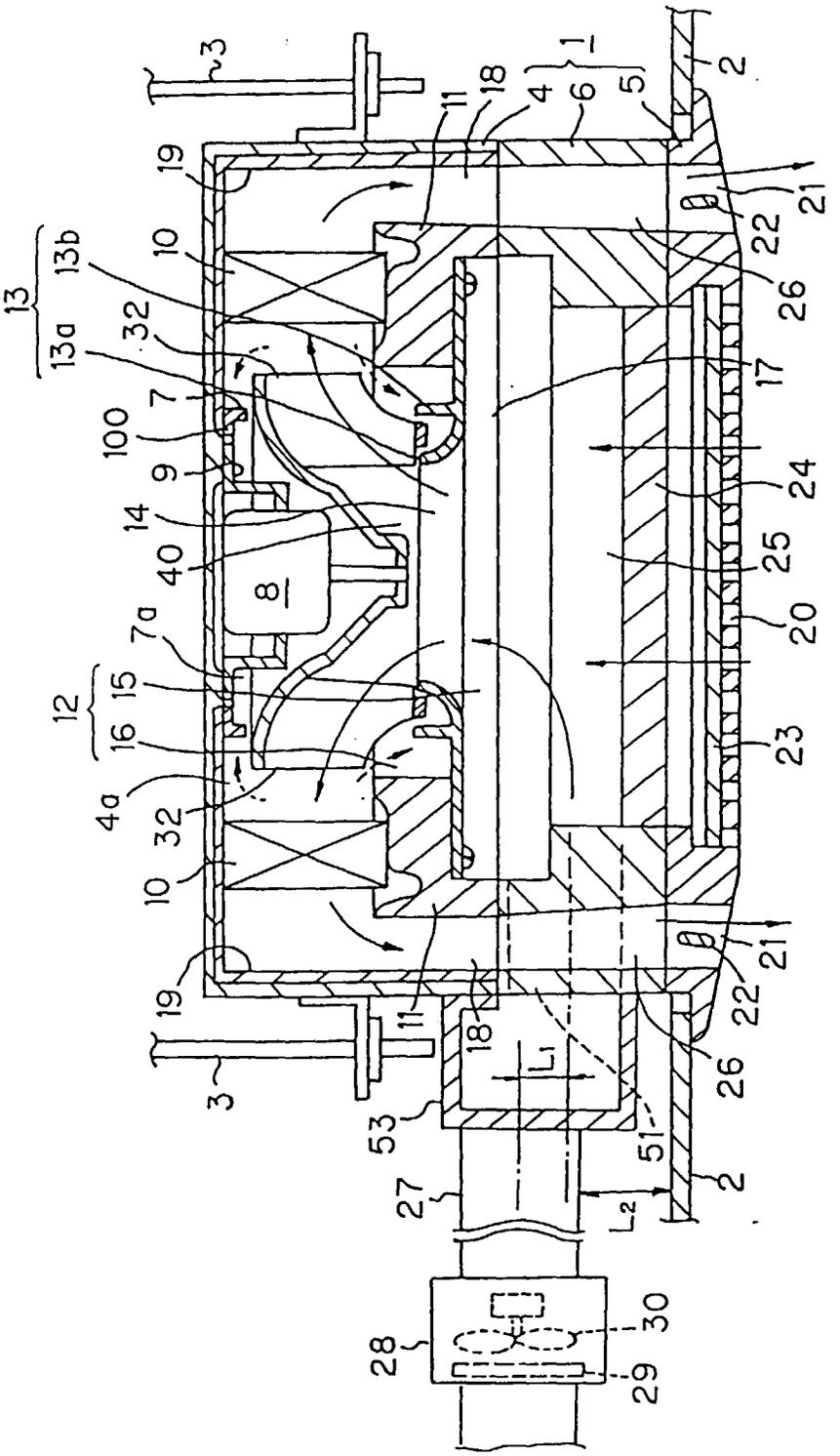

3
11
18
4
6
5
1
2
19
21
22
26
13
13b
13a
32
10
7
100
9
14
40
8
7a
12
15
16
4a
17
24
25
20
23
L1
L2
53
51
27
28
30
29

FIG. 2

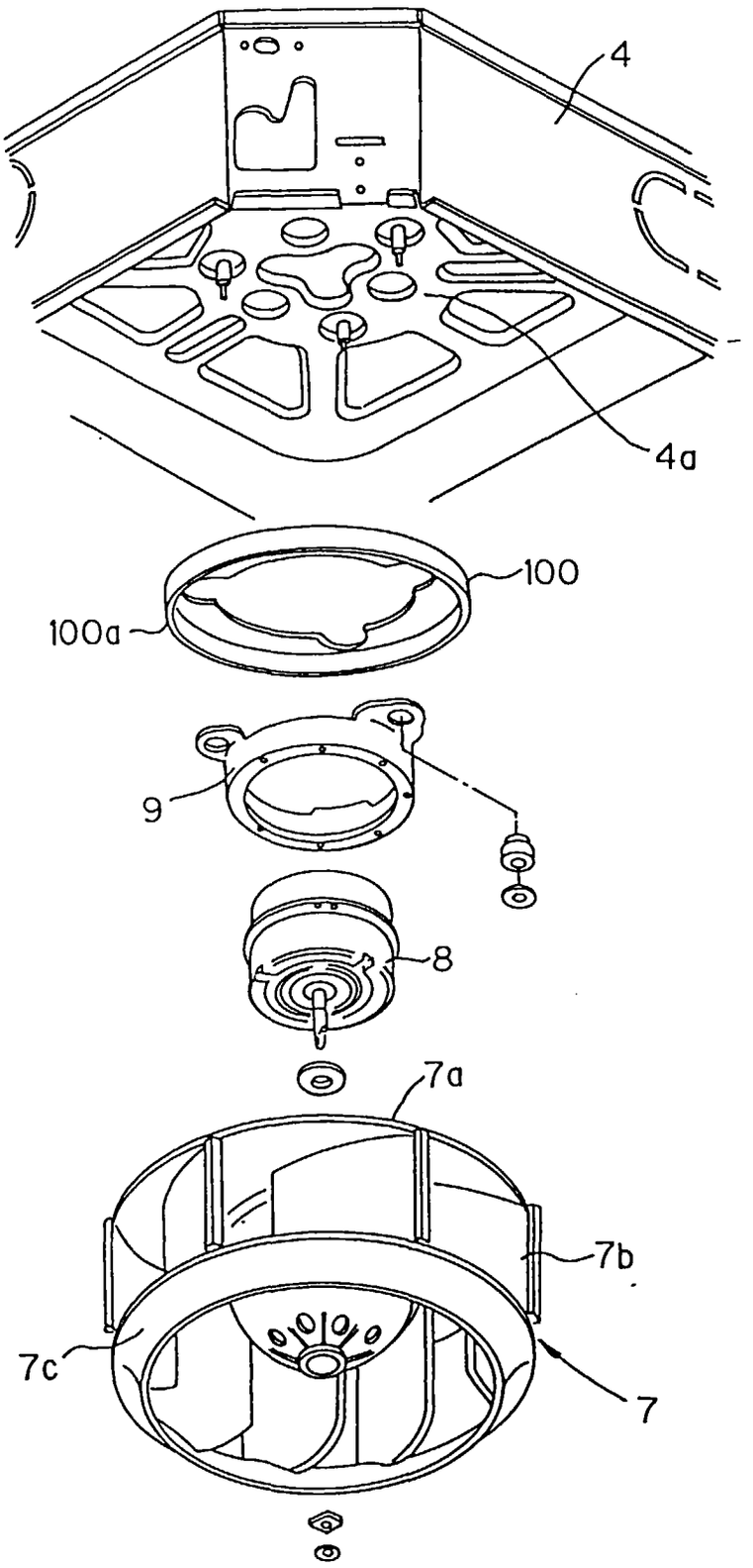


FIG. 3

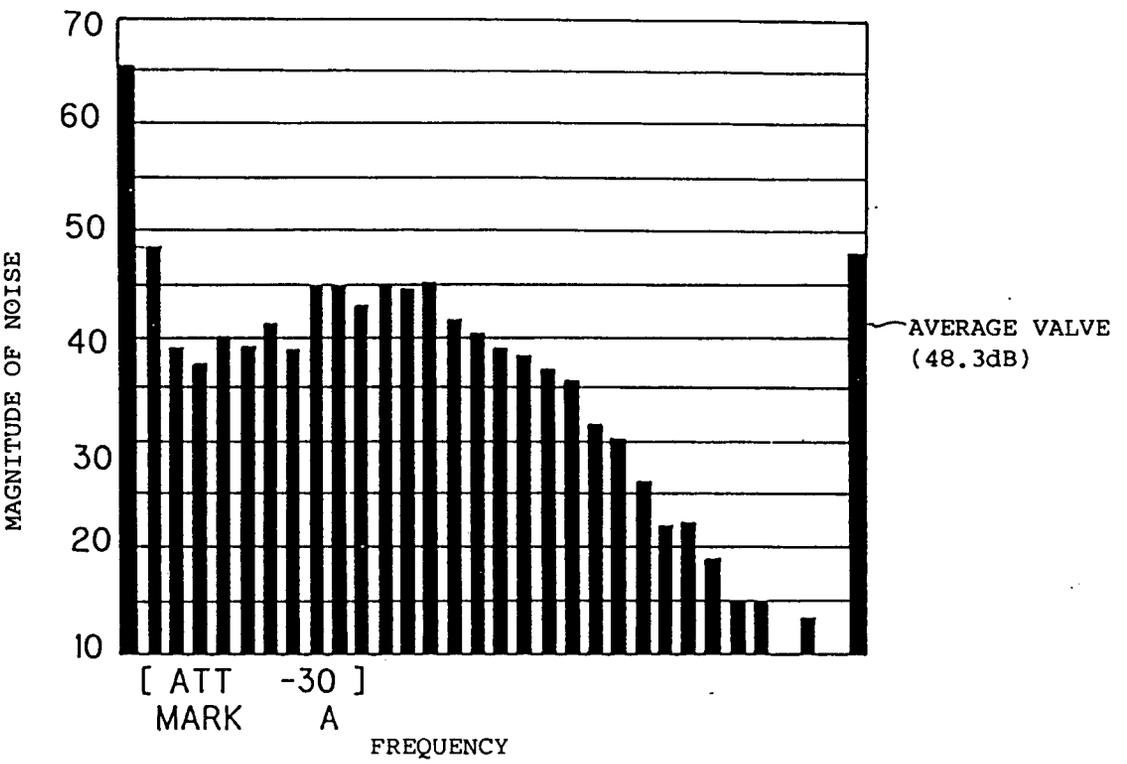

70
60
50
40
30
20
10
MAGNITUDE OF NOISE
AVERAGE VALVE
(48.3dB)
[ATT -30]
MARK A
FREQUENCY

FIG. 4

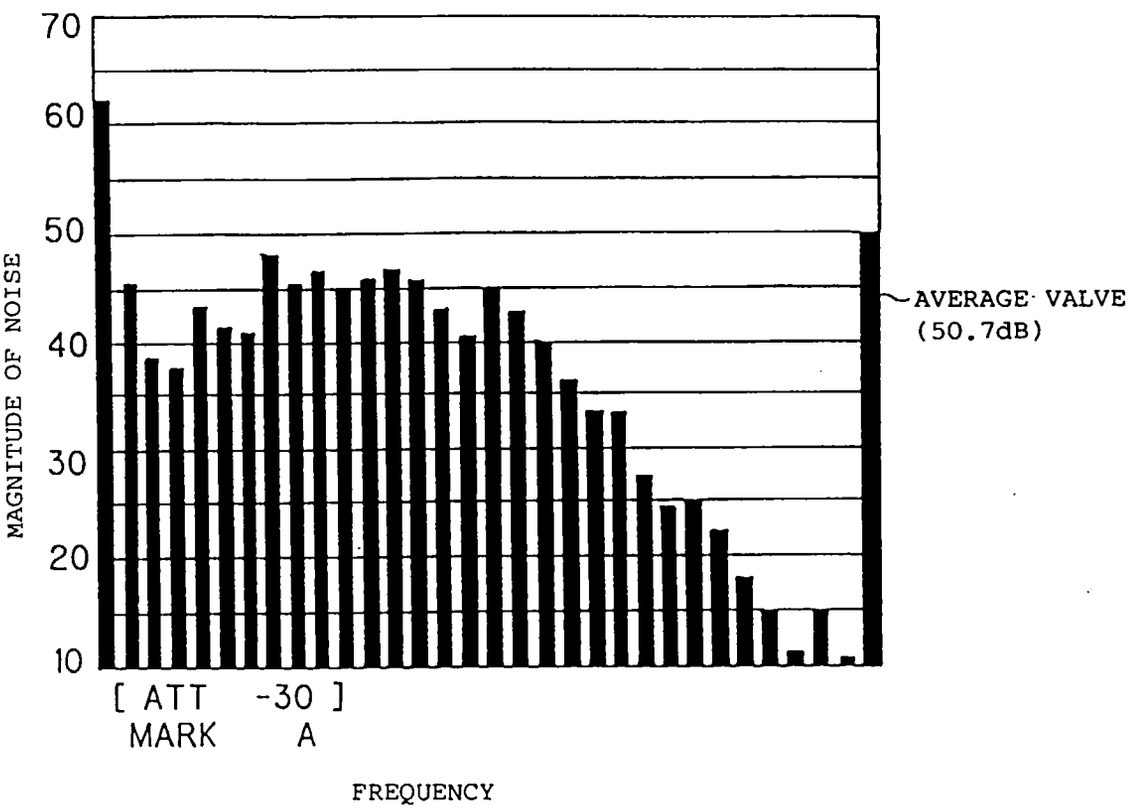

70
60
50
40
30
20
10
MAGNITUDE OF NOISE
AVERAGE VALVE
(50.7dB)
[ATT -30]
MARK A
FREQUENCY

FIG. 5

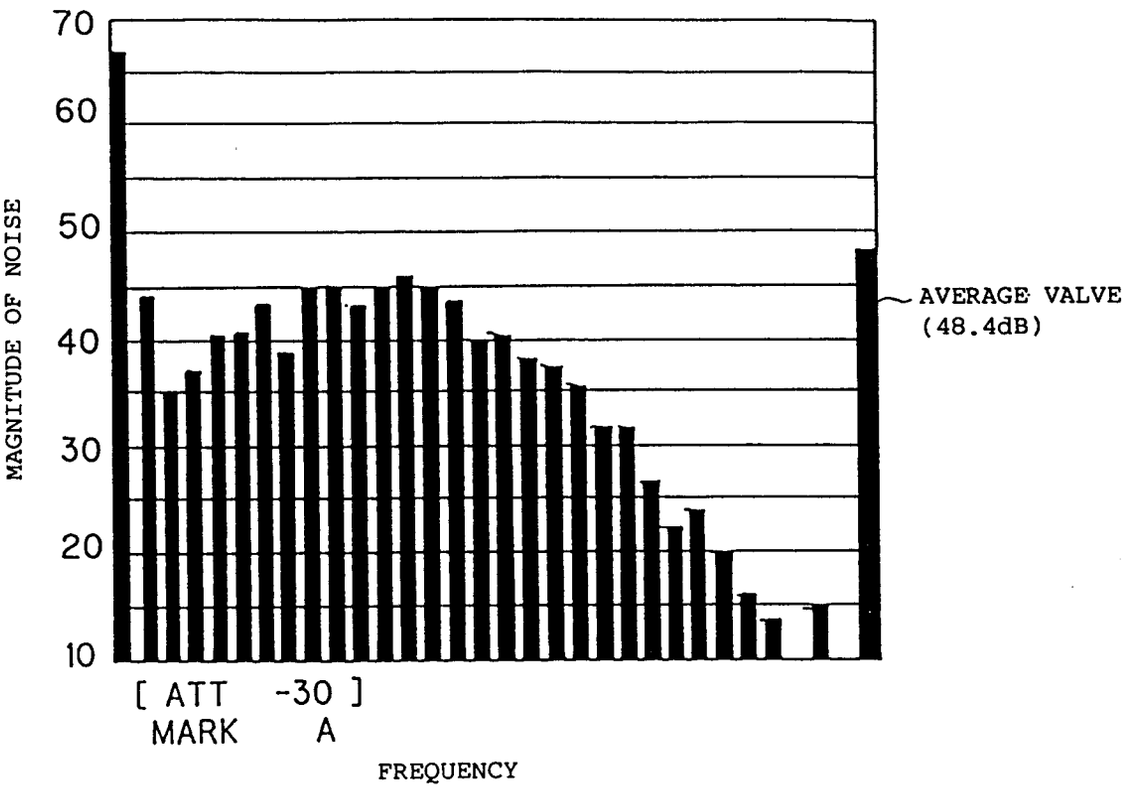
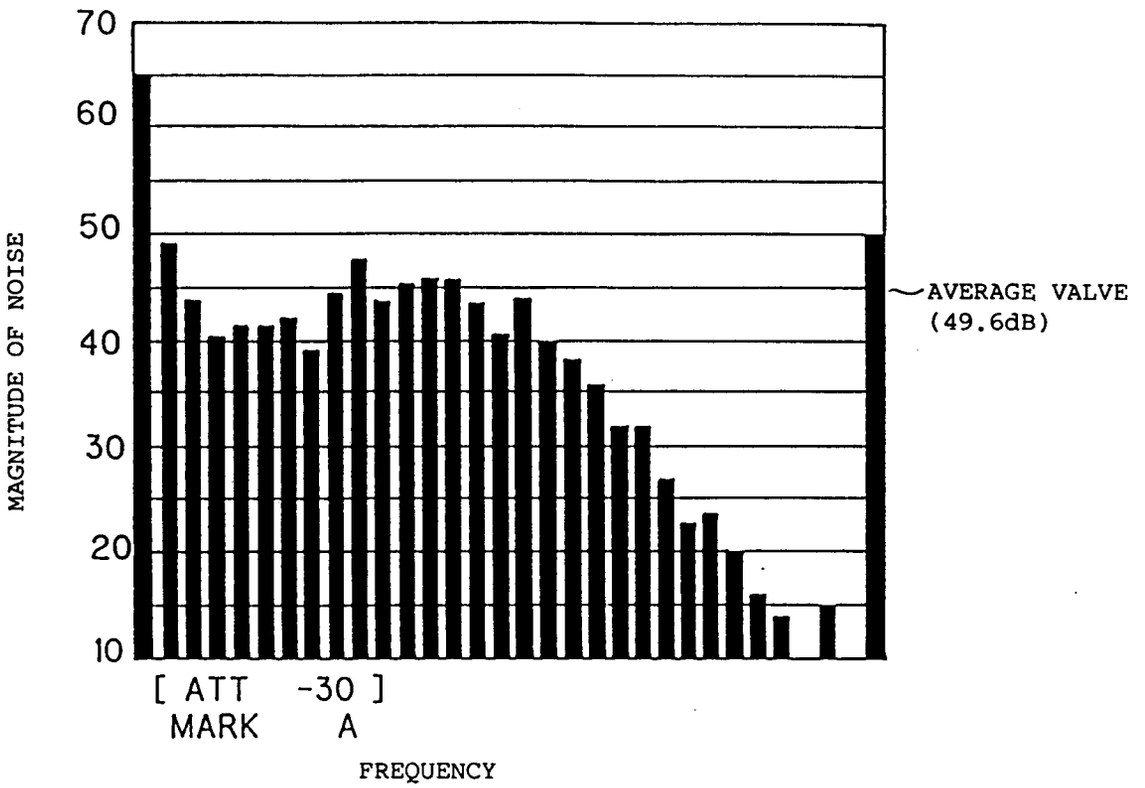

70
60
50
40
30
20
10
MAGNITUDE OF NOISE
AVERAGE VALVE
(48.4dB)
[ATT -30]
MARK A
FREQUENCY

FIG. 6


70
60
50
40
30
20
10
MAGNITUDE OF NOISE
AVERAGE VALVE
(49.6dB)
[ATT -30]
MARK A
FREQUENCY