



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
02.06.2010 Bulletin 2010/22

(51) Int Cl.:
F23L 5/02 (2006.01)

(21) Application number: **09177314.3**

(22) Date of filing: **27.11.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(72) Inventor: **Takayama, Masayoshi**
Nagoya-shi Aichi 454-0802 (JP)

(30) Priority: **28.11.2008 JP 2008304785**

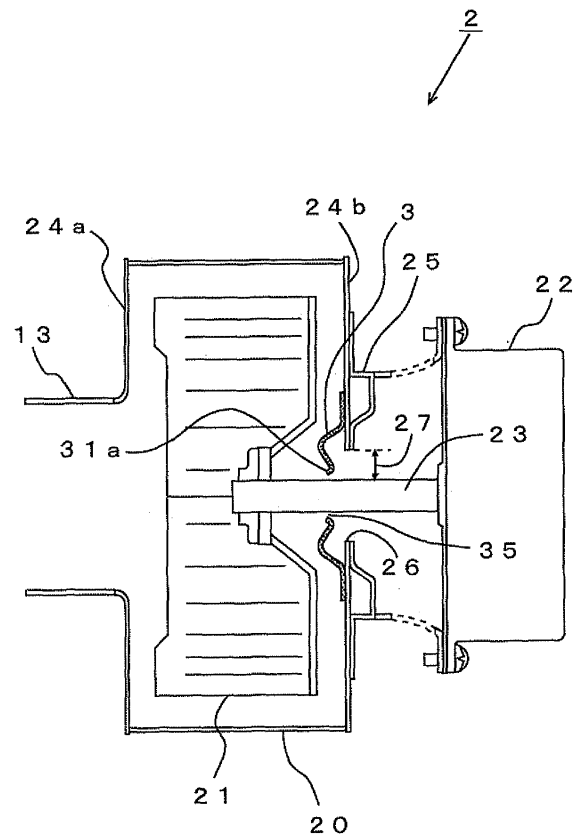
(74) Representative: **Charlton, Peter John**
Elkington and Fife LLP,
Prospect House
8 Pembroke Road
Sevenoaks,
Kent TN13 1XR (GB)

(71) Applicant: **Rinnai Corporation**
Nagoya-shi,
Aichi 454-0802 (JP)

(54) **Air supply fan device**

(57) An air supply fan device (2) including: a fan casing (20) disposed continuously to a combustion chamber containing a gas burner therein; an air supply fan (21) contained inside of the fan casing, for supplying burning air to the gas burner; and a motor (22) disposed outside of the fan casing, for rotating the air supply fan. The air supply fan device comprising: a ventilation hole (26) formed by opening a fan casing constituting wall around a motor rotary shaft (23) of the motor connected to the air supply fan; and a diaphragm valve body (3) which is fixed to the ventilation hole and has a through hole, through which the motor rotary shaft is inserted, opened at the center thereof. The valve body being formed into a shape such that a gap (35) is defined between the through hole and the motor rotary shaft when the inner pressure inside of the fan casing is negative during the rotation of the air supply fan while the gap is closed in tight contact of the peripheral edge of the through hole with the motor rotary shaft when the inner pressure inside of the combustion chamber or the fan casing is positive.

FIG. 2



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air supply fan device in a combustion apparatus and, more particularly, to an air supply fan device in which air-tightness is enhanced such that combustion exhaust gas staying inside of a combustion chamber cannot leak from the air supply fan device.

Description of the Related Art

[0002] A combustion apparatus for a water heater may be provided with an air supply fan device including an air supply fan in a combustion chamber containing a gas burner therein. In such an air supply fan device, when the temperature of air to be supplied into the combustion chamber is increased, the temperature of a motor for rotating the air supply fan device or a motor rotary shaft also is increased, thereby often raising a fear of a trouble with the rotation of the motor. In, for example, a combustion apparatus of an FF type (forced draft balanced flue type) duplex supply/exhaust system in which a supply channel, through which outside air is supplied into a combustion chamber, and an exhaust channel, through which combustion exhaust gas staying in the combustion chamber is exhausted to the outside, are constituted of a single supply/exhaust cylinder, the outside air to be supplied is heated by the combustion exhaust gas, and therefore, the temperature of the motor rotary shaft is liable to be increased.

[0003] In view of the above, there has been conventionally proposed an air supply fan device which takes measures against such an increase in temperature of a motor rotary shaft. Referring to FIGS. 6 and 7, a motor cooling ventilation hole 49 is formed in a fan casing constituting wall 411 around a motor rotary shaft 43 connected to an air supply fan device 41 inside of a fan casing 410, and further, a self-cooled fan 44, which projects by resiliency of a spring 47 during stoppage of rotation of a motor 42 so as to close the ventilation hole 49 (FIG. 6) whereas retreats against the resiliency of the spring 47 during the rotation of the motor 42 so as to open the ventilation hole 49 (FIG. 7), is disposed in the motor rotary shaft 43 outside of the fan casing 410 in an air supply fan device (the related art) disclosed in Japanese Patent Laid-open No. H05-52321. In FIGS. 6 and 7, reference numeral 45 designates a stopper, and further, 44b denotes a base for the self-cooled fan 44.

[0004] With this configuration, when the self-cooled fan 44 is rotated according to the rotation of the motor 42, an air passage is defined from the ventilation hole 49 to the fan casing 410 (FIG. 7), so that the motor rotary shaft 43 or the motor 42 is cooled. In contrast, when the rotation of the motor 42 is stopped, the ventilation hole

49 is closed with the base 44b of the self-cooled fan 44 (FIG. 6), so that combustion exhaust gas staying inside of a combustion chamber can be prevented from flowing out (back) through the ventilation hole 49, thus suppressing a leakage quantity of the combustion exhaust gas from the combustion chamber.

[0005] However, in the related art, the outer peripheral surface of the motor rotary shaft 43 and the inner circumferential edge of the ventilation hole 49 are not fully closed since there is a clearance k therebetween when the motor 42 is stopped from being rotated (see FIG. 6). In addition, although the self-cooled fan 44 is urged by the spring 47, if an inner pressure inside of the combustion chamber is increased, the self-cooled fan 44 may retreat outward of the fan casing 410 (i.e., toward the motor 42) against the resiliency of the spring 47. As a consequence, when the inner pressure inside of the combustion chamber or the fan casing 410 becomes positive by, for example, outside air blown into a supply/exhaust cylinder due to a blast, the clearance at the ventilation hole 49 is enlarged, so that the combustion exhaust gas remaining inside of the combustion chamber flows back, to flow out through the ventilation hole 49. In this manner, with the conventional structure, it is difficult to suppress the leakage of the combustion exhaust gas from the combustion chamber against the positive pressure applied to the combustion chamber and the fan casing.

SUMMARY OF THE INVENTION

[0006] The present invention has been accomplished to solve the above-described problems experienced in the related art. Therefore, an object of the present invention is to provide an air supply fan device, in which a motor rotary shaft or a motor can be securely cooled, and further, combustion exhaust gas can be prevented from leaking through a ventilation hole at the time of application of a positive pressure to a combustion chamber or a fan casing.

[0007] According to the present invention, there is provided An air supply fan device including: a fan casing disposed continuously to a combustion chamber containing a gas burner therein; an air supply fan contained inside of the fan casing, for supplying burning air to the gas burner; and a motor disposed outside of the fan casing, for rotating the air supply fan, the air supply fan device comprising:

a ventilation hole formed by opening a fan casing constituting wall around a motor rotary shaft of the motor connected to the air supply fan; and a diaphragm valve body which is fixed to the ventilation hole and has a through hole, through which the motor rotary shaft is inserted, opened at the center thereof; the valve body being formed into a shape such that a gap is defined between the through hole and the motor rotary shaft when the inner pressure inside of

the fan casing is negative during the rotation of the air supply fan while the gap is closed in tight contact of the peripheral edge of the through hole with the motor rotary shaft when the inner pressure inside of the combustion chamber or the fan casing is positive.

[0008] With the above-described configuration, when the air supply fan is rotated and the pressure inside of the fan casing becomes negative, the valve body is deformed in such a manner as to be sucked inside of the fan casing, thereby defining the clearance between the through hole and the motor rotary shaft. And then, air flow is formed to flow into the fan casing through the through hole, thus cooling the motor rotary shaft or the motor.

[0009] In contrast, when the pressure inside of the combustion chamber or the fan casing becomes positive during the stoppage of the rotation of the air supply fan, the valve body is deformed in such a manner as to be pushed outward of the fan casing, so that the peripheral edge of the through hole is brought into tight contact with the motor rotary shaft, thus closing the clearance defined between the through hole and the motor rotary shaft. Thus, it is possible to prevent combustion exhaust gas staying inside of the combustion chamber from flowing back outward through the ventilation hole, and further, to prevent the combustion exhaust gas staying inside of the combustion chamber from leaking.

[0010] Preferably, the valve body is made of a rubber sheet, and further, is formed into a projecting or recessed shape in such a manner as to enlarge a pressure receiving area of a pressure receiving portion which receives an air pressure inside of the fan casing.

[0011] In this way, a pressure receiving portion is sensitive to a change in air pressure inside of the fan casing, so that the valve body is quickly deformed. As a consequence, when the pressure inside of the fan casing becomes negative, the clearance is quickly defined, and therefore, the motor rotary shaft can be quickly cooled. In contrast, when the pressure inside of the fan casing becomes positive, the clearance is quickly closed, and therefore, the combustion exhaust gas hardly leaks.

[0012] Additionally, the valve body is excellent in tightness of the peripheral edge of the through hole with respect to the motor rotary shaft owing to the property of a rubber sheet, thereby exhibiting high sealability, so as to more securely prevent the combustion exhaust gas from leaking through the ventilation hole.

[0013] Preferably, the inner diameter of the through hole is greater than the outer diameter of the motor rotary shaft, so as to define a clearance therebetween in the valve body when the inside and outside pressures of the fan casing are equal to each other.

[0014] Therefore, the motor rotary shaft cannot be brought into contact with the through hole of the valve body when the motor is started to be rotated. As a consequence, the valve body cannot be broken due to the rotation of the motor, or an extra load cannot be exerted

on the rotation of the motor. Furthermore, the sealability of the valve body can be held for a long period of time when the pressure of the combustion chamber is positive.

[0015] As described above, in the air supply fan device according to the present invention, the motor rotary shaft or the motor can be securely cooled, and further, the combustion exhaust gas can be securely prevented from leaking through the ventilation hole when the positive pressure is applied to the combustion chamber or the fan casing.

[0016] Other objects, features and advantages of the present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not to be considered as limiting the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIG. 1 is a view schematically showing the configuration of a water heater, to which an air supply fan device in a preferred embodiment is applied;

FIG. 2 is a cross-sectional view showing the entire configuration of the air supply fan device in the preferred embodiment;

FIG. 3 is a perspective view showing a valve body to be fixed to the air supply fan device;

FIG. 4 is a cross-sectional view showing the valve body when a pressure inside of a fan casing becomes negative when an air supply fan is rotated in the air supply fan device;

FIG. 5 is a cross-sectional view showing the valve body when the pressure inside of the fan casing becomes positive when the rotation of the air supply fan is stopped in the air supply fan device;

FIG. 6 is a cross-sectional view showing a conventional air supply fan device when rotation of a motor is stopped; and

FIG. 7 is a cross-sectional view showing the conventional air supply fan device when the motor is rotated.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] A detailed description will be given below of a preferred embodiment according to the present invention with reference to the attached drawings.

[0019] FIG. 1 is a view showing the entire configuration of a combustion apparatus (i.e., a water heater), to which an air supply fan device in a preferred embodiment according to the present invention is applied; FIG. 2 is a cross-sectional view showing the entire configuration of the air supply fan device; and FIG. 3 is a perspective view showing a valve body to be fixed to the air supply fan device.

[0020] A water heater 1 serving as a combustion ap-

paratus illustrated in FIG. 1 is designed for an FF type (forced draft balanced flue type) duplex supply/exhaust system including a supply/exhaust manifold 11 provided with a duplex pipe. Inside of an apparatus body 10 of the water heater 1, there is provided a combustion chamber 14 containing a gas burner 15 and a heat exchanger 16 therein. An air supply fan device 2 is continuously disposed under the combustion chamber 14. The supply/exhaust manifold 11 is constituted of an inner pipe in a duplex pipe, that is, an exhaust cylinder 12 for allowing combustion exhaust gas to be exhausted from the combustion chamber 14 and an outer pipe, that is, a supply pipe 13 for taking air from the outside. The open end of the supply/exhaust manifold 11 is opened to the outside through a wall of a room, at which the water heater 1 is installed. The exhaust pipe 12 is connected to the upper portion of the combustion chamber 14, and constitutes an exhaust channel for exhausting the combustion exhaust gas from the combustion chamber 14 to the outside. The supply pipe 13 extends downward inside of the apparatus body 10, and the distal end thereof is continuously disposed in the air supply fan device 2 in an air-tight manner, thus constituting a supply channel for supplying outside air into the combustion chamber 14. Here, the combustion chamber 14 and the supply/exhaust manifold 11 are connected to each other in an air-tight manner.

[0021] As shown in FIG. 2, the air supply fan device 2 includes: a fan casing 20 continuously disposed in the combustion chamber 14 in an air-tight manner; an air supply fan 21, or a sirocco fan housed inside of the fan casing 20, for supplying burning air to the gas burner 15; and a motor 22 disposed outside of the fan casing 20, for rotating the air supply fan 21. Onto one constituting wall 24a sideways of the fan casing 20 is disposed the air supply cylinder 13 in an air-tight manner, and further, a fixing plate 25 for the motor 22 is securely attached to the outer surface of a constituting wall 24b opposite to the constituting wall 24a. The motor 22 is fixed to the fixing plate 25. A circular ventilation hole 26 is formed on the constituting wall 24b of the fan casing 20, onto which the motor 22 is fixed. A motor rotary shaft 23 for the motor 22 penetrates through the ventilation hole 26, and is connected to the air supply fan 21 housed inside of the fan casing 20. The inner diameter of the ventilation hole 26 is greater than the outer diameter of the motor rotary shaft 23. Therefore, an annular opening 27 is defined around the motor rotary shaft 23. A circular diaphragm valve body 3 is disposed around and in the ventilation hole 26.

[0022] As shown in FIG. 3, the valve body 3 is made of a circular rubber sheet having an outer diameter greater than that of the ventilation hole 26, and includes a through hole 31 opened at the center in such a manner as to allow the motor rotary shaft 23 to be inserted there-through and a flange 32 extending outwards in such a manner as to be fixed onto the constituting wall 24b of the fan casing 20. Incidentally, although the flange 32 is

air-tightly attached to the inner surface of the constituting wall 24b of the fan casing 20 in the valve body 3 shown in FIG. 2, it may be air-tightly attached to the outer surface of the constituting wall 24b.

[0023] Referring to FIG. 2, a peripheral edge 31a of the through hole 31 of the valve body 3 is formed in such a manner as to protrude toward the air supply fan 21 in a cylindrical shape. The inner diameter of the through hole 31 is slightly greater than the outer diameter of the motor rotary shaft 23, and therefore, a clearance 35 is defined therebetween. Therefore, the motor rotary shaft 23 cannot be brought into contact with the through hole 31 at the time of start of rotation of the motor 22 (pressure is equal inside and outside of the fan casing 20, see FIG. 2). Thus, it is possible to prevent the motor rotary shaft 23 from sliding in contact with the through hole 31 of the valve body 3 at the time of the start of the rotation of the motor 22.

[0024] A region from the through hole 31 to the flange 32 in the valve body 3 serves as a pressure receiving portion 33 for receiving an air pressure inside of the fan casing 20. The pressure receiving portion 33 is expanded (projects) inward of the fan casing 20. In this manner, a greater pressure receiving area receiving the air pressure inside of the fan casing 20 can be provided, so that the valve body 3 can be quickly moved according to a change in air pressure inside of the fan casing 20. Here, the pressure receiving portion 33 may be expanded (recessed) outward of the fan casing 20.

[0025] With the air supply fan device 2 having the above-described configuration, the gas burner 15 in the combustion chamber 14 burns the air, and then, the air supply fan 21 is rotated, so that the outside air is supplied as the burning air from the air supply cylinder 13 into the combustion chamber 14 through the fan casing 20, thereby making the inner pressure of the fan casing 20 negative. Thereafter, as shown in FIG. 4, the valve body 3 disposed in the ventilation hole 26 is deformed in such a manner as to be sucked inward of the fan casing 20, so that the diameter of the through hole 31 of the valve body 3 is increased. Thus, a gap 34 is defined between the through hole 31 of the valve body 3 and the motor rotary shaft 23. And then, the air around the motor rotary shaft 23 is sucked into the fan casing 20 through the ventilation hole 26 and the through hole 31 of the valve body 3. In this manner, the air around the motor 22 outside of the fan casing 20 flows between the motor 22 and the fan casing 20, as indicated by an arrow A in FIG. 4. That is to say, air flow A is formed to be sucked into the fan casing 20 through the ventilation hole 26 and the through hole 31 of the valve body 3. Thus, the air flow A can effectively cool the motor rotary shaft 23 and the motor 22.

[0026] In contrast, if the inner pressure inside of the combustion chamber 14 or fan casing 20 becomes positive by, for example, the outside air such as a blast blowing into the supply/exhaust manifold 11 during the stoppage of the rotation of the air supply fan 21, the valve

body 3 is deformed in such a manner as to be pushed outside of the fan casing 20 by air flow B from the inside of the fan casing 20 toward the ventilation hole 26, as shown in FIG. 5. And then, the diameter of the peripheral edge 31a of the through hole 31 projecting toward the air supply fan 21 in a cylindrical shape in the valve body 3 is reduced, the gap 34 between the through hole 31 and the motor rotary shaft 23 is closed in tight contact with the motor rotary shaft 23. As a consequence, even if the combustion exhaust gas staying inside of the combustion chamber 14 reversely flows into the fan casing 20, the combustion exhaust gas can be prevented from flowing outward through the ventilation hole 26, thus securely preventing the combustion exhaust gas staying inside of the combustion chamber 14 from leaking from the air supply fan device 2. In addition, the valve body 3 can exhibit a high sealability owing to excellent air-tightness of the peripheral edge 31a of the through hole 31 with respect to the motor rotary shaft 23 due to the properties of the rubber sheet, thus further securely preventing the combustion exhaust gas from leaking through the ventilation hole 26. The outside pressure of the air supply fan device 2 becomes negative by ventilating the room, at which the water heater 1 is installed, so that even if the air pressure inside of the combustion chamber 14 or the fan casing 20 becomes high (substantially, the pressure inside of the combustion chamber 14 or the fan casing 20 is positive), the valve body 3 is deformed to close the gap 34 defined between the through hole 31 and the motor rotary shaft 23, as shown in FIG. 5.

[0027] As described above, with the air supply fan device 2 in the present embodiment, the motor rotary shaft 23 or the motor 22 can be effectively cooled when the air supply fan 21 is rotated. During the stoppage of the rotation of the air supply fan 21, the combustion exhaust gas remaining inside of the combustion chamber 14 can be securely prevented from leaking through the ventilation hole 26 of the fan casing 20 even if the positive pressure is applied inside of the combustion chamber 14 or the fan casing 20.

[0028] When the inside and outside pressures of the fan casing 20 are equal to each other, the inner diameter of the through hole 31 of the valve body 3 is greater than the outer diameter of the motor rotary shaft 23, thus defining the clearance 35. As a consequence, when the motor 22 is started to be rotated, the motor rotary shaft 23 cannot be brought into contact with the through hole 31 of the valve body 3. Thus, it is possible to prevent the valve body 3 from being damaged by the rotation of the motor 22 or an extra load from being exerted on the rotation of the motor 22, and further, to maintain the sealability of the valve body 3 for a long period of time when the inside pressure of the combustion chamber 14 is positive.

[0029] The valve body 3 is made of the rubber sheet, and further, the pressure receiving portion 33 is formed into a projecting or recessed shape so as to enlarge the pressure receiving area, at which the air pressure inside

of the fan casing 20 is received. Consequently, the valve body 3 sensitively reacts against the change in air pressure inside of the fan casing 20, to be deformed quickly. Therefore, when the inner pressure inside of the fan casing 20 becomes negative, the gap 34 is quickly defined, thereby quickly cooling the motor rotary shaft 23 or the like. In contrast, when the inner pressure inside of the fan casing 20 becomes positive, the gap 34 is quickly closed, thereby virtually preventing any leakage of the combustion exhaust gas.

[0030] Additionally, unlike the related art shown in FIGS. 6 and 7 in which the self-cooled fan is provided in the motor rotary shaft 23, the air supply fan device 2 produces the following advantages. That is, the motor 22 can be fixed near the fan casing 20, thus configuring the compact air supply fan device 2; there is no problem of occurrence of noise in association with the rotation of the self-cooled fan; no extra load for rotating the self-cooled fan is exerted on the motor 22; and cost need not be increased since no self-cooled fan is provided.

[0031] The present invention is not limited to the above-described embodiment, but various modifications can be embodied within the scope of the present invention.

[0032] For example, the outline shape of the valve body 3 or the shape of the ventilation hole 26 is not limited to a circle, but may be a polygon such as a square.

[0033] In addition, the air supply fan device 2 according to the present invention is not limited to the water heater, but may be applied to a combustion apparatus for a heater or appliances other than the combustion apparatus of the FF type(forced draft balanced flue type) duplex supply/exhaust system.

[0034] The present application claims a priority based on a Japanese Patent Application No. 2008-304785 filed on Nov. 28, 2008, the content of which is hereby incorporated by reference in its entirety.

Claims

1. An air supply fan device including: a fan casing disposed to a combustion chamber containing a gas burner therein; an air supply fan contained inside of the fan casing, for supplying burning air to the gas burner; and a motor disposed outside of the fan casing, for rotating the air supply fan, the air supply fan device comprising:

a ventilation hole formed by opening a fan casing constituting wall around a motor rotary shaft of the motor connected to the air supply fan; and a diaphragm valve body which is fixed to the ventilation hole and has a through hole, through which the motor rotary shaft is inserted, opened at the center thereof;

the valve body being formed into a shape such that a gap is defined between the through hole

and the motor rotary shaft when the inner pressure inside of the fan casing is negative during the rotation of the air supply fan while the gap is closed in tight contact of the peripheral edge of the through hole with the motor rotary shaft when the inner pressure inside of the combustion chamber or the fan casing is positive. 5

2. The air supply fan device according to claim 1, wherein the valve body is made of a rubber sheet, and further, is formed into a projecting or recessed shape in such a manner as to enlarge a pressure receiving area of a pressure receiving portion which receives an air pressure inside of the fan casing. 10

3. The air supply fan device according to claim 1 or claim 2, wherein the inner diameter of the through hole is greater than the outer diameter of the motor rotary shaft, so as to define a clearance therebetween in the valve body when the inside and outside pressures of the fan casing are equal to each other. 15 20

25

30

35

40

45

50

55

FIG. 1

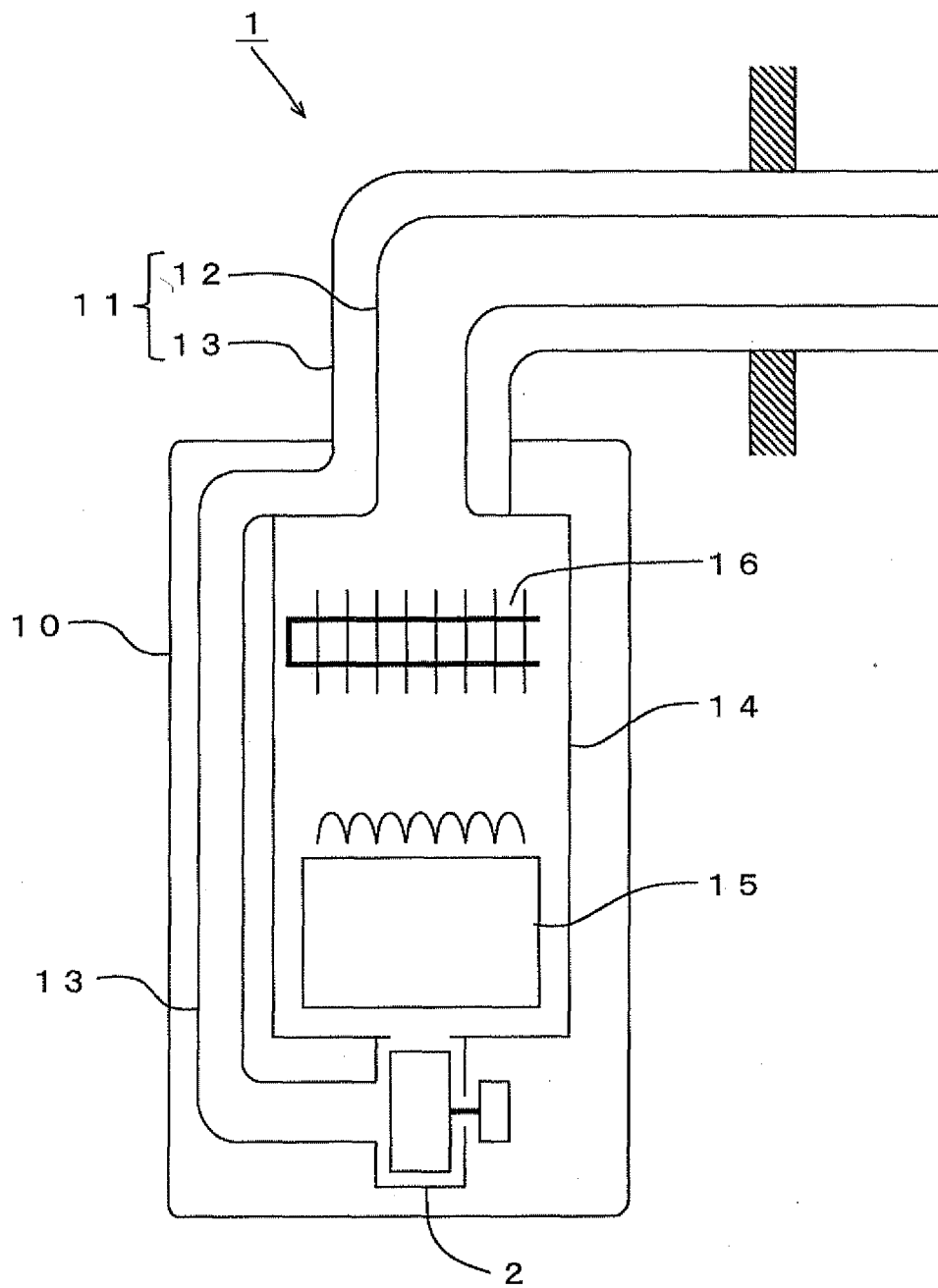


FIG. 2

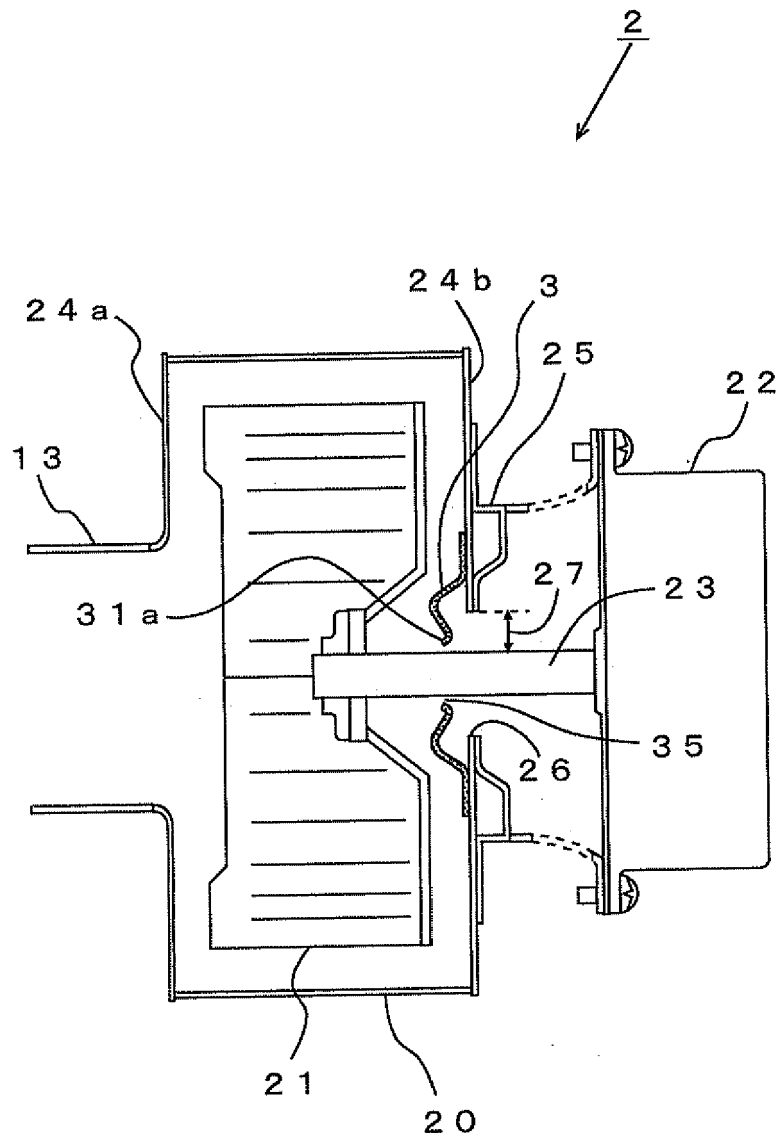


FIG. 3

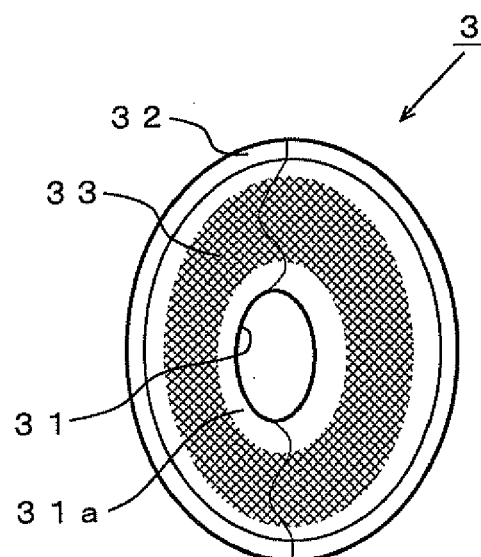
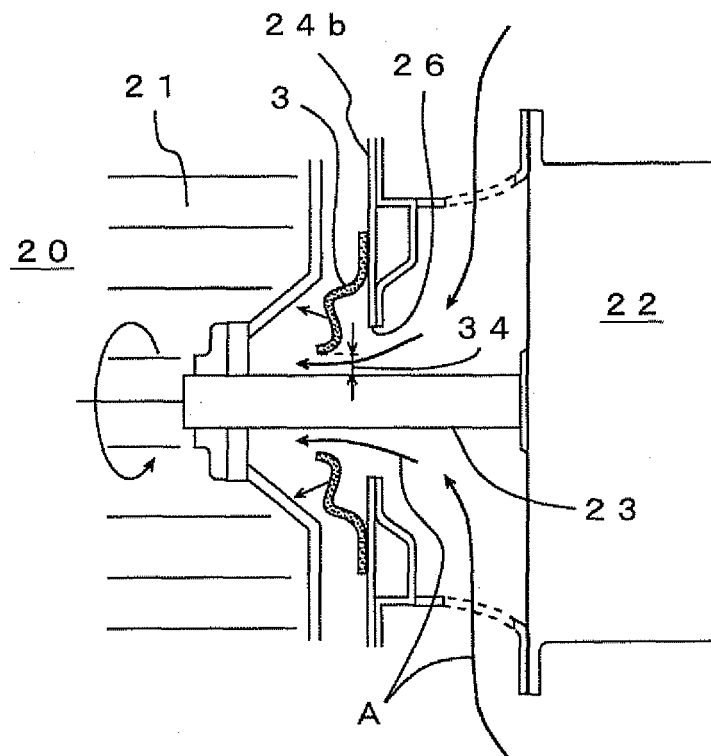
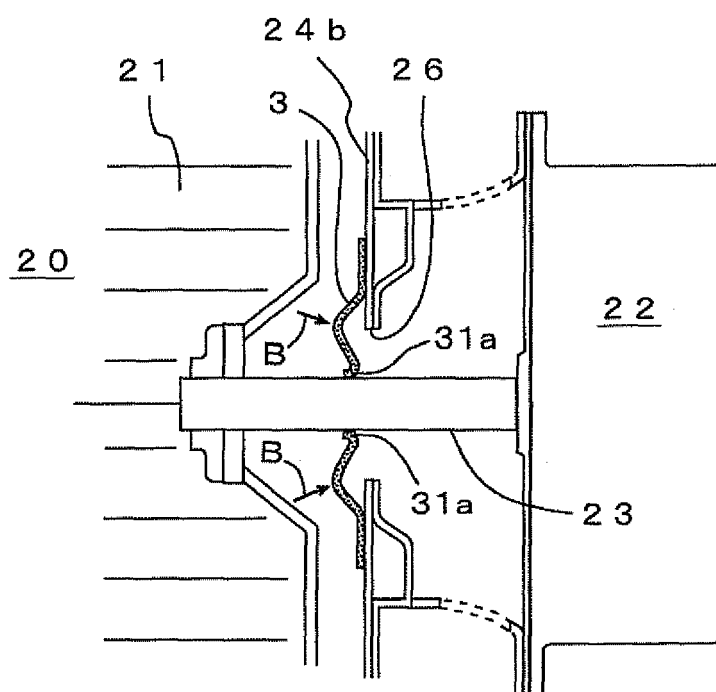


FIG. 4



(When a pressure inside of a fan casing becomes negative / Air supply fan is rotated)

FIG. 5



(When a pressure inside of a fan casing becomes positive / Air supply fan is stopped)

FIG. 6 (PRIOR ART)

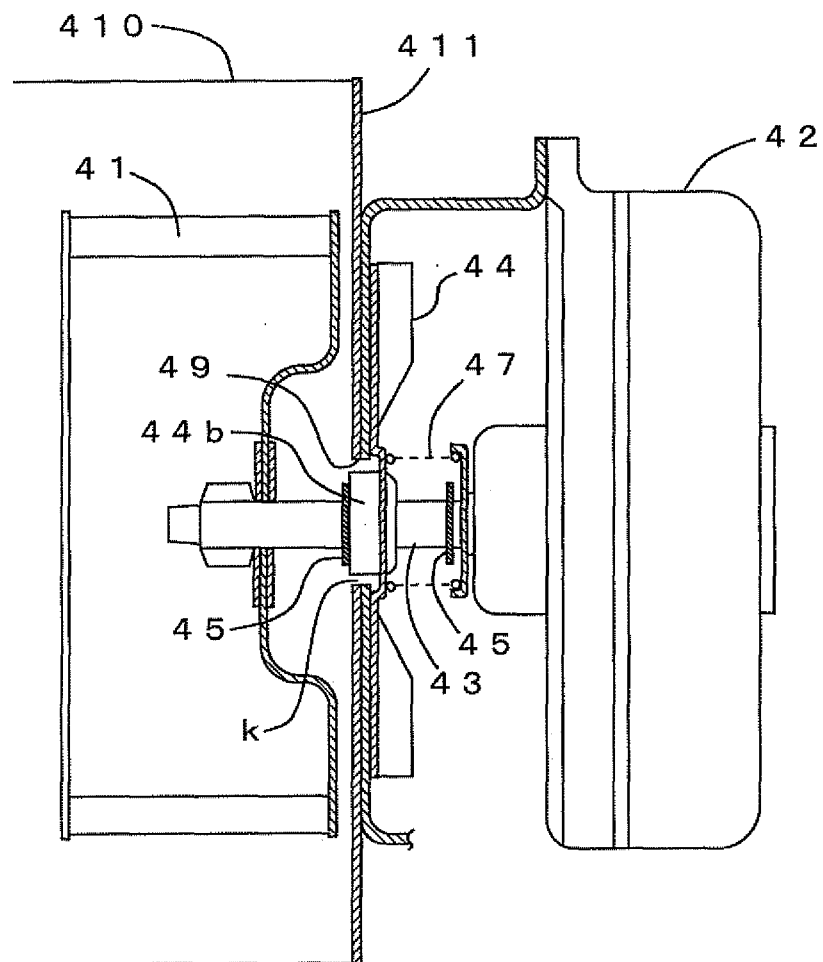
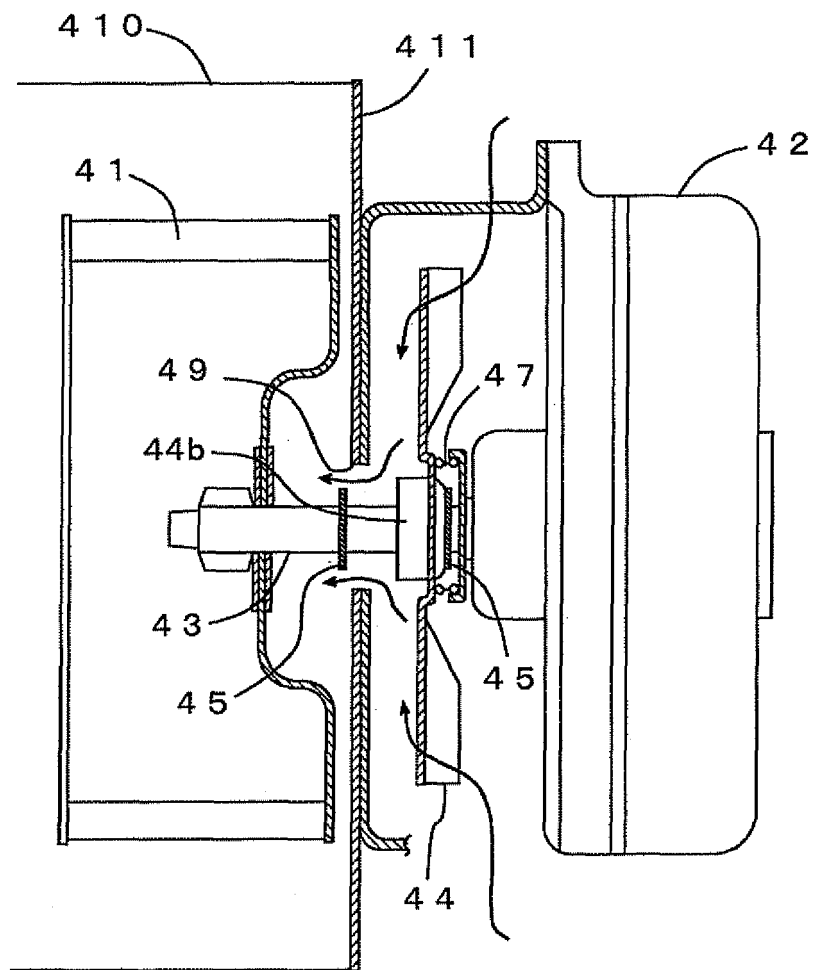


FIG. 7 (PRIOR ART)



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H0552321 B [0003]
- JP 2008304785 A [0034]