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(54) PREFABRICATED MODULE AIR CONDITIONER

- (71) We, TAKASAGO NETSUGAKU KOGYO KABUSHIKI KAISHA (TAKASAGO THERMAL ENGINEERING CO., LTD.), a Japanese Corporation, of No. 2, 4-chome, Kanda-Surugadai, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- This invention relates to an air conditioning unit and more particularly it relates to a cassette type prefabricated module air conditioner suitable for installation inbetween the ceiling and the floor above of a building structure.
- According to the present invention there is provided an air conditioning unit for a room, comprising an outer casing generally of box shape and open at its end that is to be its bottom end in use, this casing being removably attachable through an opening in a ceiling to a holding member secured in advance to an upstairs floor, for being accommodated within a ceiling space defined by the ceiling and the floor above; an upper inner casing having a shape similar to said outer casing and received within said outer casing at a spacing therefrom for forming therebetween an air passage for conditioned air, said upper inner casing having an upper opening formed in its wall that is its top wall in use and having its end that is its bottom end in use open; a lower inner casing generally of box shape fitted to said upper inner casing and having two openings formed in the outer portions of the wall thereof that is the upper wall in use; a compressor box secured to the remaining inner portion of the upper wall of said lower inner casing whereby two vacant spaces are formed at both sides thereof between the side walls thereof and the side walls of said lower inner casing, said vacant spaces having fluid communication with the inside of said upper inner casing through said openings; two air filters removably received respectively in said vacant spaces for filtering air passing therethrough; a diffuser removably attached to the bottom wall of said compressor box for covering a

substantial area of the bottom end of said outer casing; conditioning means disposed in the inside of said upper inner casing for conditioning air passing therethrough; actuating means disposed within said compressor box for actuating said conditioning means to effect the conditioning operation; and blower means for introducing ambient air through said diffuser and said air filters thereby to force this air to pass through said conditioning means and for supplying conditioned air through said air passage; access to the inside of said air conditioning unit being obtainable for inspection and repair through said vacant spaces by removing said diffuser and at least one of said filters.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a vertical cross-sectional view of the main part of an air conditioning unit,

Figure 2 is a horizontal sectional view taken along line II—II of Figure 1,

Figure 3 is a vertical sectional view of an air conditioning unit similar to that of Figures 1 and 2,

Figure 4 is a side vertical sectional view of the unit of Figure 3,

Figure 5 illustrates apparatus for hanging the units of Figures 1 to 4 from a ceiling,

Figures 6 and 6A, 7 and 7A, and 8 and 8A show various forms of blower, each in diagrammatic side view and in section on a line X—X,

Figures 9 and 10 illustrate a detail of the units of Figures 1 to 4, and

Figure 11 is a perspective view illustrating piping structure used to supply water to and drain water from the air conditioning units of Figures 1 to 4 when installed for operation.

Referring first to Figures 1 and 2, in the air conditioning unit shown therein, an outer casing A1 generally of box shape having its end that is its bottom end in use open, contains a blower housing 1 and a blower fan 2. A blower motor 3 for the fan 2 is disposed within an upper inner casing A2 which has removably fitted thereto a lower inner casing A3, each inner casing being generally of box shape. The upper inner casing A2 has a central opening A2' in its upper wall, its bottom end being open. The lower inner casing A3 has two openings A3' formed in the outer portions of its upper wall, its bottom end also being open. As can be seen from Figures 1 and 2, opposed side walls of the inner casings merge into the corresponding side walls of the outer casing such that the air passage that is disposed between the outer casing and the inner casings is generally inverted U-shaped. A heat exchanger 4 in the inner container A2 acts as an evaporator during cooling or as a

condenser during heating, and there is further provided a drain pan 5, a drain pipe 6, a compressor box 7 secured to the inner portion of the upper wall of the container A3 between the openings A3', a high pressure cut off switch 8, a low pressure cut off switch 9, a reversing valve 10, a rotary compressor 11, a refrigerant accumulator 12, a heat exchanger 13 acting as a condenser during heating or as an evaporator during cooling, a water inlet 14 for heat source, a water outlet 15 for heat source, an air filter 16, a diffuser 17, and a deflector 18.

Figures 3 and 4 illustrate the essential components of an air conditioning unit similar to that of Figures 1 and 2. In this unit, the compressor box 7 is covered all around with light weight sheet metal, the centre of gravity of the whole being concentrated on the central part of the unit thus providing an extremely compact unit. Consequently, not only the number of frames is reduced, the material cost decreased, and support of the main body of the air conditioner (as described hereinafter) made easy, but also the stability of the unit is much improved. In these Figures, 20 is an upper lid having the same form as a main frame 19, 21 a partition, 22 front and back plates, 23 a top plate, 24 an air vent, 25 a lower partition, 26 an air delivery outlet, 27 a suction inlet, 28 a diffuser, 29 hanging bolts fixed on the side brackets 30 of the box 7 and securable at their upper ends to a ceiling to hang the unit, and 31 is a cover plate. References A1, A2 A2', A3 and A3' show features of the unit of Figures 3 and 4 that are comparable with features of the unit of Figures 1 and 2.

Referring to Figure 5, either of the units so far described can be hung from a ceiling in the manner illustrated in this Figure. In the Figure 32 is an inverted L-shaped steel bracket, to the horizontal limb 33 of which the unit is suspended through the intermediary of a connecting plate 35'. The horizontal limb 33 is attached to the ceiling structure B by hanging bolts 34. A connecting plate 36 is fixed to the vertical limb 35 to hold the fittings used for the connection of water pipes and electric wires to the air conditioning unit, 37 and 38 being connecting pipes provided with valves 39 and 40, 41 is a connecting pipe used for draining, and 42 is an electric socket.

Referring next to Figures 6 and 6A, 7 and 7A, and 8 and 8A, which show various embodiments of the blower that can be employed in the air conditioning units described above, and first to Figures 6 and 6A, here the fan of the blower is at the centre of a horizontally symmetrical S-shaped air delivery unit having outlets in two opposite directions, to facilitate uniform air delivery. In these Figures 101 is a casing, 102 a rotating shaft, 103 the fan and 104 the air delivery outlets.

Figures 7 and 7A show a blower in which right and left air delivery outlets are disposed stepwise. Here 105 is an upper casing, 107 a lower casing and 108 a suction inlet. The blowers of Figures 6 and 6A, and 7 and 7A, are mounted in the unit so as to divide the air passage between the outer and inner openings into two with the blower outlets delivering one into each of the two passage portions.

Figures 8 and 8A show an embodiment of the casing body of the blower made of a rigid foamed material having good heat insulating effect and excellent damping effect. In these Figures, 109 is a casing body, 110 a peripheral part, 111 an air suction inlet having an appropriately curved form (R-shaped), 112 an axial bore, and 113 an air delivery outlet.

Figures 9 and 10 illustrate how the rotary compressor is installed inside the box 7 so as to minimise vibrations and undesirable noise. In the Figure, 114 is a cushioning material such as glass wool placed on the bottom of the box 7, 115 a fixing plate attached by a downward protrusion 116 and an upward protrusion 117, shown also in Figure 27, to the cushioning material 114, 118 is a cushioning material such as glass wool, held in place by an L-shaped holder 119 fixed to the wall of the box 7, 120 is a flexible tube, and 121 is a spring located between upper and lower brackets 122.

Finally, and referring to Figure 11, the units can be installed for operation as shown in this Figure, wherein 152 is a pair of inversed L-shaped metal hanging brackets, 153 are horizontal limbs thereof, 154 is a fixture used to hang a controller to the unit outer casing A1, 155 is a plate permitting free adjustment of the hanging fixture 154 to the front or to the rear and to the left or to the right, 156 is a fixing plate attached to the vertical limbs of the brackets to reinforce them and to retain them in place, 158 and 159 are fittings used to connect supply pipes, 160 and 161 are curved pipe sections, 162 is an opening for receiving a water drain pipe, 163 is an opening for receiving a water supply pipe, and 164 and 165 are a flexible water drain pipe and a flexible water supply pipe respectively making it possible to fix the outer casing A1 at a desired height during removal or installation of the casing.

Each of the air conditioning units described above is a compact cassette type prefabricated unit. Each unit is an air conditioning unit for a room, comprising an outer casing A1 generally of box shape and open at its end that is to be its bottom end in use, this casing A1 being removably attachable through an opening in a ceiling to a holding member secured in advance to a floor above, for being accommodated within a ceiling space defined by the ceiling and the floor

above — see Figure 1 wherein the ceiling space is referenced S. Fresh air inlet ports shown in dotted lines in Figure 2, disposed in the vicinity of the filters 16, open into this space S for allowing passage of fresh air therethrough into the filters, this fresh air having been supplied into the ceiling space from outside the room. The unit further has an upper inner casing A2 having a shape similar to the outer casing A1 and received within the outer casing at a spacing therefrom for forming therebetween an air passage for conditioned air, the upper inner casing A2 having an upper opening formed in its wall that is its top wall in use and having its end that is its bottom end in use open; a lower inner casing A3 generally of box shape fitted to the upper inner casing A2 and having two openings A3' formed in the outer portions of the wall thereof that is the upper wall in use; and a compressor box 7 secured to the remaining inner portion of the upper wall of the lower inner casing whereby two vacant spaces are formed at both sides thereof between the side walls thereof and the side walls of the lower inner casing. These vacant spaces have fluid communication with the inside of the upper inner casing A1 through the openings A3' and two air filters 16 are removably received respectively in these vacant spaces for filtering air passing therethrough. Each unit also has a diffuser 17 removably attached to the bottom wall of the compressor box 7 for covering a substantial area of the bottom end of the outer casing A1; conditioning means 4 disposed in the inside of the upper inner casing A2 for conditioning air passing therethrough; actuating means 8/9/10 disposed within the compressor box 7 for actuating the conditioning means 4 to effect the conditioning operation; and blower means 3 for introducing ambient air through the diffuser 17 and the air filters 16 thereby to force this air to pass through the conditioning means 4 and for supplying conditioned air through the air passage. Access to the inside of the air conditioning unit is obtainable for inspection and repair through the vacant spaces just mentioned by removing the diffuser 17 and at least one of the filters 16.

In the units described a pair of the side walls of the inner casings that are opposed to each other merge into the corresponding side walls of the outer casing such that the air passage that is defined between the outer casing and the inner casings is generally inversed U-shaped.

WHAT WE CLAIM IS:—

1. An air conditioning unit for a room, comprising an outer casing generally of box shape and open at its end that is to be its bottom end in use, this casing being removably attachable through an opening in a ceil-



Figures 7 and 7A show a blower in which right and left air delivery outlets are disposed stepwise. Here 105 is an upper casing, 107 a lower casing and 108 a suction inlet. The blowers of Figures 6 and 6A, and 7 and 7A, are mounted in the unit so as to divide the air passage between the outer and inner openings into two with the blower outlets delivering one into each of the two passage portions.

Figures 8 and 8A show an embodiment of the casing body of the blower made of a rigid foamed material having good heat insulating effect and excellent damping effect. In these Figures, 109 is a casing body, 110 a peripheral part, 111 an air suction inlet having an appropriately curved form (R-shaped), 112 an axial bore, and 113 an air delivery outlet.

Figures 9 and 10 illustrate how the rotary compressor is installed inside the box 7 so as to minimise vibrations and undesirable noise. In the Figure, 114 is a cushioning material such as glass wool placed on the bottom of the box 7, 115 a fixing plate attached by a downward protrusion 116 and an upward protrusion 117, shown also in Figure 27, to the cushioning material 114, 118 is a cushioning material such as glass wool, held in place by an L-shaped holder 119 fixed to the wall of the box 7, 120 is a flexible tube, and 121 is a spring located between upper and lower brackets 122.

Finally, and referring to Figure 11, the units can be installed for operation as shown in this Figure, wherein 152 is a pair of inverted L-shaped metal hanging brackets, 153 are horizontal limbs thereof, 154 is a fixture used to hang a controller to the unit outer casing A1, 155 is a plate permitting free adjustment of the hanging fixture 154 to the front or to the rear and to the left or to the right, 156 is a fixing plate attached to the vertical limbs of the brackets to reinforce them and to retain them in place, 158 and 159 are fittings used to connect supply pipes, 160 and 161 are curved pipe sections, 162 is an opening for receiving a water drain pipe, 163 is an opening for receiving a water supply pipe, and 164 and 165 are a flexible water drain pipe and a flexible water supply pipe respectively making it possible to fix the outer casing A1 at a desired height during removal or installation of the casing.

Each of the air conditioning units described above is a compact cassette type prefabricated unit. Each unit is an air conditioning unit for a room, comprising an outer casing A1 generally of box shape and open at its end that is to be its bottom end in use, this casing A1 being removably attachable through an opening in a ceiling to a holding member secured in advance to a floor above, for being accommodated within a ceiling space defined by the ceiling and the floor

above — see Figure 1 wherein the ceiling space is referenced S. Fresh air inlet ports shown in dotted lines in Figure 2, disposed in the vicinity of the filters 16, open into this space S for allowing passage of fresh air therethrough into the filters, this fresh air having been supplied into the ceiling space from outside the room. The unit further has an upper inner casing A2 having a shape similar to the outer casing A1 and received within the outer casing at a spacing therefrom for forming therebetween an air passage for conditioned air, the upper inner casing A2 having an upper opening formed in its wall that is its top wall in use and having its end that is its bottom end in use open; a lower inner casing A3 generally of box shape fitted to the upper inner casing A2 and having two openings A3' formed in the outer portions of the wall thereof that is the upper wall in use; and a compressor box 7 secured to the remaining inner portion of the upper wall of the lower inner casing whereby two vacant spaces are formed at both sides thereof between the side walls thereof and the side walls of the lower inner casing. These vacant spaces have fluid communication with the inside of the upper inner casing A1 through the openings A3' and two air filters 16 are removably received respectively in these vacant spaces for filtering air passing therethrough. Each unit also has a diffuser 17 removably attached to the bottom wall of the compressor box 7 for covering a substantial area of the bottom end of the outer casing A1; conditioning means 4 disposed in the inside of the upper inner casing A2 for conditioning air passing therethrough; actuating means 8/9/10 disposed within the compressor box 7 for actuating the conditioning means 4 to effect the conditioning operation; and blower means 3 for introducing ambient air through the diffuser 17 and the air filters 16 thereby to force this air to pass through the conditioning means 4 and for supplying conditioned air through the air passage. Access to the inside of the air conditioning unit is obtainable for inspection and repair through the vacant spaces just mentioned by removing the diffuser 17 and at least one of the filters 16.

In the units described a pair of the side walls of the inner casings that are opposed to each other merge into the corresponding side walls of the outer casing such that the air passage that is defined between the outer casing and the inner casings is generally inverted U-shaped.

WHAT WE CLAIM IS:—

1. An air conditioning unit for a room, comprising an outer casing generally of box shape and open at its end that is to be its bottom end in use, this casing being removably attachable through an opening in a ceil-



ing to a holding member secured in advance to an upstairs floor, for being accommodated within a ceiling space defined by the ceiling and the floor above; an upper inner casing having a shape similar to said outer casing and received within said outer casing at a spacing therefrom for forming therebetween an air passage for conditioned air, said upper inner casing having an upper opening formed in its wall that is its top wall in use and having its end that is its bottom end in use open; a lower inner casing generally of box shape fitted to said upper inner casing and having two openings formed in the outer portions of the wall thereof that is the upper wall in use; a compressor box secured to the remaining inner portion of the upper wall of said lower inner casing whereby two vacant spaces are formed at both sides thereof between the side walls thereof and the side walls of said lower inner casing, said vacant spaces having fluid communication with the inside of said upper inner casing through said openings; two air filters removably received respectively in said vacant spaces for filtering air passing therethrough; a diffuser removably attached to the bottom wall of said compressor box for covering a substantial area of the bottom end of said outer casing; conditioning means disposed in the inside of said upper inner casing for conditioning air passing there-through; actuating means disposed within said compressor box for actuating said conditioning means to effect the conditioning operation; and blower means for introducing ambient air through said diffuser and said air filters thereby to force this air to pass through said conditioning means and for supplying conditioned air through said air passage; access to the inside of said air conditioning unit being obtainable for inspection and repair through said vacant spaces by removing said diffuser and at least one of said filters.

2. An air conditioning unit as claimed in claim 1, wherein a pair of the side walls of the inner casings that are opposed to each

other merge into the corresponding side walls of the outer casing such that the air passage that is defined between the outer casing and the inner casings is generally inverted U-shaped.

3. An air conditioning unit as claimed in either one of the preceding claims in combination with a holding means that includes a support, and a unit carrier mounted on this support for movement thereon so that the positioning of the air conditioning unit relative to the support may be finely adjusted by moving the carrier along the support.

4. An air conditioning unit as claimed in any one of the preceding claims and further comprising fresh air intake ports disposed in the vicinity of said air filters to open, in use, into said ceiling space for allowing passage of fresh air therethrough into said air filters.

5. An air conditioning unit as claimed in any one of the preceding claims wherein said blower separates said air passage into two and is formed with two outlet ports respectively discharging into the two passage portions so formed.

6. An air conditioning unit substantially as hereinbefore described with reference to Figures 1 and 2 or Figures 3 and 4 with or without any of Figure 5 or Figures 6 and 6A or Figures 7 and 7A or Figures 8 and 8A or Figures 9 and 10 or Figure 11 of the accompanying drawings.

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