SPECIFICATION

Fan Coil Unit

Technical Field

[0001]

The present invention relates to a fan coil unit that does not require cushioning materials etc. during transportation and is easy to transport and assemble.

Background Art

[0002]

Conventional fan coil units use a steel plate casing and a drain pan as structures to house a blower, a heat exchanger (coil) and a filter therein, heat insulation material is attached to an inner surface of the casing to ensure effective thermal insulation. In addition, the fan coil units vary in shape and installation method depending on installation conditions in building. Each time installation conditions changed, the casing, cushioning material and thermal insulation material required redesign and preparation.

[0003]

In said fan coil unit, "a combination steel plate and thermal insulation material" is used as a component member to prevent transmitted sound of the blower installed inside the casing and condensation due to differences in air temperature and humidity between air conditioning air after passes through a heat exchanger (coil) of air and surrounding air outside the casing, and to reduce energy loss.

In addition, cushioning materials are used to absorb

impact during transportation and movement.

[0004]

Anyway, while many fan coil units are used in air conditioning systems, in a fan coil unit, the weight of the casing is large, and furthermore, it is burdensome to prepare in advance shapes of the casing according to installation conditions. Moreover, the overall weight is large, and a large amount of cushioning material is generated and discarded after installation, which is burdensome on the global environmental footprint.

Prior Technical Literature

Patent Document

[0005]

Patent Document 1: Japanese Patent laid-open No. 2021-241830

Summary of the Invention

Technical Problem

[0006]

A purpose of the present invention is, in a fan coil unit, to replace a conventional steel plate casing and thermal insulation member with foam material so that cushioning material that was previously discarded can be eliminated, thereby significantly reducing the weight of the conventional fan coil unit, and either by integrally molding using the foam material or by molding separately and assembling, thereby to form a drain pan in the casing using the foam material to reduce the number of components, and to make assembly easier by reduced weight.

In addition, by molding the casing and the thermal insulation member using “biodegradable foam material”, they are easily decomposed in nature, contributing to a recycling-oriented society. Therefore, the purpose also includes reducing its global environmental footprint.

In addition, a drive motor driving a vibrating blower is fixed to an insert fitting embedded in the foam material.

Furthermore, in the fan coil unit, an inlet and an outlet for coil refrigerant are provided vertically, and outlets for draining water from condensation of the coil are also provided symmetrically in the vertical direction, this combination allows the coil and a fan of the fan coil unit to be used even if the coil and the fan are installed upside down when assembling and installing.

Solution to Problem

[0007]

To achieve the above purpose, the casing and the thermal insulation member of the fan coil unit are either integrally molded using the foam material or molded separately and thereafter assembled. The foam material is used as the cushioning material during transportation, and the biodegradable foam material is used as the foam material.

The attachment part of the drive motor of the blower is fixed to the insert fitting embedded in the foam material.

The inlet and the outlet for coil refrigerant of the fan coil unit are provided symmetrically in the vertical direction, and the outlets for draining water from condensation of the coil

are also provided symmetrically in the vertical direction.

Advantageous Effects of the Invention

[0008]

According to the fan coil unit of the present invention, because the casing and the thermal insulation member are either integrally molded up and down using the foam material or molded separately,(1) the overall weight is reduced,(2) transport packaging materials and transport cushioning materials are not required,(3) CO_2 emissions during manufacturing and transportation are reduced due to weight reduction, and (4) by using the biodegradable foam material as the foam material, disposed fan coil unit can be returned to the soil at the end of its operational life and product replacement, thereby reducing the global environmental footprint and contributing to the recycling-oriented society.

In addition, the attachment part of the drive motor driving the blower enhances the strength of the foam material by embedding the insert fitting in it.

In addition, a housing is not required separately, because a “blower housing”, which is a component of the fan coil unit, is integrally molded therewith using the foam material. Since the inlet and the outlet for coil refrigerant are provided symmetrically in the vertical direction, the coil and the fan of the fan coil unit can operate in either orientation depending on a taking-out direction of piping at an installation site, even if installed upside down during installation and assembly. Additionally, a drainage path for draining water from

condensation of the coil is integrally molded using the foam material, eliminating the need for a connecting pipe.

The foam material serves as casing material and at the same time as the cushioning material, and thermal insulation material, so there is no need to provide another thermal insulation member.

In addition, reduced weight of the fan coil unit makes installation easier when the unit is installed on a ceiling and used.

Brief Description of the Drawings

[0009]

FIG. 1 is a plain view of a fan coil unit of Embodiment 1, with an outer frame removed, showing centrifugal type Sirocco fans 31 mounted on both sides of a drive motor as a blower 3.

FIG. 2 is a front view of FIG. 1 with the outer frame removed.

FIG. 3 is a left side schematic view of part divided from FIG.1.

FIG. 4 is a front view of FIG. 2 with the outer frame.

FIG. 5 is a rear view of FIG. 2 with the outer frame.

FIG. 6 is an explanatory illustration showing the relationship between a motor and an insert for fixing the motor to a casing made of foam material of Embodiment 1.

FIG. 7 is a perspective view of Embodiment 2, which is a variant of Embodiment 1 and horizontally extended as a whole.

FIG. 8 is a perspective view of Embodiment 3 of the floor-standing type, which is a variant of Embodiment 1 and vertically extended as a whole.

FIG. 9 is a perspective view of vertically divided casing of

the fan coil unit of Embodiment 4, with three axial fans 32 arranged in parallel as a blower 3.

FIG. 10 is a perspective view of an assembled fan coil unit of Embodiment 4 in FIG. 9.

Description of Embodiments

[0010]

According to the present invention, in the fan coil unit, by replacing the conventional steel plate casing and the thermal insulation member with foam material, cushioning material that was previously discarded can be eliminated, thereby significantly reducing the weight of the conventional fan coil unit. Supports for component and a drain pan are formed using the foam material, either by integrally molding or molding separately and thereafter assembling. This results in a reduction in the number of components and the overall weight of the fan coil unit, thereby simplifying the assembly process of the fan coil unit.

In addition, if biodegradable foam material, such as BASF's ecovioEA® (registered trademark), is used, it can be composted and contributes to the biodegradable cycle. In addition, characteristics of ecovioEA® (registered trademark) are similar in those of EPS (Expanded Polystyrene), offering excellent energy absorption and a high modulus of elasticity under various impact loads, which makes it suitable for use as the casing material. Embodiments of the present invention are described below.

[0011]

Embodiment 1

First, Embodiment 1 of the present invention will be described with reference to FIG. 1 to FIG. 6.

Embodiment 1 is the fan coil unit 1, comprising the blower 3 using the Sirocco fan 31 that is a centrifugal blower, positioned on both sides of the drive motor 4, and the coil 5 that is a heat exchanger placed downstream of airflow.

The casing 2, that also serves as a thermal insulation member of the fan coil unit 1, is integrally molded into vertically divisible upper casing 21 and lower casing 22 using the foam material to eliminate cushioning materials during transportation, and it is desirable that the foam material is biodegradable foam material to reduce the global environmental footprint. The corrugated paper packaging material 6 is used as needed, and the outer dotted line in FIG. 1 shows the corrugated paper packaging material 6 to be used during transportation.

[0012]

In addition, the casing 2 is configured to form a continuous hollow structure, as shown in FIG. 3, and airflow (Air) is drawn through the inlet 11 by the Sirocco fan 31 placed upstream. The enlarged portion 121 which also serves as the drain pan is provided downstream of the central cavity 12 to support the coil 5, and drain water accumulated by condensation in the coil 5 during cooling is discharged through the drain water outlet 53. This drain water outlet 53 is also provided at the top of the enlarged portion 121. This configuration

allows drainage even when the fan coil unit 1 is installed upside down.

In addition, in Embodiment 1, water is used as refrigerant, with cold or hot water supplied through the lower inlet 51 and collected through the outlet 52 after being used for air conditioning, moreover the inlet 51 and the outlet 52 for refrigerant of the coil 5 in the fan coil unit 1 are provided symmetrically in the vertical direction, allowing the coil to operate even when the fan coil unit 1 is installed upside down.

In this way, the casing of the fan coil unit 1 is formed using the foam material 2. A cavity, except for the central cavity 12, is filled with the foam material 2, which also serves as structural reinforcement and thermal insulation material, ensuring airtightness.

It is desirable to reduce the number of components by integrally molding the casing whenever possible. Alternatively, components produced by molding separately can be assembled into a single unit and sealed using adhesive materials or adhesive tapes.

[0013]

[Structural Integrity Issues in Casing due to Use of Foam Material]

In the fan coil unit 1 of the present invention, forming the casing 2 and the thermal insulation member using the foam material causes issues, such as the supporting strength for the vibrating drive motor 4. Reinforcement measures addressing this issue will be explained below.

In Embodiment 1, if a fitting leg of the drive motor 4 is the same as that of the motor used in the current ceiling-suspended concealed type fan coil unit (SCR), the insert fitting 41 —having concave and convex shape shown in FIG.6— is used to fix the motor. The fixing bolt 42 is vertically attached to this insert fitting 41, and the recess of the insert fitting 41 is formed to be embedded in the foam material 2 during foam molding. After that, the drive motor is fixed by inserting the fixing bolt 42 into the motor support fitting 43 and fastening the nut 44.

Here, by enlarging the part of the insert fitting 41 into which the foam material is embedded, the contact area between the insert fitting 41 and the foam material 2 can be increased, which enables the load of the blower 3 and the motor 4 to be distributed more evenly, even when the fan coil unit 1 is installed upside down.

[0014]

Next, physical properties of the entire EPS (Expanded Polystyrene) used in the fan coil unit 1 will be considered.

When equipped with the same internal components as the conventional ceiling-concealed type fan coil unit 1, the main heavy components are the coil 5 and the blower 3. For medium-sized fan coil unit 1, each of these components weighs 4.0 kg.

When the foaming ratio of EPS is 30 times, its bulk density is 33.3 kg/m^3, flexural strength is 0.55 MPa, and compressive elastic modulus is 10 MPa. Meanwhile, in the current fan coil

unit, hot-dip galvanized steel plate SGCC with a thickness of 0.8 mm is adapted to the casing, and its physical properties include the elastic modulus of 205 GPa, a density of 7860 kg/m^3, and a yield point of 205 MPa.

Therefore, when the thickness of the casing 2 at the section where the coil 5 is mounted is 25 mm, the amount of deflection of the casing 2 caused by the coil 5 —when calculated under the assumption of a two-ends support with an equally distributed load— is 2/3 of the current product, this ensures sufficient strength.

In the case of ceiling-suspended concealed type fan coil unit 1, depending on the specification and a shape of a hanging bracket for hanging the fan coil unit 1, stress may be concentrated in the vicinity of the hanging bracket, potentially causing deformation or damage to the casing. Therefore, as shown in FIG. 3, it is desirable to place the angle members 15 beneath the coil 5 and the blower 3, supporting the fan coil unit 1 from underneath.

[0015]

Embodiment 2

Next, Embodiment 2 in a variant of embodiment 1 will be explained. Embodiment 2 is also of ceiling-suspended type with a horizontally extended casing same as Embodiment 1. The fan coil unit 1 may be of ceiling-suspended concealed type or ceiling-suspended exposed type or the cassette type, in which the Sirocco fan 31 of the centrifugal blower is also used as the blower 3 and the coil 5 is arranged diagonally.

As shown in FIG. 7, airflow drawn by the Sirocco fan 31 through the front inlet 11 passes through the coil 5 for air conditioning and is then supplied to the living room through the rear outlet 13.

While this is otherwise the same as Embodiment 1, the casing 2 of the fan coil unit 1 in this type is also made using the foam material. Areas not involved in airflow are filled with the foam material, which also serve as the thermal insulation material ensuring airtightness.

[0016]

Embodiment 3

Next, Embodiment 3 in a variant of Embodiment 1 will be explained. Embodiment 3 is the fan coil unit 1 of floor-standing type with a vertically extended casing. The fan coil unit 1 is of the SFR floor-standing concealed type or a floor-standing exposed type, in which the Sirocco fan 31 of the centrifugal blower is also used as the blower 3 and the coil 5 is arranged diagonally at the top of the blower 3.

As shown in FIG. 8, airflow also drawn by the Sirocco fan 31 through the inlet 11 on the front of the floor, passes through the upper coil 5 for air conditioning, and is then supplied to the living room from the outlet 13 at the top. While this is otherwise the same as Embodiment 1, the casing 2 of the fan coil unit 1 in this type is also made using the foam material. Areas not involved in airflow are filled with the foam material, which also serves as thermal insulation material ensuring airtightness.

[0017]

Embodiment 4

Next, Embodiment 4 will be explained with reference to FIG. 9 and FIG. 10, in which three axial fans 32 are arranged in parallel as the blowers 3.

FIG. 9 is a perspective view of the casing 2 of the fan coil unit 1 divided into the upper casing 21 and the lower casing 22 according to Embodiment 4, and FIG. 10 is a perspective view of the fan coil unit 1 assembled with the upper casing 21 and the lower casing 22.

In Embodiment 4, three axial fans 32 are used as the blower 3. Upstream of air, the filter 7, the coil 5, and the perforated metal plate 8 are arranged in that order. The three axial fans 32 are positioned in parallel near the outlet 13 for air. This type allows for a shorter front-to-back distance, resulting in more compact fan coil unit 1.

The casing 2, that also serves as the thermal insulation member for the fan coil unit 1, is integrally molded into vertically divisible upper casing 21 and lower casing 22 using the foam material, the foam material can be used as cushioning material during transportation. This eliminates the need to dispose of the cushioning material during installation. Furthermore, using the biodegradable foam material as the foam material helps to reduce the global environmental footprint when the fan coil unit 1 is eventually discarded.

[0018]

In addition, as shown in FIG. 9 and FIG. 10, the casing

2 is formed as a hollow structure. Airflow (Air) is drawn through the inlet 11 for air, and the enlarged portion 121 is provided downstream of the central cavity 12. The coil 5 is supported centrally by the casing 2. This enlarged portion 121 also functions as the drain pan, allowing drain water accumulated due to condensation of the coil 5 to be discharged through the drain water outlet 53.

This drain water outlet 53 is also provided at the top of the enlarged portion 121. This configuration allows drainage even when the fan coil unit 1 is installed upside down.

In addition, the inlet 51 and the outlet 52 for refrigerant(water) of the coil 5 in the fan coil unit 1 are provided symmetrically in the vertical direction. Cold or hot water as refrigerant is supplied from the lower inlet 51, and water used for air conditioning is collected from the outlet 52. This configuration allows the coil to operate even when the fan coil unit 1 is installed upside down.

In this way, the casing 2 of the fan coil unit 1 is made of the foam material, and areas not involved in airflow are also filled with the foam material, which serves as structural reinforcement and thermal insulation material, and ensure airtightness.

It is desirable to mold this casing 2 integrally whenever possible, but it is also possible to mold separately and thereafter assemble into a single unit to seal using adhesive materials or adhesive tapes.

[0019]

According to the configuration of Embodiments 1 to 4 of the present invention, the casing which is made using the foam material and the thermal insulation member are either integrally molded top and bottom or assembled into a single unit after being molded separately. Subsequently, the entire assembly is molded again using the foam material. In addition, regarding the fan coil unit 1, the casing 2 is made using the foam material, and areas not involved in airflow are filled with the foam material 2 which serve as the thermal insulation material, to ensure airtightness. As a result, the overall weight of the fan coil unit 1 can be reduced.

In the fan coil unit 1, by using the foam cushioning material for the casing 2 and as the thermal insulation material, it is possible to eliminate the cushioning material that was previously discarded, and the weight of the fan coil unit can be dramatically lighter than conventional weight, and either by integrally molding the casing 2 and the thermal insulation member, or by molding them separately and thereafter assembling, supports for component and drain pans can also be formed using the foam material. Therefore, by reducing the weight, the number of components can be reduced and the assembly process can be simplified.

Furthermore, molding the cushioning material using the "biodegradable foam material" enhances its ability to decompose naturally, thereby contributing to the recycling-oriented society and reducing the global environmental footprint.

[0020]

As a result,

(1) Since the casing and the thermal insulation member are integrally molded using the foam material or molded separately and thereafter assembled, the "blower housing" and transport packaging materials and transport cushioning materials which were previously discarded are no longer required, (2) CO_2 emissions during manufacturing and transportation are reduced due to weight reduction, (3) On-site installation of the fan coil unit 1 is facilitated due to weight reduction, and (4) By using the biodegradable foam material as the foam material, the disposed fan coil unit can be returned to the soil at the end of its operational life and product replacement, thereby reducing the global environmental footprint and contributing to the recycling-oriented society.

In addition, because the inlet 51 and the outlet 52 for refrigerant (water) of the coil 5 are provided symmetrically in the vertical direction, they can be used even when the coil 5 of the fan coil unit 1 and the blower 3 are installed upside down during assembly and on-site installation, and since the drainage path from condensation of the coil is integrally molded using the foam material, another drainage connecting pipe is not required. Since the drain water outlets 53 are provided at upper and lower parts, drain water can be drained even when the fan coil unit 1 is installed upside down.

Since said foam material is used to form the casing 2, and at the same time serves as both cushioning material and thermal insulation material, there is no need to provide the

thermal insulation member separately. In addition, reduced weight of the fan coil unit 1 makes installation easier when the unit is installed on the ceiling and used.

Descriptions of Symbols

[0021]

1…Fan coil unit, 11…Inlet for air, 12…Central cavity, 121…enlarged portion, 13…outlet for air, 15…angle member, 16…Duct fixing fittings, 2…Casing (thermal insulation member) (foam material), 21…Upper casing, 22…Lower casing, 3…Blower (Sirocco fan 31, axial fan 32), 4…Drive motor, 41…Insert fittings for motor fixation, 42…Fixing bolt, 43…Motor support fittings, 44…Nut, 5…Heat exchanger (coil), 51…Inlet for refrigerant, 52…Outlet for refrigerant, 53…Drain water outlet (upper and lower, respectively), 6…Corrugated paper packaging material, 7…Filter, 8…Perforated metal plate.

Claims

1. A fan coil unit comprising a casing and a thermal insulation member,

wherein the casing and the thermal insulation member are integrally molded using foam material or molded separately and thereafter assembled, and

wherein said foam material is biodegradable foam material and used as cushioning material during transportation, and

wherein an attachment part of a drive motor of a blower is configured that an insert fitting is embedded in the foam material and a support fitting of said drive motor is fixed to said insert fitting.

2. The fan coil unit according to Claim 1,

the fan coil unit further comprising:

an inlet and an outlet for coil refrigerant of the fan coil unit provided symmetrically in the vertical direction; and

outlets for draining water from condensation of the coil provided symmetrically in the vertical direction; and

wherein the fan coil unit can be operated in either orientation depending on a taking-out direction of piping, when installed upside down.