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(71) Applicant: **Daikin Industries, Ltd.**
Osaka-shi, Osaka 530-8323 (JP)

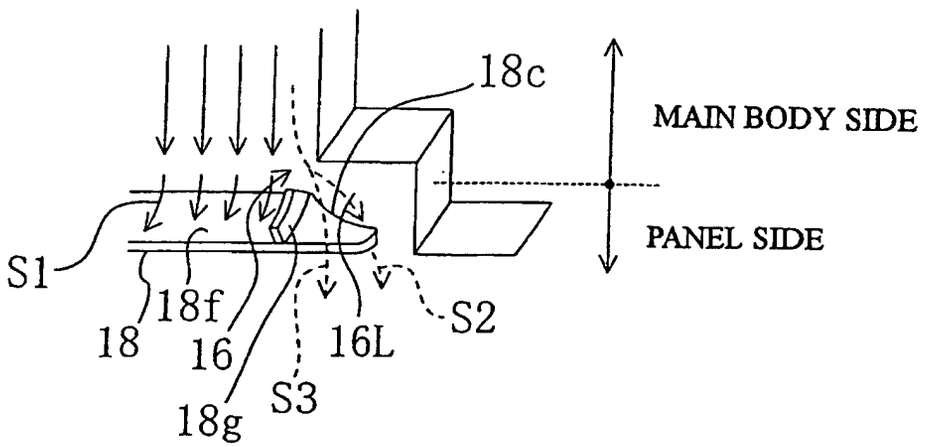
(72) Inventors:
- **Nakanishi, Jyunichi, Kanaoka Factory**
  Sakai-shi, Osaka 591-8511 (JP)
- **Satoh, Yoshikazu, Kanaoka Factory**
  Sakai-shi, Osaka 591-8511 (JP)
- **Hirakawa, Taku, Kanaoka Factory**
  Sakai-shi, Osaka 591-8511 (JP)
- **Shigesawa, Tooru, Kanaoka Factory**
  Sakai-shi, Osaka 591-8511 (JP)

(74) Representative: **Zinnecker, Armin, Dipl.-Ing.**
Lorenz-Seidler-Gossel,
Widenmayerstrasse 23
80538 München (DE)

(54) DECORATIVE PANEL FOR AIR CONDITIONING SYSTEM, AIR OUTLET UNIT, AND AIR CONDITIONING SYSTEM

(57) Improvements in the shape of a horizontal vane **(18)** mounted at an air vent **(16)** of an airconditioner make it possible to set an adequate emission direction according to the operating status of the airconditioner, and in order to prevent, without fail, occurrence of ceiling fouling when an extension portion **(16L)** is defined at a lengthwise end of the air vent **(16)**, the horizontal vane **(18)** is provided, at a position substantially corresponding to an inside end of the extension portion **(16L)** of the air vent **(16)**, with a guide plate **(18g)** for guiding conditioned air in a direction substantially orthogonal to the lengthwise direction of the air vent **(16)**.

Fig. 7



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Description

Technical Field

[0001] The present invention relates to airconditioner decorative panels, to airconditioner vent units, and to airconditioners. More specifically, the invention relates to structures for a horizontal vane, mounted at an air vent, for controlling the direction in which conditioned air is emitted, and to configurations for an air vent at which such a horizontal vane is mounted.

Background Art

[0002] In conventional airconditioners of for example the ceiling flush mounting type or the duct type, horizontal vanes, capable of vertically changing the direction in which conditioned air is emitted, are mounted at air vents. During heating mode of operation, the emission direction of conditioned air is oriented relatively downward by the horizontal vanes and, on the other hand, during cooling mode of operation, the emission direction is oriented relatively upward so as to be as parallel as possible to a ceiling surface (so-called a "horizontal emission" operation), with a view to achieving a uniform distribution of room temperature during each mode of operation for the purpose of increasing the efficiency of air-conditioning.

[0003] However, in a state of "horizontal emission", particulate dust contained in the emitted conditioned air and dust contained in indoor air are likely to deposit on a ceiling surface. As a result, the ceiling surface becomes partially dirty. More specifically, a flow of air emitted from an air vent **(a)** in a state of "horizontal emission" forms a shape approximately similar to a V-shape along the flow, when viewing the airconditioner from a horizontal direction (see Figure **10**). Here, the velocity of a flow of air emitted at a lengthwise middle portion of the air vent **(a)** is rapid, so that negative pressure grows stronger, thereby preventing emitted air from reaching a ceiling surface **(b)** in the vicinity of the air vent.

[0004] On the other hand, since the velocity of a flow of air emitted at each end of the air vent **(a)** is slow, the air is drawn by negative pressure at the middle portion. As a result, the air reaches the ceiling surface **(b)** in the vicinity of the air vent **(a)**. At this time, dust contained in such a slow airflow emitted at each end of the air vent **(a)** (more specifically, dust contained in the slow airflow emitted at each end of the air vent **(a)** plus indoor dust involved by the slow airflow) will deposit on the ceiling surface **(b)**. Because of this, ceiling surface fouling is normally found in regions **(D)** in close proximity to both sides of the air vent **(a)** and in approximately a V shape, being directed toward the middle portion from the both ends of the air vent **(a)** as it leaves away from the air vent **(a)** (see Figure **2**).

[0005] Various measures have been taken in order to circumvent such ceiling surface fouling. For example, Japanese Patent Application *Kokai* Gazette No. H03-160266 proposed a technique in which an auxiliary fin operable to change the emission direction to orient in the direction of a ceiling surface is mounted detachably on a horizontal vane. And, the auxiliary fin is installed and removed, depending on the tendency that ceiling fouling occurs. In an airconditioner constructed in accordance with the gazette, the auxiliary fin is removed and the horizontal vane is oriented downward, for example in an environment likely to cause ceiling fouling because of indoor air that contains dust in large amounts or in a place such as a hospital that requires high levels of contamination prevention. On the other hand, the auxiliary fin is installed so that a horizontal emission operation can be performed, for example in an environment unlikely to cause ceiling fouling or in a place that does not require high levels of contamination prevention.

[0006] However, even when an auxiliary fin is provided as in the aforementioned prior art example, the auxiliary fin must be removed in an environment likely to cause ceiling fouling. After all, conditioned air is continuously emitted downward from the air vent. This causes a drop in air-conditioning efficiency during cooling mode of operation in which horizontal emission operation should basically be carried out. Besides, there is another problem that cold air falls directly on a person present in a room. This may cause uncomfortable feeling (so-called "draft feeling") to the person.

[0007] Incidentally, for example in a ceiling flush type airconditioner, its decorative panel is required to have four air vents of the same opening shape for the purpose of providing a better exterior appearance, and if pipes and electrical component boxes are disposed at comers of a main body casing, this may create a difference in the lengthwise opening length of the air vent **(a)** between the main body casing side and the decorative panel side, as shown in Figure **11.** In such a case, there are defined extension portions **(c)** at lengthwise ends of the air vent **(a)** so that the opening length of the air passageway is extended, at areas facing an indoor space, in the lengthwise direction of the air vent **(a)**.

[0008] In cases where the extension portions **(c)** are defined at the ends of the air vent **(a)** as described above, if a horizontal vane **(d)** is set in a state of "horizontal emission", this causes air to flow laterally from the lengthwise middle portion toward the ends of the horizontal vane **(d)**, as indicated by arrows of Figures **11**. Because of this, the velocity of air emitted from the ends of the air vent **(a)** is slow, as a result of which the air emitted from the ends of the air vent **(a)** is likely to reach a ceiling **(b)** by negative pressure at the middle portion of the air vent **(a)**. This causes the ceiling surface **(b)** to become easily dirty.

[0009] Bearing in mind the above-described problems, the invention was made. Accordingly, an object of the invention is to make it possible to set an adequate emission direction according to the operating status of

an airconditioner while, in cases where extension portions are provided at lengthwise ends of an air vent, preventing ceiling fouling by making improvements in the shape of a horizontal vane mounted at the air vent.

DISCLOSURE OF THE INVENTION

[0010] The invention provides improvements to horizontal vanes so that conditioned air is guided, in the inside of an extension portion of an air vent, in a direction substantially orthogonal to the lengthwise direction of the air vent. As a result, the conditioned air is unlikely to flow into the extension portion.

[0011] More specifically, the invention provides problem-solving means which are premised on a decorative panel for an airconditioner comprising an air vent **(16)** through which conditioned air is emitted from the direction of a ceiling surface **(70)** into an indoor space and a horizontal vane **(18)**, mounted at the air vent **(16)**, for adjusting the direction in which conditioned air is emitted, on a vent unit for an airconditioner comprising an air vent **(16)** through which conditioned air is emitted from the direction of a ceiling surface **(70)** into an indoor space and a horizontal vane **(18),** mounted at the air vent **(16)**, for adjusting the direction in which conditioned air is emitted, on an airconditioner comprising the decorative panel **(14)** which is mounted along a ceiling surface, and on an airconditioner in which the vent unit **(51)** is mounted on a ceiling surface and is connected, through a fan duct **(52)**, to an airconditioner main body **(53)**.

[0012] The air vent **(16)** has, in the vicinity of an end thereof, an extension portion **(16L)** so that the lengthwise opening length of the air vent **(16)** extends at an area facing an indoor space, and the horizontal vane **(18)** is so formed that, at a position substantially corresponding to an inside end of the extension portion **(16L)** of the air vent **(16)**, conditioned air is guided in a direction substantially orthogonal to the lengthwise direction of the air vent **(16)**. The inside end of the extension portion **(16L)** of the air vent **(16)** is a lengthwise central side end of the extension portion in the air vent **(16)** and, preferably the position substantially corresponding to the inside end of the extension portion **(16L)** is a position located slightly more inwardly than the inside end of the extension portion **(16L)**. In addition, the direction in which conditioned air is guided by the horizontal vane **(18)** is not necessarily limited to the direction orthogonal to the lengthwise direction of the air vent **(16)**, in other words conditioned air may be guided in any direction other than the direction in which it (the conditioned air) flows into the extension portion **(16L)** (the same can be applied to the following).

[0013] In this construction, it may be arranged such that the horizontal vane **(18)** is provided, at a position substantially corresponding to an inside end of the extension portion **(16L)** of the air vent **(16)**, with a guide means **(18g)** for guiding conditioned air in a direction substantially orthogonal to the lengthwise direction of the air vent **(16)**.

[0014] In addition, the guide means **(18g)** may be composed of a guide plate mounted on an upper surface **(18f)** of the horizontal vane **(18)** in a state of horizontal emission. Preferably the guide plate **(18g)** is disposed along a direction substantially orthogonal to the lengthwise direction of the horizontal vane **(18)**; however, the guide plate **(18g)** may assume such an inclined position that conditioned air is guided toward the lengthwise center of the air vent **(16)**.

[0015] With the above-described construction, when conditioned air is emitted indoors through the air vent **(16)**, the conditioned air is guided in an approximately horizontal direction at the middle portion of the air vent **(16)** at which the emission flow velocity is relatively high, during cooling mode of operation. Further, most of conditioned air, which has struck the horizontal vane **(18)**, will not flow into the extension portion **(16L)** because of the guide means **(18g)**, such as a guide plate, mounted on the upper surface **(18f)** of the horizontal vane **(18)**, but it flows along the guide plate **(18g)** and is emitted in an approximately horizontal direction, still at a high flow velocity. On the other hand, a part of the conditioned air striking the horizontal vane **(18)** flows into the extension portion **(16L)**; however, its volume is slight and the volume of air flowing out of the end of the air vent **(16)** is slight. Because of this, the flow rate of conditioned air, emitted at a slow initial emission velocity and flowing along a ceiling surface, will decrease at the end of the horizontal vane **(18)**. Further, conditioned air is emitted indoors in downward direction from the entire air vent **(16)** by adjusting the horizontal vane **(18)** in downward direction, during heating mode of operation.

[0016] Furthermore, preferably an airflow upstream side end edge in the vicinity of a lengthwise end of the horizontal vane **(18)** is so formed that conditioned air is allowed to pass in a region substantially corresponding to the extension portion **(16L)** of the air vent **(16)**. For example, an opening portion **(18c)** may be defined by notching a part of the horizontal vane **(18)**.

[0017] With the above-described construction, during cooling mode of operation conditioned air is guided in an approximately horizontal direction at the middle portion of the air vent **(16)** at which the emission flow velocity is relatively high. On the other hand, a part of conditioned air, after passing through the opening portion **(18c)** in the vicinity of the end of the horizontal vane **(18)**, is emitted in a more downward direction at the lengthwise end of the air vent **(16)** at which the emission flow velocity is relatively slow than at the middle portion. Accordingly, the flow rate of conditioned air, emitted at a slow initial velocity at the end of the air vent **(16)** and flowing along a ceiling surface, decreases.

[0018] Further, in the above-describe construction, preferably the air vent **(16)** is so formed that conditioned air is emitted in a more downward direction at a sidewall **(16b-s)** of a lengthwise end region of the air vent **(16)**

substantially corresponding to the extension portion **(16L)** than at a sidewall **(16b-c)** of a lengthwise middle portion of the air vent **(16)**. For example, it may be arranged such that the angle of each sidewall of the air vent **(16)** with respect to the ceiling surface at the lengthwise middle portion differs from that at the lengthwise end.

[0019] With the above-described construction, during cooling mode of operation conditioned air is emitted definitely in a more downward direction at the lengthwise ends of the air vent **(16)** at which the emission flow velocity is relatively slow than at the lengthwise middle portion. As a result, the flow rate of conditioned air, emitted at a slow initial velocity and flowing along a ceiling surface, decreases.

Effects

[0020] In accordance with the foregoing problem-solving means, air flowing downward in the air passageway **(W)** hardly flows longitudinally outward (i.e., toward the extension portion **(16L)**) after striking the horizontal vane **(18)**. Conventionally a flow of air flowing toward the outside causes the velocity of air at the ends of the air vent **(16)** to decrease. As a result, the air flows out laterally and, therefore, is likely to reach the ceiling surface **(70)** by negative pressure at the middle portion. On the other hand, in accordance with the foregoing problem-solving means, air at the ends of the air vent **(16)** is unlikely to reach the ceiling surface **(70)**, and fouling of the ceiling surface **(70)** is unlikely to occur.

[0021] Accordingly, the occurrence of ceiling fouling is prevented while making it possible to allow the emission direction of conditioned air to come closer to a horizontal direction than conventional, particularly during cooling mode of operation which requires horizontal emission of conditioned air. This prevents a resident present in the room from having uncomfortable feeling (draft feeling) while securing air-conditioning efficiency. In addition, the ceiling surface **(70)** hardly becomes dirty, which does not cause disfigurement of the ceiling surface **(70)**. The ceiling surface **(70)** requires no cleaning accordingly.

[0022] Further, in conventional cases where the horizontal vane **(18)** is not provided with guide plates **(18g)**, cold air leaks longitudinally outward of the air vent **(16)** and condensation is likely to occur on a panel lower surface and other surface. This requires some measure, such as implanting of materials shaped like hair, to be taken. In accordance with the foregoing problem-solving means, air flowing from the ends of the horizontal vane **(18)** toward the outside is unlikely to be produced, so that condensation hardly occurs. There is no need to take measures for condensation prevention. Further, since such a measure is not required, there are advantages such as improvement in appearance and cleaning property.

[0023] Finally, because of the arrangement that conditioned air is allowed to pass through the airflow upstream end edge in the vicinity of the lengthwise end of the horizontal vane **(18)**, and because of the arrangement that conditioned air is emitted in a more downward direction at the sidewall **(16b-s)** of the lengthwise end of the air vent **(16)** than at the sidewall **(16b-c)** of the lengthwise middle portion of the air vent **(16)**, conditioned air is emitted in downward direction at the end of the air vent **(16)**. This, coupled with the fact that the volume of air flowing in this part is small, definitely prevents dust from depositing on the ceiling surface **(70)**.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

Figure **1** is a schematic cross-sectional diagram of a ceiling flush type airconditioner according to an embodiment of the invention;

Figure **2** is a perspective view of the ceiling-mounted airconditioner when viewed from below;

Figure **3**, which is an enlarged structural diagram of an air vent, illustrates a state in which the direction in which conditioned air is emitted is set to a state of "horizontal emission";

Figure **4** is a diagram which is similar to Figure **3** but illustrates a state in which the conditioned air emission direction is set to a state of "downward emission";

Figure **5** is a perspective view of the air vent when viewed from below;

Figure **6** is a perspective view of a horizontal vane;

Figure **7** is a partial perspective view when extension portions are defined in the air vent;

Figure **8** is a schematic construction diagram of a duct type airconditioner;

Figure **9** is comprised of Figures **9A-9D** which are perspective views showing horizontal vanes having different opening portion shapes;

Figure **10** is an explanatory diagram illustrating a state of a flow of conditioned air from an air vent when viewed from at a side of a conventional airconditioner; and

Figure **11** is a partial perspective view when extension portions are defined in an air vent in a conventional airconditioner.

BEST MODE FOR CARRYING OUT THE INVENTION

[0025] Hereinafter, embodiments of the invention will be described in detail with reference to the Figures.

[0026] Figure **1** is a vertical section showing an arrangement of the ceiling flush type airconditioner **(1)** according to an embodiment of the invention. As shown in the Figure, the airconditioner **(1)** comprises a casing **(10)** in which are housed a fan **(20)** and a heat exchanger **(30)**. The airconditioner **(1)** is embedded in an installation opening **(71)** which opens in a ceiling board (ceil-

ing surface) **(70)**. In this way, the airconditioner **(1)** is installed in an under-roof space.

[0027] The casing **(10)** is made up of a box-shaped main body casing **(11)** which opens downward and a decorative panel **(14)** with which a bottom opening portion of the main body casing **(11)** is covered. The main body casing **(11)** is fixedly suspended from an overlying beam or the like by the use of a hanging ring, which is not shown in the Figure. More specifically, the main body casing **(11)** is made up of an octagonally shaped top plate **(12)** formed by notching, in a chamfering manner, four comers of a square plate (not shown) and side plates **(13)** extending downward from the outer edges of the top plate **(12)**. The decorative panel **(14)** is a plate having a substantially square shape and is attached to the lower ends of the side plates **(13)** of the main body casing **(11)**. The decorative panel **(14)** is attached along the ceiling board **(70)** so that its periphery is brought into abutment with a lower surface of the ceiling board **(70)**.

[0028] Further, as shown also in Figure **2** which is a perspective view showing a state in which the airconditioner **(1)** is ceiling-installed, an air inlet **(15)** is formed in substantially a central portion of the decorative panel **(14)** so as to open squarely. Formed immediately outside the four sides of the air inlet **(15)** and in parallel therewith are four rectangular air vents **(16)**. And, the air inlet **(15)** is provided, all over its surface, with an air filter **(17)** for removal of suspended substances such as particulate dust contained in indoor air. The entire lower surface of the air filter **(17)** is supported by a lattice filter cover.

[0029] As shown enlargedly in Figures **3** and **4,** the air vent **(16)** of the decorative panel **(14)** is defined between an outside guide surface **(16a, 16b)** which is a side wall on the panel outer peripheral side (on the right-hand side in the Figures) of an air passageway and an inside guide surface **(16c, 16d)** which is a side wall on the panel inner peripheral side (on the left-hand side in the Figures). The outside guide surface **(16a, 16b**) is made up of a first outside guide surface **(16a)** extending substantially vertically downward and a second outside guide surface **(16b)** inclining, from the lower end of the first outside guide surface **(16a)** to the lower surface of the decorative panel **(14)**, obliquely in a downward direction toward the panel outer periphery. These outside guide surfaces **(16a, 16b)** are joined together smoothly.

[0030] The second outside guide surface **(16b)** comprises a middle portion **(16b-c)** and both ends **(16b-s)**. The middle portion **(16b-c)** is located longitudinally centrally in the air vent **(16)** and its inclination with respect to the ceiling surface **(70)** is set relatively small (an angle of about 30 degrees). The both ends **(16b-s)** are located in the vicinity of both lengthwise ends of the air vent **(16)** and their inclination to the ceiling surface **(70)** is set relatively large (an angle of about 60 degrees). The inclination of the second outside guide surface **(16b)** varies gradually from the middle portion **(16b-c)** toward each end **(16b-s)** and the angle formed between the second outside guide surface **(16b)** and the ceiling surface **(70)** varies continuously. And, as shown in Figure 5 which is a perspective view of the air vent **(16)** when viewed from below, the second outside guide surface **(16b)** further comprises a lower end edge **(16b-e)** shaped like a circular arc.

[0031] On the other hand, as shown in Figures **3** and **4**, the inside guide surface **(16c, 16d)** is made up of a first inside guide surface **(16c)** which extends substantially vertically downward and a second inside guide surface **(16d)** which gently inclines obliquely downward toward the panel outer periphery from the lower end of the first inside guide surface **(16c)**. These inside guide surfaces **(16c, 16d)** are joined together smoothly.

[0032] The outside guide surface **(16a, 16b)** is formed in an outside member **(14a)** of the decorative panel **(14)**, whereas the inside guide surface **(16c, 16d)** is formed in an inside member **(14b)** of the decorative panel **(14)**. The air vent **(16)** is, as described above, defined between the outside guide surface **(16a, 16b)** and the inside guide surface **(16c, 16d)**. And, in the air vent **(16)**, the horizontal vane **(18)** capable of vertically adjusting the direction in which conditioned air is emitted is disposed between the outside guide surface **(16a, 16b)** of the outside member **(14a)** and the inside guide surface **(16c, 16d)** of the inside member **(14b)**.

[0033] The horizontal vane **(18)** is, as depicted in Figure **6**, a long plate member and bends slightly throughout its width direction. Arms **(18a, 18a)** projecting from an inside surface of the horizontal vane **(18)** are formed integrally with the both lengthwise ends of the horizontal vane **(18)**, respectively. Formed at the end of each arm **(18a)** is a connecting pin **(18b)** that extends outward along the lengthwise direction of the horizontal vane **(18)**. The horizontal vane **(18)** is mounted at the air vent **(16)** in such a way that it can swivel about the connecting pins **(18b, 18b).** More specifically, the horizontal vane **(18)** is swiveled about the connecting pins **(18b, 18b)** by a motor (not shown). In the above-described arrangement, the horizontal vane **(18)** is oriented downward when conditioned air is required to be emitted in the most downward direction, as shown in Figure **4**. On the other hand, in a so-called "horizontal emission" mode of operation, the horizontal vane **(18)** is so set as to be oriented upward, as shown in Figure **3**.

[0034] The outside guide surface **(16a, 16b)** bends substantially conformingly to the cross-sectional shape of the horizontal vane **(18)** (the shape is not limited to such a bent one and any shape may be used as long as it substantially conforms to the shape of the horizontal vane **(18)**). On the other hand, the inside guide surface **(16c, 16d)** is so formed as to extend, in totality, more vertically downward than the outside guide surface **(16a, 16b)** of the outside member **(14a)**. In addition, the shape of the inside guide surface **(16c, 16d)** is a matter of choice.

[0035] And, these two wall surfaces (the outside guide surface **(16a, 16b)** and the inside guide surface **(16c,**

16d)) having the aforesaid shapes and lying face to face with each other, are formed so as to stretch the lengthwise length of the air vent **(16)** (i.e., in a direction normal to the paper surface of the Figure). The air passageway defined between the wall surface **(16a, 16b)** and the wall surface **(16c, 16d)** has a function of serving as an "approach way" for adjusting a flow of conditioned air while changing the direction of the conditioned air flow.

[0036] In the ceiling flush type airconditioner according to the present embodiment, pipes and electrical component boxes are disposed at comers of the main body casing **(11)** and the decorative panel **(14)** has four air vents of the same opening shape for the purpose of providing a better exterior appearance, which may produce a difference in the lengthwise opening length of the air passageway between the main body casing's **(11)** side and the decorative panel's **(14)** side, as shown in Figure 7. In other words, there is defined an extension portion **(16L)** in the vicinity of each lengthwise end of the air vent **(16)** so that the opening length of the air passageway is extended, at areas facing an indoor space, in the lengthwise direction of the air vent **(16)**. In addition, the length of the extension portions **(16L)** varies from one air vent **(16)** to another depending upon the product embodied according to the invention.

[0037] The inclination of the second outside guide surface **(16b)** is set according to the foregoing angle setting so that conditioned air is emitted in a more downward direction at sidewalls in regions corresponding to these extension portions **(16L)** (the both ends **(16b-s)** of the second outside guide surface **(16b))** than at the sidewall **(16b-c)** of the lengthwise middle portion. In other words, the middle portion **(16b-c)** of the sidewall **(16b)** located longitudinally centrally in the air vent **(16)** is set at a relatively small angle (about 30 degrees) with respect to the ceiling surface **(70)**. On the other hand, substantially correspondingly to the extension portions **(16L)** located at the both lengthwise ends of the air vent **(16)**, the both ends **(16b-s)** of the sidewall **(16b)** are each set at a relatively large angle (about 60 degrees) with respect to the ceiling surface **(70)**.

[0038] Further, the horizontal vane **(18)** is so formed as to guide, at its areas substantially corresponding to the inside ends of the extension portions **(16L)** of the air vent **(16)**, conditioned air in a direction substantially orthogonal to the lengthwise direction of the air vent **(16)**. More specifically, the horizontal vane **(18)** is provided, at its positions substantially corresponding to the inside ends of the extension portions **(16L)** of the air vent **(16)**, with guide means **(18g)** for guiding conditioned air in a direction substantially orthogonal to the lengthwise direction of the air vent **(16)**. And, each guide means **(18g)** is composed of a guide plate **(18g)** mounted on an upper surface **(18f)** of the horizontal vane **(18)** in a state of "horizontal emission". Each guide plate **(18g)** is disposed along a direction substantially orthogonal to the lengthwise direction of the horizontal vane **(18)**. In addition, the guide plate **(18g)** may be inclined somewhat so that conditioned air is guided toward the lengthwise center of the air vent **(16)**.

[0039] Further, notches **(18c)** as opening portions through which conditioned air is allowed to pass are defined at the airflow upstream side end edges in the vicinity of the both lengthwise ends of the horizontal vane **(18)**. The notches **(18c)** are formed in regions substantially corresponding to the extension portions **(16L)** of the air vent **(16)**. More specifically, the notches **(18c)** are formed at the airflow upstream side end edges in the vicinity of the both lengthwise ends of the horizontal vane **(18)**, having a length of approximately a quarter of the lengthwise length of the horizontal vane **(18)**. Because of the provision of these notches **(18c)**, the horizontal vane **(18)** has such a shape that the both ends **(18e)** have a narrowed width about two thirds of that of the middle portion **(18d)**. Further, the horizontal vane **(18)** may have for example the following specific dimensions. The entire length of the horizontal vane **(18)** is about 480 mm. The width of the horizontal vane **(18)** (the width of the middle portion **(18d))** is about 37 mm. The width of each end **(18e)** is about 25 mm. The length of each notch **(18c)** is about 120 mm.

[0040] On the other hand, the fan **(20)** is located substantially centrally in the inside of the main body casing **(11)**. This fan is a so-called turbofan in which a blade **(23)** is held between a shroud **(21)** and a hub **(22)**. A drive shaft **(26)** of the fan motor **(25)** mounted on the top plate **(12)** of the main body casing **(11)** is fixedly inserted in the hub **(22)** of the fan **(20)**. The fan **(20)** is rotationally driven by driving force of the fan motor **(25)**, whereby air withdrawn from below the fan **(20)** is delivered radially laterally. Further, a bell-mouth **(27)** for guiding, to the fan **(20)**, air that has flowed into the inside of the casing **(10)** through the air inlet **(15)**, is provided underneath the fan **(20)**.

[0041] The heat exchanger **(30)** is a so-called cross fin heat exchanger made up of a large number of plate-like fins **(31)** which are arranged in parallel with each other and a heat transfer pipe **(32)** so arranged as to pass through the fins **(31)**. The heat exchanger **(30)** is formed into a rectangular cylinder, when viewed from top, so as to surround the periphery of the fan **(20)**. The heat exchanger **(30)** is connected, through a refrigerant pipe (not shown), to an outdoor unit. The heat exchanger **(30)** functions as an evaporator during cooling mode of operation, and as a condenser during heating mode of operation, for controlling the temperature state of air delivered from the fan **(20).** And, a drain pan **(33)** for receiving drain water is disposed under the heat exchanger **(30)**.

[0042] By the above-described construction, an air circulation passageway **(W)** extending from the air inlet **(15)** of the decorative panel **(14)** to the air vent **(16)** by way of the air filter **(17)**, the bell-mouth **(27)**, the fan **(20)**, and the heat exchanger **(30)**, is defined in the inside of the main body casing **(11)** of the airconditioner **(1)**. And, when the fan **(20)** is driven during air-conditioning mode

of operation, indoor air taken into the inside of the casing **(10)** from the air inlet **(15)** through the air filter **(17)** flows in the bell-mouth **(27)**, in the fan **(20)**, and in the heat exchanger **(30)** in that order in the air circulation passageway **(W)**. The indoor air exchanges heat with refrigerant in the heat exchanger **(30)** and is temperature controlled (cooled during cooling mode of operation and heated during heating mode of operation). Thereafter, the air is emitted, as conditioned air, into an indoor space. In this way, the indoor space is air-conditioned.

[0043] Here, when there is a demand for conditioned air to be emitted in a relatively downward direction, for example as in heating mode of operation or the like, the horizontal vane **(18)** is oriented substantially vertically downward (see Figure **4**) so that conditioned air is made to flow along the horizontal vane **(18)** between the panel outer peripheral side sidewall **(16a, 16b)** and the panel inner peripheral side sidewall **(16c, 16d)** of the air vent **(16)** and is emitted in a downward direction as indicted by Arrow S of the Figure.

[0044] On the other hand, during so-called "horizontal emission" mode of operation (for example during cooling mode of operation and so on), the horizontal vane **(18)** is turned in an upward direction (see Figure **3**) so that the upper surface **(18f)** of the horizontal vane **(18)** becomes substantially parallel with the middle portion **(16b-c)** of the second outside guide surface **(16b)** of the air vent **(16).** As a result of this, conditioned air flows curvedly along the middle portion **(18d)** of the horizontal vane **(18)** at the middle portion of the air vent **(16)** and the direction of its line of flow varies greatly and smoothly. Then, as indicated by Arrow S1 of the Figure, the conditioned air passes between the second outside guide surface **(16b)** on the panel outer peripheral side of the air vent **(16)** and the horizontal vane **(18)**. Thereafter, the conditioned air is emitted through the air vent **(16)** at an emission angle as parallel as possible to the lower surface of the ceiling board **(70)** (for example, at angles of from 30 to 35 degrees with respect to the ceiling board's **(70)** lower surface).

[0045] Further, at the both ends of the air vent **(16)**, most of conditioned air, which has flowed through the air circulation passageway **(W)** in a downward direction, flows along the guide plates **(18g)** as shown in Figure **7** and only a very small volume of conditioned air flows into each extension portion **(16L)** and its flow rate is very low. The slight conditioned air, which has flowed into the extension portions **(16L)**, passes through the notches **(18c)** in the vicinity of the both ends **(18e)** of the horizontal vane **(18)** and is emitted in a substantially downward direction as indicated by Arrow S2 of Figure **3**. Further, the air emitted at the both ends of the air vent **(16)**, since the both ends **(16b-s)** of the second outside guide surface **(16b)** have a more raised shape (a less inclined shape) than the middle portion **(16b-c)**, will flow in a more downward direction indicated by Arrow S3 than the Arrow **S1** direction (see Figure **3**). As a result, at the both ends of the air vent **(16),** most of conditioned air is emitted downwardly (in the directions indicated by Arrows S2 and S3), in other words the conditioned air hardly flows in the Arrow S1 direction. Because of this, at the both ends of the air vent **(16)**, the flow rate of air flowing in the Arrow S1 direction decreases, and air is unlikely to flow along the ceiling surface.

[0046] In a conventional ceiling flush type airconditioner, a flow of air emitted at portions of low air emission velocity (at the both ends of the air vent **(16))** is liable to reach the lower surface of the ceiling board **(70)**. If, during cooling mode of operation, the emission direction of conditioned air is oriented relatively upward by the horizontal vane **(18)** so that the angle formed between the emission direction and the lower surface of the ceiling board **(70)** ranges between about 30 and about 35 degrees, this causes a flow of air to flow along the lower surface of the ceiling board **(70)**. As a result, ceiling fouling occurs in the regions **(D)** as indicated by virtual lines of Figure **2**. In other words, ceiling fouling is distributed, substantially in a V-shape for each air vent. However, in accordance with the airconditioner **(1)** of the present embodiment, air emitted at the both ends of the air vent **(16)** is unlikely to flow along the lower surface of the ceiling board **(70)** during cooling mode of operation that especially requires a "horizontal emission" of conditioned air. Therefore, even when the emission direction of conditioned air emitted through the air vent **(16)** is varied by the horizontal vane **(18)** so that the angle formed between the conditioned air emission direction and the lower surface of the ceiling board **(70)** is made to come near to, for example, about 30 to about 35 degrees at the middle portion of the air vent, the occurrence of ceiling fouling can be prevented.

[0047] Particularly in the present embodiment, since the horizontal vane **(18)** is provided with the guide plates **(18g)**, air flowing downward through the air passageway **(W)** hardly flows longitudinally outward after striking the horizontal vane **(18)**. Conventionally, such a flow of air directed toward the outside causes the velocity of air at the ends of the air vent **(16)** to decrease. As a result, the air flows out laterally and, therefore, is likely to reach the ceiling surface **(70)** by negative pressure at the middle portion. On the other hand, in accordance with the present embodiment, air emitted at the ends of the air vent **(16)** is unlikely to reach the ceiling surface **(70)**, and fouling of the ceiling surface **(70)** is unlikely to occur.

[0048] Accordingly, in accordance with the airconditioner **(1)** of the present embodiment, ceiling fouling is prevented while making it possible to allow the emission direction of conditioned air to come closer to a horizontal direction than conventional, particularly during cooling mode of operation which requires horizontal emission of conditioned air. This prevents a resident present in the room from having uncomfortable feeling (draft feeling) while securing air-conditioning efficiency. In addition, the ceiling surface **(70)** hardly becomes dirty, therefore circumventing disfigurement of the ceiling surface **(70)**. The ceiling surface **(70)** requires no cleaning ac-

cordingly.

[0049] Further, in cases where the horizontal vane **(18)** is not provided with guide plates **(18g)**, it is likely that cold air leaks outward with respect to the lengthwise direction of the air vent **(16)** to condense on a panel lower surface and other surface. This requires some measure, such as implanting of materials shaped like hair, to be taken. However, in accordance with the present embodiment, air is unlike to flow from the ends of the horizontal vane **(18)** toward the outside, so that condensation hardly occurs, and there is no need to take any measure to prevent condensation. Further, since such a condensation prevention measure is not required to take, this makes it possible to reduce costs. Besides, there are advantages such as improvement in appearance and cleaning property.

[0050] Furthermore, in the present embodiment, each notch **(18c)** of the horizontal vane **(18)** is formed only in a region of each end **(18d)** of the horizontal vane **(18)** whose length is about a quarter of that of the horizontal vane **(18)**, which makes it possible to achieve, in totality, a satisfactory "horizontal emission" operation while at the same time preventing the occurrence of ceiling fouling.

[0051] Further, the invention is not limited to the above-mentioned embodiment. The invention includes other various embodiments.

[0052] For example, in the above-described embodiment, a single guide plate **(18g)** is mounted in the vicinity of each end of the horizontal vane **(18)**. However, a plurality of guide plates **(18g)** may be mounted. Further, in such a case that the extension portion **(16L)** is provided only at one of the ends of the air vent **(16),** the guide plate **(18g)** is mounted only on the side of the one end where the extension portion **(16L)** is provided.

[0053] Further, the invention is applied to the airconditioner **(1)** of a so-called ceiling flush four-direction emission type which is provided with a turbofan and which emits conditioned air in four directions. However, the invention is not limited to such an application. For example, the invention is applicable to an airconditioner of a so-called ceiling flush two-direction emission type which emits conditioned air in two directions.

[0054] Furthermore, the invention is applicable not only to ceiling flush type airconditioners but also to duct type airconditioners. As shown in Figure **8**, the duct type airconditioner **(50)** is an airconditioner in which a vent unit **(51)** mounted on the ceiling board **(70)** is connected, through a fan duct **(52)**, to an airconditioner main body **(53)** mounted on a building roof or the like. Even for the vent unit **(51)** of the airconditioner **(50)**, the same effects as obtained in the above-described embodiment can be obtained by provision of a guide plate **(18g)** at each lengthwise end of the horizontal vane **(18)**.

[0055] Further, in the above-mentioned embodiment, the notches **(18c)** as opening portions are formed in the vicinity of the both ends **(18e)** of the horizontal vane **(18)**. However, the opening portions **(18c)** are not necessarily provided. Even in cases where such opening portions are provided, through holes may be formed in the horizontal vane **(18)** in place of the notches **(18c)**. In other words, the airflow upstream side end edges may employ any construction as long as conditioned air is emitted in a downward direction at the both ends of the air vent **(16)** during "horizontal emission" mode of operation.

[0056] Furthermore, the shape and the dimensions of the horizontal vane **(18)** and the shape and the dimensions of the notch **(18c)** (the opening portion) shown above are only examples and therefore can of course be altered properly according to the shape and the dimensions of a product embodied according to the invention.

[0057] When the opening portion **(18c)** is a notch, the notch **(18c)** may be formed into various shapes, and Figures **9A-9C** show horizontal vanes **(18)** having different ends. Figure **9A** illustrates an example of the notch **(18c)** in which airflow upstream side end edges of areas in the vicinity of both lengthwise ends of a horizontal vane **(18)** are shaped into a circular arc. Figure **9B** illustrates another example of the notch **(18c)** in which airflow upstream side end edges of areas in the vicinity of both lengthwise ends of a horizontal vane **(18)** are obliquely linearly shaped. Figure **9C** illustrates still another example of the notch **(18c)** in which airflow upstream side end edges of areas in the vicinity of both lengthwise ends of a horizontal vane **(18)** are formed into a reversed circular arc with respect to the one shown in Figure **9A**.

[0058] Further, Figure **9D** shows a substitute for the opening portion **(18c)**. More specifically, each end of the horizontal vane **(18)** is formed into a three-dimensionally twisted shape so that the airflow upstream side end edges rise from the lengthwise middle portion toward the both ends of the horizontal vane **(18)**. In this case, since air is unlikely to separate at the ends of the horizontal vane **(18)**, the ends of the horizontal vane **(18)** are unlikely to involve surrounding warm air. This provides an advantage that condensation is unlikely to occur.

[0059] Further, in the above-described embodiment, the inclination of the second outside guide surface **(16b)** of the air vent **(16)** is set in such a way that the both ends **(16b-s)** are inclined at an angle nearer to a vertical than the middle portion **(16b-c)**. However, such arrangement is not necessary made. The second outside guide surface **(16b)** may be inclined, for example throughout the air vent **(16)**, correspondingly to the inclination of the middle portion **(16b-c)** of the above-described embodiment.

Claims

1. A decorative panel for an airconditioner comprising an air vent **(16)** through which conditioned air is emitted from the direction of a ceiling surface **(70)** into an indoor space and a horizontal vane **(18)**, mounted at said air vent **(16)**, for adjusting the di-

rection in which conditioned air is emitted,
wherein:

said air vent **(16)** has, in the vicinity of an end thereof, an extension portion **(16L)** so that the lengthwise opening length of said air vent **(16)** extends at an area facing an indoor space, and said horizontal vane **(18)** is so formed that, at a position substantially corresponding to an inside end of said extension portion **(16L)** of said air vent **(16)**, conditioned air is guided in a direction substantially orthogonal to the lengthwise direction of said air vent **(16).**

2. The airconditioner decorative panel of claim 1, wherein said horizontal vane **(18)** is provided, at a position substantially corresponding to an inside end of said extension portion **(16L)** of said air vent **(16)**, with guide means **(18g)** for guiding conditioned air in a direction substantially orthogonal to the lengthwise direction of said air vent **(16)**.

3. The airconditioner decorative panel of claim 2, wherein said guide means **(18g)** is composed of a guide plate mounted on an upper surface **(18f)** of said horizontal vane **(18)** in a state of horizontal emission.

4. The airconditioner decorative panel of claim 3, wherein said guide plate **(18g)** is disposed along a direction substantially orthogonal to the lengthwise direction of said horizontal vane **(18).**

5. The airconditioner decorative panel of any one of claims 1-4, wherein an airflow upstream side end edge in the vicinity of a lengthwise end of said horizontal vane **(18)** is so formed that conditioned air is allowed to pass in a region substantially corresponding to said extension portion **(16L)** of said air vent **(16)**.

6. The airconditioner decorative panel of any one of claims 1-5, wherein said air vent **(16)** is so formed that conditioned air is emitted in a more downward direction at a sidewall **(16b-s)** of a lengthwise end region of said air vent **(16)** substantially corresponding to said extension portion **(16L)** than at a sidewall **(16b-c)** of a lengthwise middle portion of said air vent **(16)**.

7. A vent unit for an airconditioner comprising an air vent **(16)** through which conditioned air is emitted from the direction of a ceiling surface **(70)** into an indoor space and a horizontal vane **(18)**, mounted at said air vent **(16)**, for adjusting the direction in which conditioned air is emitted,
wherein:

said air vent **(16)** has, in the vicinity of an end thereof, an extension portion **(16L)** so that the lengthwise opening length of said air vent **(16)** extends at an area facing an indoor space, and said horizontal vane **(18)** is so formed that, at a position substantially corresponding to an inside end of said extension portion **(16L)** of said air vent **(16)**, conditioned air is guided in a direction substantially orthogonal to the lengthwise direction of said air vent **(16)**.

8. The airconditioner vent unit of claim 7, wherein said horizontal vane **(18)** is provided, at a position substantially corresponding to an inside end of said extension portion **(16L)** of said air vent **(16)**, with guide means **(18g)** for guiding conditioned air in a direction substantially orthogonal to the lengthwise direction of said air vent **(16)**.

9. The airconditioner vent unit of claim 8, wherein said guide means **(18g)** is composed of a guide plate mounted on an upper surface **(18f)** of said horizontal vane **(18)** in a state of horizontal emission.

10. The airconditioner vent unit of claim 9, wherein said guide plate **(18g)** is disposed along a direction substantially orthogonal to the lengthwise direction of said horizontal vane **(18)**.

11. The airconditioner vent unit of any one of claims 7-10, wherein an airflow upstream side end edge in the vicinity of a lengthwise end of said horizontal vane **(18)** is so formed that conditioned air is allowed to pass in a region substantially corresponding to said extension portion **(16L)** of said air vent **(16)**.

12. The airconditioner vent unit of any one of claims 7-11, wherein said air vent **(16)** is so formed that conditioned air is emitted in a more downward direction at a sidewall **(16b-s)** of a lengthwise end region of said air vent **(16)** substantially corresponding to said extension portion **(16L)** than at a sidewall **(16b-c)** of a lengthwise middle portion of said air vent **(16)**.

13. An airconditioner comprising a decorative panel **(14)** mounted along a ceiling surface **(70)**,
wherein said decorative panel **(14)** is composed of a decorative panel according to any one of claims 1-6.

14. An airconditioner in which a vent unit **(51)** mounted on a ceiling surface **(70)** is connected, through a fan duct **(52)**, to an airconditioner main body **(53)**,
wherein said vent unit **(51)** is composed of a vent unit according to any one of claims 7-12.

Fig. 1

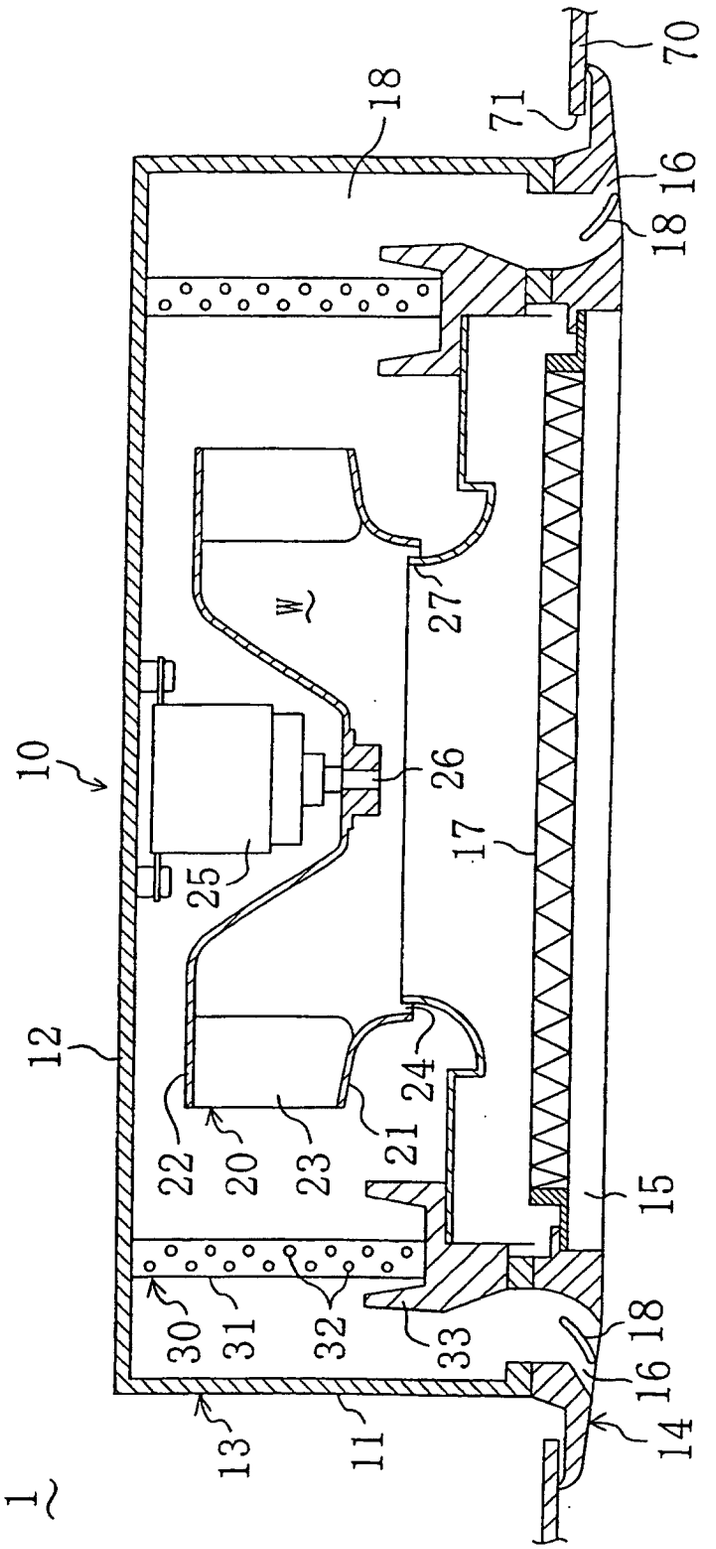


Fig. 2

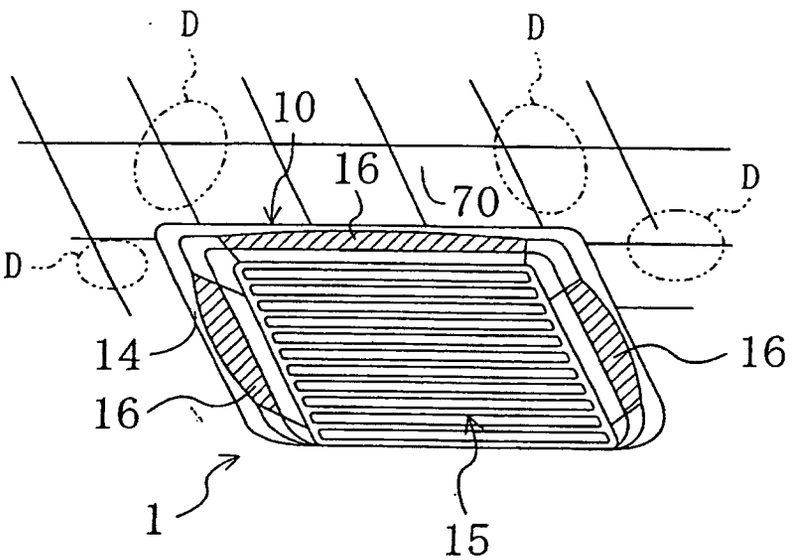


Fig. 3

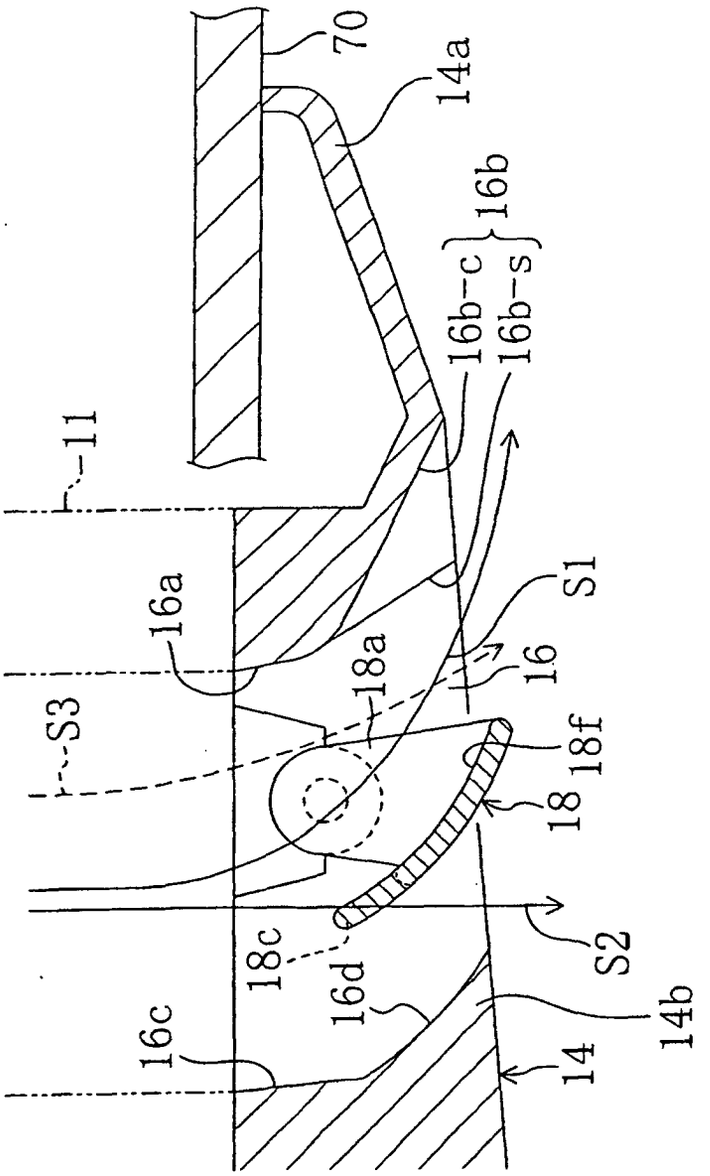

70
14a
16b
16b-c
16b-s
11
S1
16a
16
18a
S3
18f
18
S2
18c
16d
14b
16c
14

Fig. 4

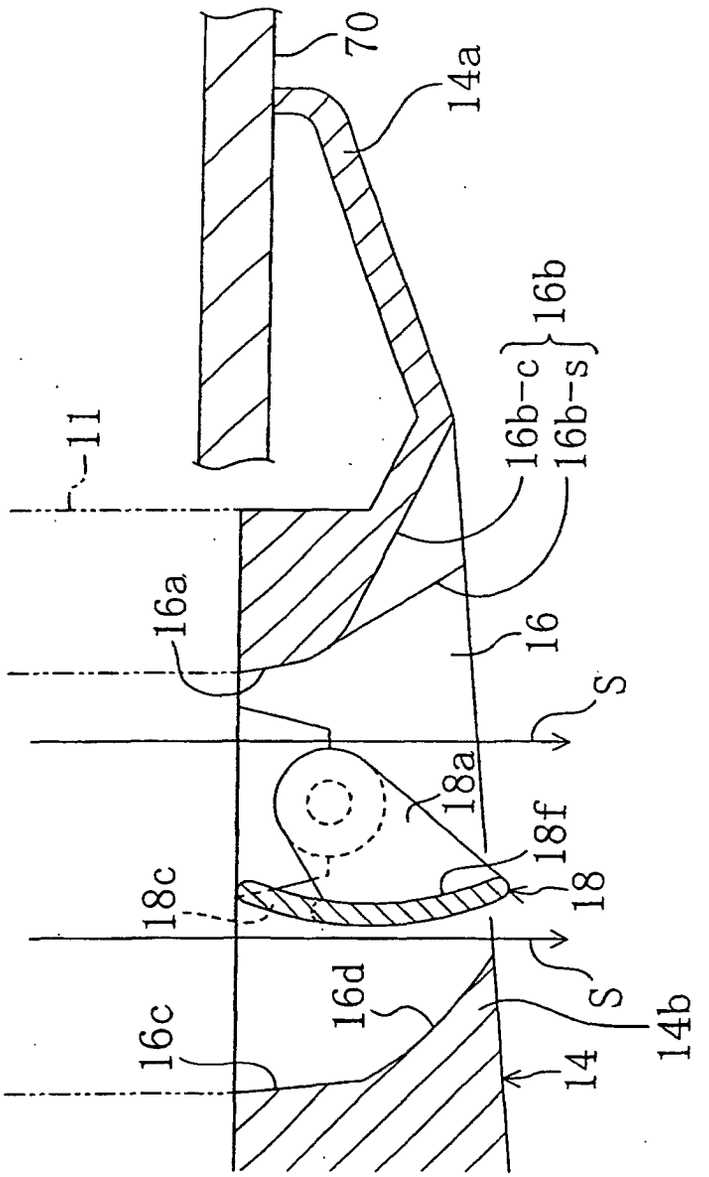


Fig. 5

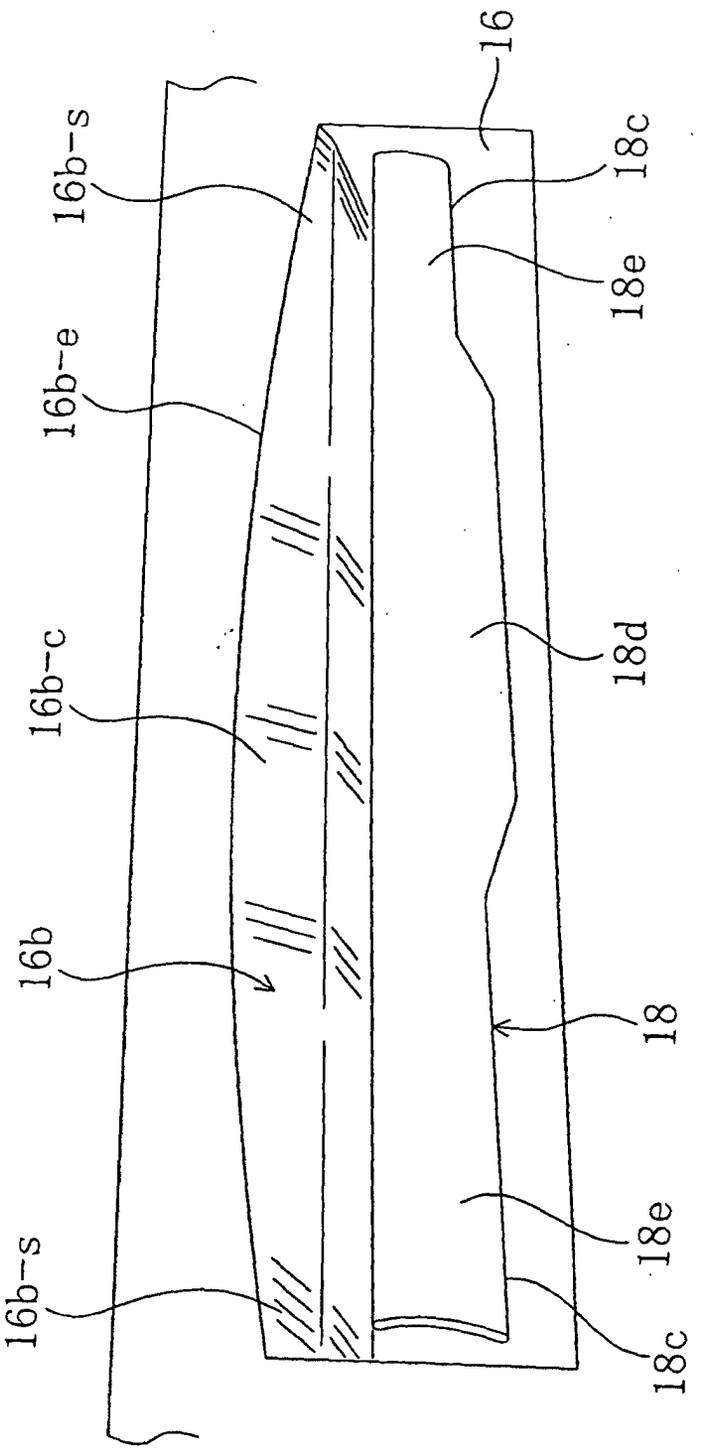


Fig. 6

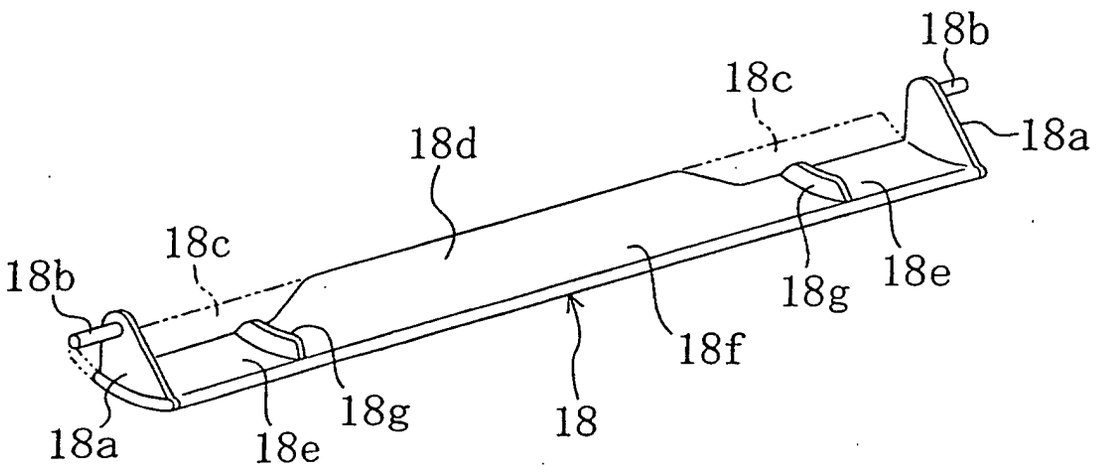


Fig. 7

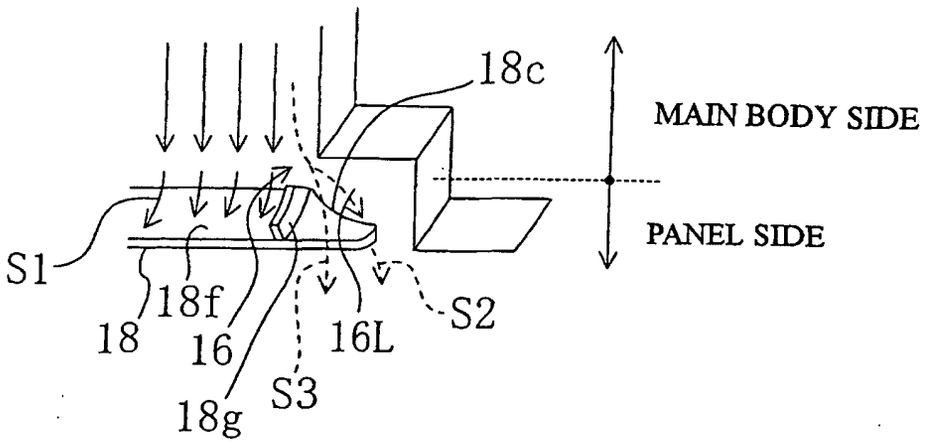

18c
MAIN BODY SIDE
PANEL SIDE
S1
18
18f
16
18g
S3
16L
S2

Fig. 8

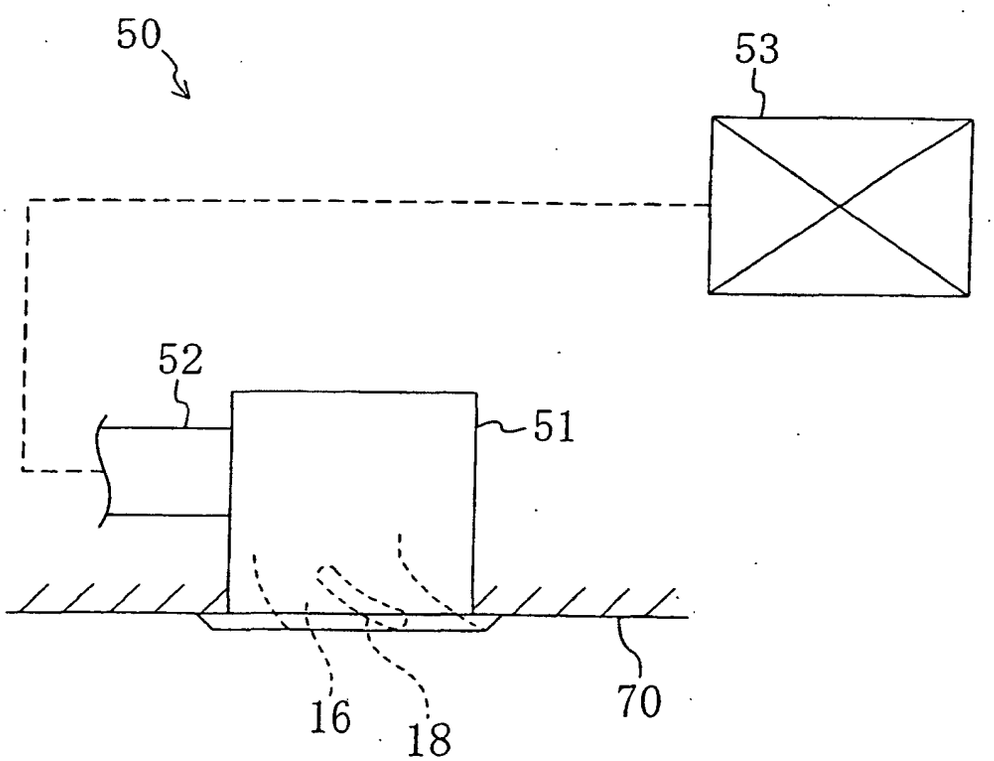

50
53
52
51
16
18
70

Fig. 9A

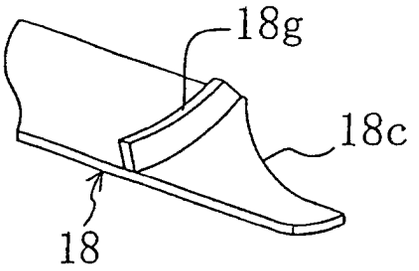


Fig. 9B

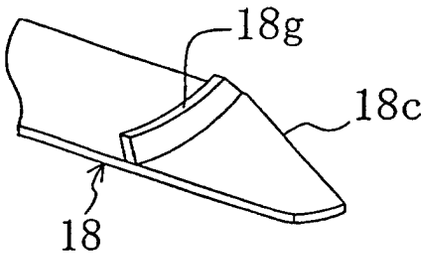


Fig. 9C

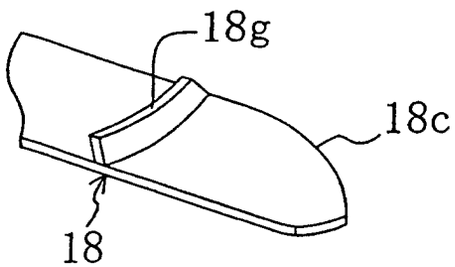


Fig. 9D

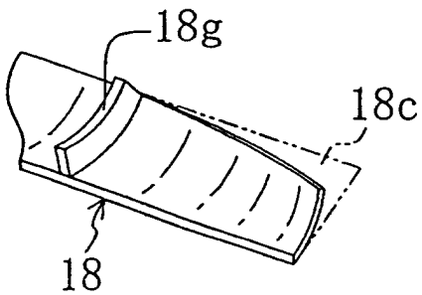


Fig. 10

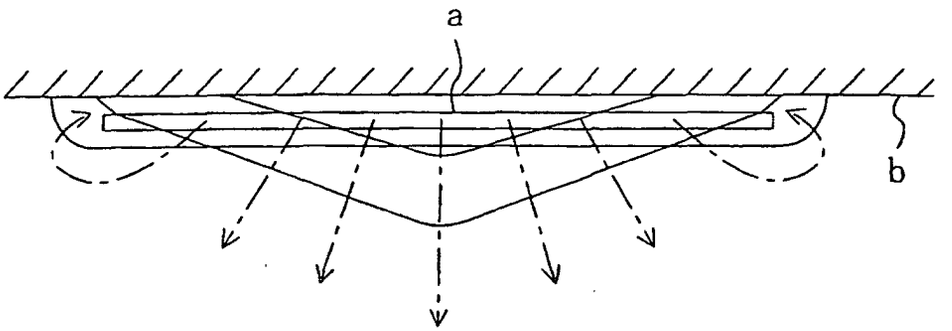
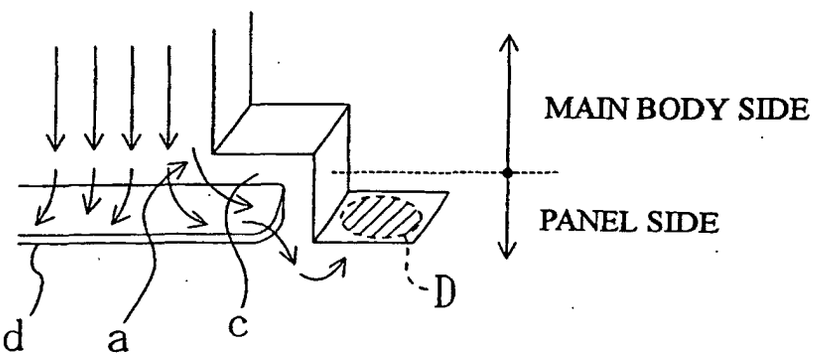


Fig. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/07504

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F24F1/00, 13/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F24F1/00, 13/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2001
Kokai Jitsuyo Shinan Koho 1971-2001 Jitsuyo Shinan Toroku Koho 1996-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 8-285303 A (Daikin Industries, Ltd.), 01 November, 1996 (01.11.96), Full text; all drawings (Family: none)	1-4 5,7-11,13,14
Y	JP 9-14742 A (Mitsubishi Heavy Industries, Ltd.), 17 January, 1997 (17.01.97), Full text; all drawings (Family: none)	5,11
Y	JP 7-12398 A (Mitsubishi Electric Corporation), 17 January, 1995 (17.01.95), Full text; all drawings (Family: none)	7-11,14
E,A	JP 2001-65911 A (Mitsubishi Heavy Industries, Ltd.), 16 March, 2001 (16.03.01), Full text; all drawings (Family: none)	1-14
A	JP 7-324802 A (Daikin Industries, Ltd.), 12 December, 1995 (12.12.95), Full text; all drawings (Family: none)	1-14

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 October, 2001 (23.10.01)	30 October, 2001 (30.10.01)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/07504

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 10-205795 A (Daikin Industries, Ltd.), 04 August, 1998 (04.08.98), Full text; all drawings (Family: none)	1-14

Form PCT/ISA/210 (continuation of second sheet) (July 1992)