Feb. 7, 1967 N. LAING 3,302,426

AIR CONDITIONING APPARATUS

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FIG.1.

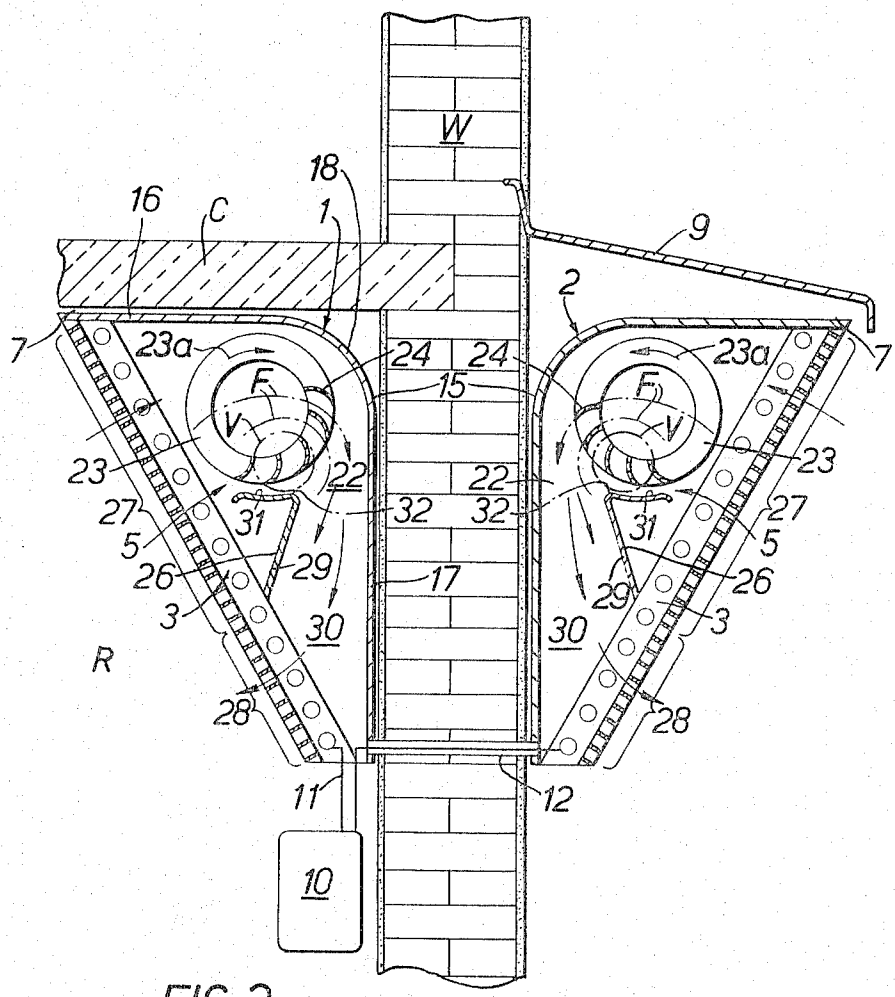
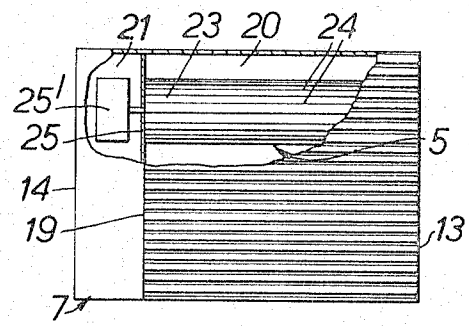


FIG.2.



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AIR CONDITIONING APPARATUS

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This invention relates to room air conditioning apparatus and to heat exchange apparatus which may form part of the room air conditioning apparatus in a preferred form thereof but which may also be made use of indedependently.

Room air conditioning apparatus, as the term will be used herein, comprises two heat exchanger blocks cooperating with a compressor to form a refrigerator wherein one block forms the condenser and the other the evaporator, air from a room being circulated by one blower through the one heat exchanger block and air from the outside atmosphere being circulated by another blower through the other heat exchanger block. Commonly, the heat exchanger block forming the evaporator is within the room so as to cool it, the other heat exchanger block forming the condenser and rejecting heat to the exterior. However the reverse arrangement is possible, the apparatus then functioning as a a heat pump.

Hitherto it has been the general practice in the air conditioning art to air condition a room either by means of a central plant common to the whole building of which the room forms part, or by means of individual room units each forming a separate self-contained air conditioner apparatus; the latter alternative has generally been regarded as the only practical possibility for older buildings not designed for air conditioning. A room air conditioner unit is bulky, and where and how to install it is often a problem. In my Patent 3,200,609 there is described a room air conditioner unit having a relatively compact block-like form which can be installed in an opening in an outside wall of the room. However, it is often not convenient to make an aperture in the wall, for example it may endanger the stability of the building or it may be unduly difficult and expensive as with some concrete walls, or it may be objectionable visually; these considerations will apply particularly when it is desired to air condition an existing building.

By contrast with previous concepts the invention provides room air conditioning apparatus comprising refrigeration apparatus having a condenser, an evaporator and a compressor connected in a closed refrigerant circuit; two heat-exchanger/blower units are provided, the heat exchanger of one unit forming said condenser and the heat exchanger of the other unit forming said evaporator, the blower of each unit causing an air flow through the respective heat exchanger to effect exchange of heat between the refrigerant therein and said air flow; and one of said heat exchanger/blower units is located inside the room and the other outside it. The only aperture required in the wall of the room is a hole sufficient for a small-bore refrigerant pipe, which can readily be bored with a drill. The heat exchanger/blower units may be located as desired, both inside the room and outside it, and also the compressor may be separately located, e.g., in a soundproof compartment; this provides a degree of flexibility in the installation of the apparatus which with conventional units has been unobtainable.

My prior mentioned patent discloses a heat exchanger/blower unit based on the concept of inducing the air flow through a rectangular heat exchanger block by means of a cross-flow blower disposed opposite thereto having its rotor parallel to one side edge of the block, the blower being such as to turn the air flow through an angle exceeding 90° between inlet and outlet areas disposed both on

the same side of the apparatus. The air may thus be made to flow through the heat exchanger over substantially the whole area thereof; flow between inlet and outlet may be made to take place at least approximately in planes perpendicular to the rotor axis, the deflection of flow in such planes occurring at least to a large extent within the rotor and without the energy losses associated with ducting.

A cross-flow blower as above mentioned is understood herein to comprise a bladed cylindrical rotor and guide means co-operating with the rotor on rotation thereof to induce a flow of air from an entry side of the rotor through the path of the rotating blades to the interior of the rotor and hence again through the path of the rotating blades to a discharge side of the rotor.

The present invention in its preferred form makes use of the concepts of my earlier invention. However, in forms of heat exchanger/blower unit illustrated in my above mentioned prior patent the rotor is located opposite one side edge of the heat exchanger and the rear wall of the apparatus defines with end walls and the heat exchanger air circulation of narrow generally triangular form with the rotor, opposite the apex of the triangle. This narrow triangular air circulation space enables two heat exchanger/blower units to be arranged back to back in a casing to form the compact block-like room air conditioner unit previously mentioned which forms the preferred embodiment of my earlier invention.

By contrast with the heat exchanger/blower unit of my above-mentioned prior patent, that of the present invention comprises a casing in the general form as seen in section of a right angled triangle with the right angle rounded off and the heat exchanger across the hypotenuse, and the blower is a cross flow blower with its rotor in the casing adjacent the rounded-off right angle and extending the length of the heat exchanger and setting up an air flow in through one part of the heat exchanger, through the rotor and out through the other part of the heat exchanger. Such a heat exchange/blower unit may advantageously form one of the units of the room air conditioning apparatus of my invention, and is well suited to location in the angle formed by the ceiling and one wall of the room, one side of the triangle lying adjacent the ceiling and the other against the wall. In this way the unit occupies virtually no useful space, and is ideally placed to draw in and cool the hottest air in the room, and to deliver the cooled air in a manner promoting favourable air circulation in the room and also the physiological comfort of the occupants of the room.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings in which:

FIGURE 1 is a vertical cross-section of one outside wall of a room showing apparatus for air conditioning the room installed on the wall, and

FIGURE 2 is an elevation of one heat exchanger/blower unit forming part of the air conditioner apparatus, with a portion broken away to show interior parts.

Referring to the drawing, part of an outside wall of a room R is show at W, together with the ceiling C of the room.

Room air conditioning apparatus is shown comprising a pair of generally similar heat exchanger/blower units designated generally **1**, **2** each including respectively a rectangular heat exchanger block **3** and a cross flow blower **5** mounted within a casing **7**, the unit **1** being mounted in the room in the corner formed by the ceiling C and wall W, and the unit **2** being mounted outside the room under a hood **9** which protects it from the weather. The air conditioning apparatus further comprises a com-

pressor 10 illustrated only diagrammatically and connected by piping 11 with the heat exchanger block 3 in a closed circuit, so that these elements form a refrigeration apparatus wherein the heat exchanger block 3 on the room side of unit 1 forms the evaporator and the heat exchanger block of the external unit 2 the condenser: the piping extends through a bored hole 12 in the wall W.

The casing 7 of each heat exchanger/blower unit 1, 2 comprises a pair of parallel vertical end walls 13, 14 and a rear wall 15 extending between them and having horizontal and vertical portions 16, 17 interconnected by a rounded intermediate portion 18. The casing 7 is subdivided by a vertical partition wall 19 parallel to the end walls into a main compartment 20 and a motor compartment 21. The heat exchanger block 3 extends across the main compartment 20 between the walls 13, 19 and between the free edges of the rear wall 15. In cross-section through the main compartment 20 the casing 7 defines an air circulation space 22 which has the form of a right-angled triangle with the right angle rounded off and the heat exchanger block 3 across the hypotenuse.

The horizontal rear wall portion 16 is shorter than the vertical portion 17, and the upper acute angle of the triangle is smaller than the lower angle. The cross flow blower 5 has its rotor 23 in the larger part of the air circulation space 22, i.e., nearer the upper acute angle of the triangle and adjacent the wall portion 16. The rotor 23 comprises a series of similar forwardly curved blades 24 supported on end discs 25 one of which is mounted flexibly (as by a rubber bushing, not shown) on the end of the shaft of a motor 25' in the motor compartment 21, the other end disc being mounted flexibly on an end bearing (not shown) carried by the casing end wall 13. The rotor 23 extends substantially the whole distance between the walls 13, 19: when energized the motor 25 rotates the rotor 23 in the direction of the arrow 23*a*.

A guide wall 26 extends the length of the main compartment 20 and towards the rotor 23 from the heat exchanger block 3 which it divides into a larger rectangular inlet portion 27 and a smaller rectangular outlet portion 28. The guide wall 26 comprises an outlet portion 29 defining with the vertical rear wall portion 17 a diffuser 30 leading from the rotor 23 to the outlet portion 28 of the heat exchanger block 3. Adjacent the rotor 23 the guide wall 26 has a portion 31 which is bent back towards the heat exchanger block and defines with the rotor a gap 32 which in the embodiment shown is slightly convergent in the direction of rotor rotation. The guide wall 26 and the rear wall 17, which are both well spaced from the rotor 23, form guide means which co-operate with the rotor on rotation thereof in the direction of the arrow 23*a* to set up and stabilize a vortex of Rankine type having a core region interpenetrating the path of the rotating blades of the rotor adjacent the guide wall portion 31, this core region being indicated schematically at V. The vortex sets up a flow of air through the inlet portion 27 of the heat exchanger block 3, twice through the path of the rotating blades of the rotor 23, and through the diffuser 30 and the outlet portion 28 of the block: the lines F indicate schematically the general direction of air flow, which takes place in vertical planes parallel to the end walls 13, 19 of the main compartment 20.

The above-described arrangement of the heat exchanger blower unit 1 is well adapted for its position in the corner formed by the ceiling C and wall W. Physically the unit 1 takes up a minimum of space, with the vertical and horizontal portions 16, 17 of its rear wall close against the ceiling and wall. From the air flow point of view, the heat exchanger block inlet portion 27 is ideally placed to take warm air from adjacent the ceiling, where it collects by natural convection, and discharge it after cooling in a generally downward direction outwardly from the wall W, so as to promote air circulation in the room and the comfort of its occupants.

The compressor 10 has been shown purely diagrammatically and may be of conventional type. While it may be convenient to have the compressor separate from the heat exchanger/blower units, for example so that it can be installed in a sound-insulated enclosure, it is to be understood that the compressor can also if desired form part of one of the heat exchanger/blower units. Thus the motor compartment may be enlarged to contain the compressor.

The room air conditioning apparatus described may be used as a heat pump to warm the room, by putting the condenser in the room and the evaporator outside it. The heat exchangers can be made interchangeable in function, and reversing valves provided so that the same apparatus can serve alternatively for cooling or heating the room.

I claim:

1. Room air conditioning apparatus comprising refrigeration apparatus having a condenser, an evaporator and a compressor connected in a closed refrigerant circuit; two heat exchanger blower units and the heat exchanger of one unit forming said condenser and the heat exchanger of the other unit forming said evaporator, the blower of each unit causing an air flow through the respective heat exchanger to effect exchange of heat between the refrigerant therein and said air flow, one of said units being inside the room and the other outside the room, and wherein at least one heat exchanger blower unit comprises a casing in the general form as seen in section of a right angled triangle with the right angle rounded off and the heat exchanger across the hypotenuse, and the blower is a cross flow blower with its rotor in the casing adjacent the rounded off right angle and extending the length of the heat exchanger and setting up an air flow in through one part of the heat exchanger, through the rotor and out through the other part of the heat exchanger.

2. Apparatus as claimed in claim 1, wherein of the two acute angles in said right-angled triangle one is larger than the other and the rotor lies adjacent to said larger angle.

3. Apparatus as claimed in claim 2, wherein said one part of the heat exchanger is larger than said other part.

4. Apparatus as claimed in claim 1, wherein said one heat exchanger/blower unit is mounted immediately under the ceiling of the room, with one side of said triangle adjacent thereto and the other against an adjacent wall surface.

5. Heat exchange apparatus comprising a casing having end walls and a rear wall extending between the end walls and having two portions at a right angle to one another joined by a rounded intermediate portion, a rectangular heat exchanger block extending across the casing between the end wall and the rear wall, a cylindrical bladed rotor within the casing extending between the end walls, a guide wall extending between the heat exchanger and the rotor on the side thereof opposite the rounded intermediate rear wall portion and dividing the heat exchanger block into an inlet portion and an outlet portion, the rotor on rotation in a given direction co-operating with the guide wall and rear wall to set up a flow of air transverse to the rotor axis through the inlet portion of the heat exchanger block, twice through the path of the rotating blades of the rotor and out through the outlet portion of the heat exchanger block.

6. Apparatus as claimed in claim 5, wherein the outlet portion of the heat exchanger block is smaller than the inlet portion thereof.

7. Apparatus as claimed in claim 5, wherein one of said rear wall portions is smaller than the other and said rotor is mounted nearer said smaller portion.

8. Apparatus as claimed in claim 5, wherein the guide

wall and rear wall define a diffuser leading to the outlet portion of the heat exchanger block.

9. For mounting in an angle, heat exchange apparatus comprising a casing having generally parallel end walls and a rear wall the casing as seen in cross section having the general form of a right angled triangle with the right angle rounded off, a rectangular heat exchanger block across the front of the casing and forming the hypotenuse of the triangle, guide wall means extending between the end walls and towards said rounded-off right angle from midway in the heat exchanger block and dividing the latter into an inlet portion and an outlet portion and a bladed cylindrical rotor co-operating with said rear wall and guide wall means on rotation in a given direction to induce a flow of air transverse to the rotor axis through the inlet portion of the heat exchanger block, twice through the path of the rotating blades of the rotor and out through the outlet portion of the heat exchanger block.

10. For mounting in an angle, heat exchange apparatus comprising a casing having generally parallel end walls and a rear wall the casing as seen in cross section having the general form of a right angled triangle, a rectangular heat exchanger block across the front of the casing and forming the hypotenuse of the triangle, guide wall means extending between the end walls and towards the right angle from midway in the heat exchanger block and dividing the latter into an inlet portion and an outlet portion and a bladed cylindrical rotor cooperating with said rear wall and guide wall means on rotation in a given direction to induce a flow of air transverse to the rotor axis through the inlet portion of the heat exchanger block, twice through the path of the rotating blades of the rotor and out through the outlet portion of the heat exchanger block.

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