

Feb. 12, 1957

R. E. ROSEMAN

2,780,929

AIR COOLED UNIT AIR CONDITIONER

Filed March 7, 1956

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Fig. 2

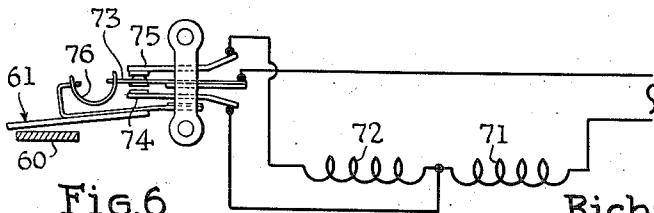
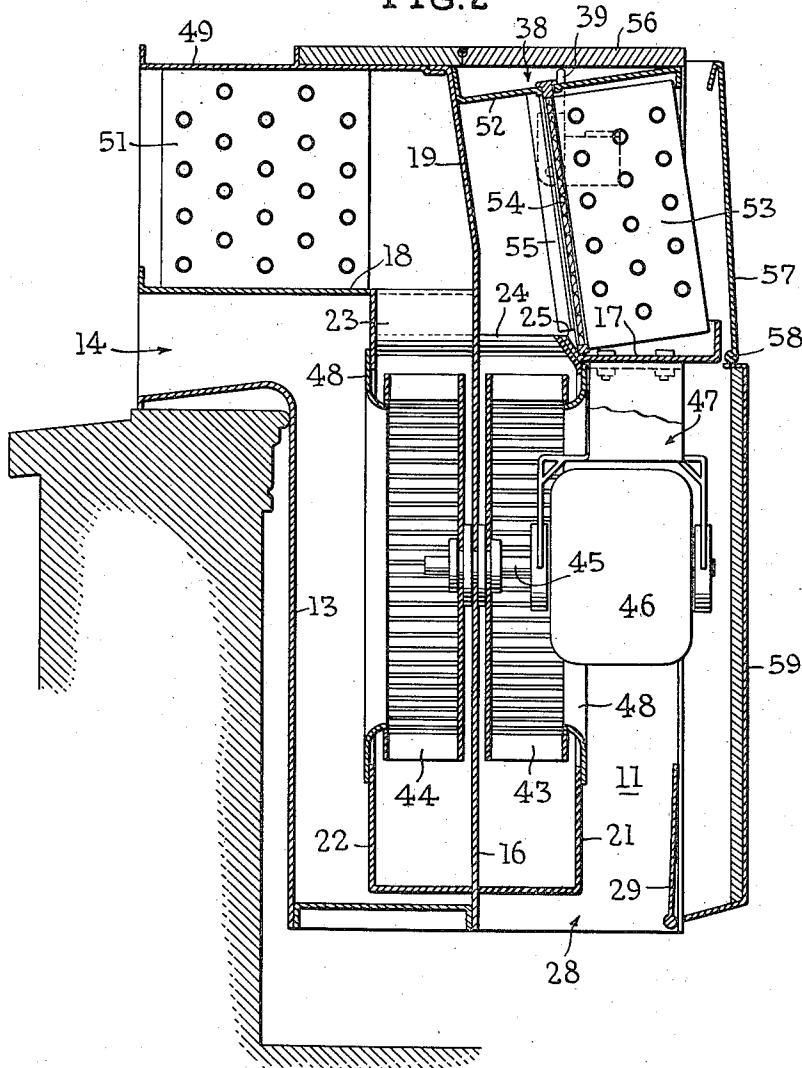


Fig. 6

INVENTOR
Richard E. Roseman

BY

Rodger *Att. Invs*

ATTORNEYS

Feb. 12, 1957

R. E. ROSEMAN

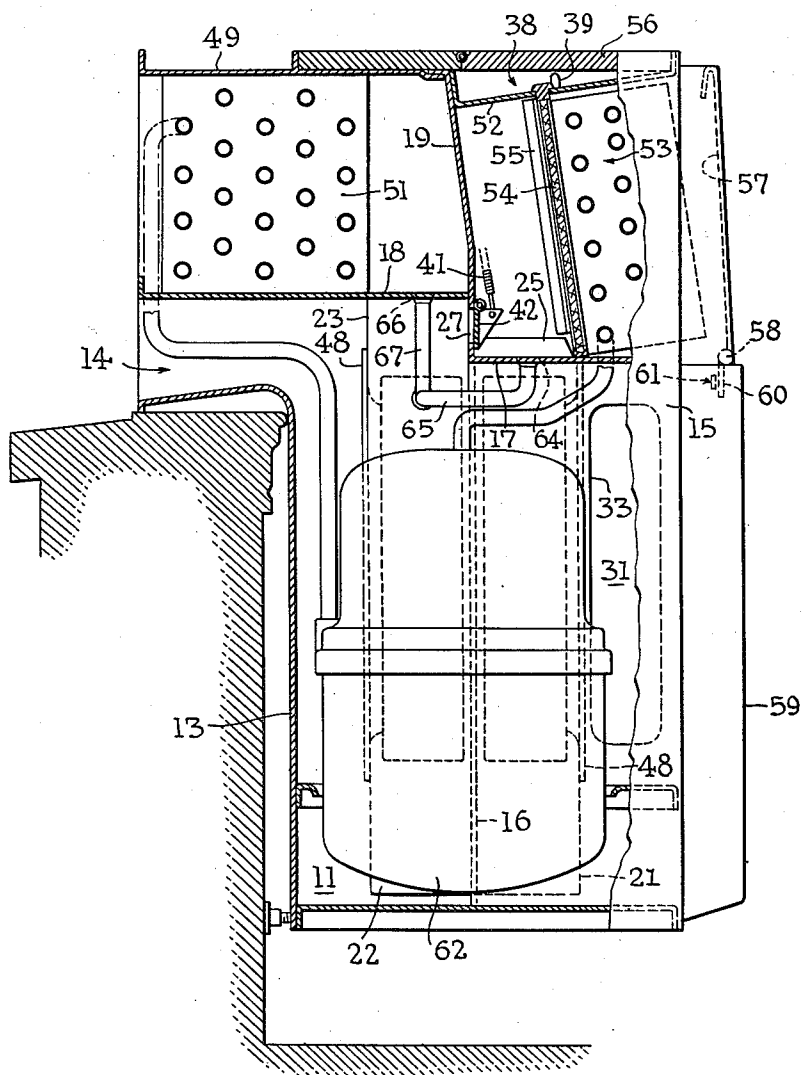
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Fig. 3



INVENTOR

Richard E. Roseman

BY

Doyle and Inn

ATTORNEYS

Feb. 12, 1957

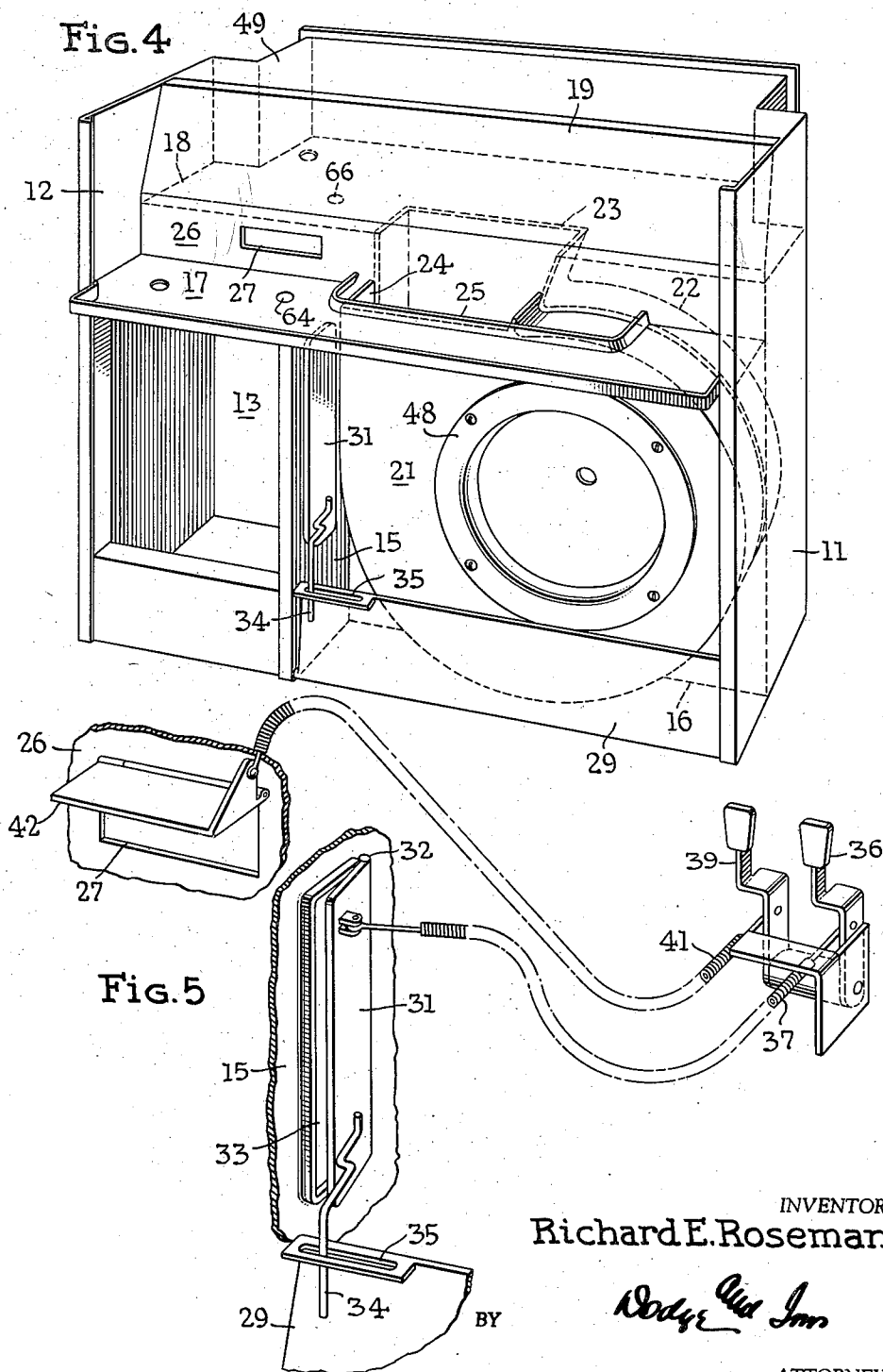
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2,780,929

AIR COOLED UNIT AIR CONDITIONER

Richard E. Roseman, York, Pa., assignor, by mesne assignments, to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

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8 Claims. (Cl. 62—129)

This invention relates to air conditioners of the type in which the machine housing is wholly within the room against the wall and spaced above the floor, the machine being suspended by the condenser air duct which rests on a window sill and reaches not quite to the inner plane of the lower sash (assuming a double hung window).

This arrangement has a number of outstanding advantages particularly as compared with conventional consoles. The condenser air duct need not be adjustable. The lower sash can be closed and locked while the machine is in position (but shut down). The obstruction of the window is only for the height of the condenser air duct and condenser plenum. The entire machine is completely protected from the weather when the window is closed and only slightly exposed when the window is open. The unit is adaptable to use with casement windows. It may be wholly or partly recessed in the wall and pass the condenser air streams through an opening in the wall provided for that purpose. Finally installation and removal are safe and easy to perform.

Units having such a combination of qualities were not practicable until it became possible to reduce greatly the size and weight of the unit. This has now been done, and the cubage of the present one horsepower unit is less than half that of a commercial floor mounted one horsepower console which it replaces. While part of the advantage arises from the high efficiency hermetic compressor, significant space-saving comes from mounting this with its shaft vertical. Great economy of space is had by the use of a new duplex variable speed fan unit, characterized by large-diameter single-eye runners of short axial dimension mounted in large diameter snail shell housings. Finally the mounting of the heat-exchangers (condenser and evaporator) at the top of the unit, immediately above the fans and extending horizontally parallel with each other and with the wall, saves space and reduces the problem of drip-disposal to the ultimate of simplicity.

Closely related to the mounting of the evaporator and condenser is the use of a longitudinal vertical partition, parallel with the wall of the room, to divide the space within the main housing into two spaces one containing the evaporator fan and the other containing the condenser fan. These spaces underlie respective plenum spaces.

Removal of the front panel gives direct access to the front space and to the entire machine, except the condenser fan runner, and reveals the fact that the available space is efficiently utilized, but not objectionably crowded. For example, in the illustrated preferred embodiment, the snail shell fan housings discharge directly into the plenum spaces which respectively enclose the condenser and evaporator. Internal duct work is conspicuously absent.

The fan motor has been described as variable in speed. Slowing the fans increases the latent heat cooling of room air but reduces the total refrigerative effect. Since the condenser fan and the evaporator fan are driven in unison the system remains nearly enough in balance to prevent

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freeze-ups, even at slower speed. Somewhat similar controls have been used in the past, but as used heretofore, slowing of the evaporator fan reduced the velocity of air discharge into the room, with attendant impairment of the induced room-air circulation. In the conditioner about to be described, air leaving the evaporator passes through an adjustable tapering nozzle extending the width of the machine. The fan speed control and the means for adjusting nozzle taper are so interconnected that as the fan is slowed, and hence as less air is discharged into the room, the nozzle is constricted so as to maintain the velocity of air discharge at a useful level, and preferably substantially unchanged.

The invention will now be described by reference to the accompanying drawings which show one commercial embodiment. In the drawings:

Fig. 1 is a front elevation of the machine as it appears with the lower front panel removed.

Fig. 2 is a section on the line 2—2 of Fig. 1.

Fig. 3 is a section on the line 3—3 of Fig. 1.

Fig. 4 is a perspective view of the main housing with the snail shell fan housings in place. The dampers which control the flows of fresh and recirculated air are shown. The pump-out opening is shown, but not the adjustable damper which controls it.

Fig. 5 is a perspective view of the pump-out opening, with its damper, the fresh air opening with its damper, the related return air damper (which controls inflow through an open portion of the bottom of the main housing), and two manual damper-controls.

Fig. 6 is a wiring diagram for the fan control.

In these views conventional sound insulating linings and coatings are omitted, though they are used.

In the above views, some details not of patentable moment have been omitted, to simplify the disclosure. Selection of satisfactory expedients is within the skill of the art.

The main housing (see particularly Fig. 4) comprises end plates 11 and 12, a back plate 13 which is curved over to form the bottom of the condenser air inlet passage 14 (see Figs. 2 and 3). A vertical cross partition 15 forward of a longitudinal partition 16 divides the compressor space from the evaporator fan space. The longitudinal vertical partition 16 extends between end plate 11 and the rear edge of the cross partition 15 and divides the evaporator fan space at the front of the machine from the condenser fan space which is at the rear. As viewed in plan the compressor space and the condenser fan space form a single L-shaped chamber. The partition 16 is one of the most significant and distinctive features of the invention and has led to remarkable simplicity of form with attendant saving of space and material.

The evaporator fan space and the compressor space are separated by a horizontal pan 17 from the evaporator plenum which is immediately above the pan. A horizontal partition 18, at a higher level than pan 17 forms the bottom of the condenser plenum, overlies the condenser fan space and is connected with the end plates 11, 12. The inclined upper portion 19 of partition 16 above horizontal partition 18 separates the evaporator plenum from the condenser plenum.

The snail shell 21 for the evaporator fan and the snail shell 22 for the condenser fan are mirror duplicates except that shell 22 has a somewhat longer discharge neck 23 to reach the condenser air opening formed through the partition 18 which is at a higher level. The shell 21 has a shorter neck 24 which reaches through the evaporator air opening in the evaporator drip pan 17. This opening has an upstanding rim 25 for water retention purposes. It should be observed that the partition 16 extends up to and is connected with partition 18, and though the portion

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of it below pan 17 ends at partition 15, there is an extension 26 above pan 17 which extends from partition 15 to end plate 12. In this extension 26 the pump-out opening 27 is formed.

It is convenient structurally, to have the two snail-shell housings mirror duplicates supported by the partition 16, but they need not be. They could differ in dimension and be otherwise supported. The illustrated construction has obvious advantages.

As best shown in Fig. 2 the bottom of the main housing forward of partition 16 and between partition 15 and end plate 11, is open to afford a return-air passage indicated at 28. Flow through this can be modulated by adjusting damper 29 which is hinged at its lower edge to move from its fully open position shown in Fig. 2 to a flow restricting position in which its free, upper edge is against snail shell 21. In this last setting it does not completely close the return-air inlet. Damper 29 is actuated by the fresh air damper 31 which is hinged at 32 to partition 15 and controls a port 33 through that partition. The dampers are connected by a pin 34 on damper 31 working in a slot 35 carried by damper 29.

As damper 31 moves from closed position in its opening direction, damper 29 is moved in its closing direction. This permits proportioning the mixture of fresh and recirculated air. Damper 31 is actuated by lever 36 through the Bowden wire unit 37. Lever 36 is in a space 38 to the right of the evaporator plenum. A second lever 39, also in space 38 is connected by a Bowden wire unit 41 with the hinged pump-out damper 42.

Opening of damper 31 connects the air inlet passage 14 through the condenser fan spaced behind partition 16 and thence through the compressor space to the left of partition 15 with the inlet eye of evaporator fan 21. Opening of damper 42 connects the discharge side of evaporator fan 21 with the inlet eye of condenser fan 22 so that the fans act in series and a rapid pump-out is assured.

In snail shell 21 there is a single-eye runner 43 whose radial dimension greatly exceeds its axial dimension. Similarly in snail shell 22 there is a single-eye runner 44 whose dimensions in the example illustrated are approximately the same as those of the runner 43. The two runners are mounted back to back on a drive shaft 45 which is driven by a variable speed motor 46. The motor 46 is hung in a bracket 47 beneath the drip pan 17. This is considered the simplest possible way to drive the fan runners in unison, but the same effect can be secured in other ways. The significant fact is that they are driven in unison.

The snail shells 21, 22 have each an entrance shroud ring 48. These favor smooth flow to the corresponding fan runner. Removability is necessary to permit removal of the corresponding runner. The discharge neck 23 of snail shell 22 delivers condenser cooling air directly into the space above horizontal partition 18. This is the combined condenser plenum and condenser air discharge duct. It is closed at the top by plate 49 and it and the duct 14 terminate in a plane vertical open face spaced inward a short distance from the plane of the inner face of the window sash. To fill out the portions of the window opening at the sides of the structure which encloses the condenser air paths some window board or other conventional closure (not illustrated) would be used.

A finned tubular condenser 51 is mounted above partition 18 in the path of discharging air.

Above pan 17 is the evaporator plenum of which the back is defined by plate 19, the top by plate 52 and the ends by the end plates 11 and 12 of the main housing. The evaporator 53 is of the finned tubular type and overlies the front portion of pan 17. The pan collects the drip water resulting from dehumidification of air. Snail shell 21 discharges into the space behind evaporator 53 and air discharging therefrom flows first through a filter 54 and thence forward in heat-exchange relation with the evaporator tubes. The filter 54 is mounted in edge

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guides 55 and may be withdrawn upward. A hinged cover 56 may be opened to give access to the filter, and also to controls, such as the damper levers 36 and 39 which are illustrated and other conventional controls which are not shown (such as the compressor switch and adjusting means for a thermostatic controller, when used, and the like). A removable panel 59 closes the front of the housing.

Air, cooled and dehumidified by heat exchange with evaporator 53, discharges at the front of the evaporator. It is desired that this air discharge upward at considerable velocity so as to induce air circulation in the room and assure immediate tempering of the cold dry air by mixture with the room air. To this end, a door or baffle 57 hinged at 58 along its lower edge to the main housing, forms the adjustable front member of an air-discharge nozzle.

There is an optimum value for the velocity of air discharge, and to keep the discharge velocity at or near this value the door 57 is connected with means to vary the speed at which at least fan runner 43 is driven. With a constant speed fan, restriction of the nozzle would tend to increase the velocity of discharging air. To neutralize this tendency means are provided to slow the fan as the nozzle front 57 moves in a closing direction. As a practical matter this has to be done in steps when the fan runner is electrically driven. Hence the door 57 carries a lug 60 projecting below the axis on which the door is hinged to engage the actuator 61 of a toggle switch which controls the speed of motor 46. The control circuit is diagrammed in Fig. 6, and the toggle switch is there shown in plan.

In Fig. 6 two field windings of motor 46 are indicated at 71 and 72. The switch, which is of known commercial form, has a movable contactor 73 which shifts to close selectively against contacts 74 and 75, a reversing bias being afforded by the spring 76.

When door 57 is drawn forward to open the nozzle wide, lug 60 moves inward and shifts actuator 61 inward. Contactor 73 closes against contact 74. Only winding 71 is in circuit and the fan motor 46 runs at full speed. When the door 57 is partly closed and the nozzle slot is restricted lug 60 has moved forward permitting actuator 61 to move forward. The switch contactor 73 engages contact 75, both windings 72 and 71 are in circuit and the fan motor 46 operates at reduced speed. Two speeds illustrate the principle, and ordinarily are sufficient. More can be provided by means familiar in the motor control art, should closer graduation be desired.

The control is so proportioned that the velocity of air discharging from the nozzle remains uniform, so that the room air is induced to circulate at an acceptable rate.

The condenser 51, and evaporator 53 are connected in a compressor, condenser evaporator circuit with the hermetically sealed compressor 62. To control flow of liquid refrigerant from the condenser to the evaporator, use is made of a fixed restrictor (not shown), so that the compressor is the only moving part in the circuit. Such circuits are in extensive use in the conditioner art and hence detailed illustration and description are not needed.

Water condenses from the air on evaporator 53 and drips to pan 17, whence it drains via port 64 and tube 65 into the condenser fan snail shell 22, and is carried upward by the air stream to condenser 51 where it is re-evaporated and blown out-of-doors with the condenser air. If any water precipitates on partition 18 from any source it drains via port 66 and drain tube 67 to the condenser fan snail shell to be sprayed by the condenser fan runner. Various schemes to improve the spraying of drip by a condenser fan are known, and any preferred one may be used.

The basic operative principle of the conditioner conforms to well known practice. Air, drawn from the room by the evaporator fan either alone or mixed with air from out of doors, is forced to flow in heat-exchange relation with the evaporator and then is discharged into the room

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in such direction and at such velocity that circulation in the room is stimulated, and the cold dry air leaving the evaporator is tempered by mixture with room air.

At the same time, air drawn from out of doors is circulated in heat-exchange relation with the condenser. This air, after exchange of heat with the condenser, is discharged out of doors. Drip water which condenses on the evaporator is fed to the condenser air stream and is there re-evaporated by heat from the condenser. As a consequence, both the heat and the moisture which are withdrawn from the conditioned space are removed by way of the condenser air stream.

The most important aspect of the invention is a co-ordinated arrangement of the essential components of a unit air conditioner, to utilize effectively the space within the housing while giving that housing proportions which render it reasonably inconspicuous and adapt it to mounting upon a window sill or beneath a window of conventional form. Modifications of proportion are obviously possible, but the arrangement shown is based on a long and careful study of the problem, and is believed to mark a substantial advance in the art.

What is claimed is:

1. For use in a room adjacent a wall having an opening to external space, an air conditioner comprising in combination a housing which (described with reference to its operative position) is substantially a parallelepiped closely adjacent the wall and of small horizontal dimension measured away from the wall and of larger vertical and horizontal dimensions parallel with the wall, said housing having an extension subdivided into two ducts for communicating with external space through the wall opening, said housing being divided by a substantially vertical partition approximately parallel with the wall into a room-air circuit space remote from the wall, and a condenser-air circuit space adjacent said wall, there also being within said housing means dividing the room-air circuit space into a fan chamber having an inlet from the room, and an evaporator plenum space having an air discharge to the room and there being also within said housing means dividing the condenser-air circuit space into a fan chamber having an inlet passage from external space through one of said ducts in said extension and a condenser plenum space having an exit through the other duct in said extension; two fans each comprising a rotary impeller whose diameter is a multiple of its axial dimension and an enclosing housing, said fans being mounted in respective fan chambers each to receive air from its fan chamber and discharge it through the corresponding plenum space, the axes of the fan impellers being horizontal and substantially normal to said vertical partition; means for driving said fans; and a refrigeration circuit comprising an evaporator enclosed in said evaporator plenum space in the path of room air flowing therethrough and a condenser in said condenser plenum space in the path of external air circulated therethrough.

2. A conditioner as defined in claim 1, in which the rotary impellers of the two fans are mounted on a motor-driven shaft which extends through the vertical partition first named.

3. A conditioner as defined in claim 1 in which the rotary impellers of the two fans are mounted on a motor-

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driven shaft which extends through the vertical partition first-named; and each fan impeller is enclosed in a corresponding volute shell, the two shells having their proximate faces on opposite sides of said vertical partition, each volute shell having an entrance eye remote from said partition.

4. A conditioner as defined in claim 1 in which the rotary impellers of the two fans are mounted on a shaft which extends through the vertical partition first-named; each fan impeller is enclosed in a corresponding volute shell, the two shells having their proximate faces on opposite sides of said vertical partition, each volute shell having an entrance eye remote from said partition; and the means for driving said fans comprises a motor at least partially received within the eye of one of said fans.

5. A conditioner as defined in claim 1 in which the evaporator plenum space is horizontal, elongated and wholly above the top of the corresponding fan; and the condenser plenum space is within the exit duct in said extension.

6. In an air conditioner, the combination of a cooling unit; a fan for circulating air into heat-exchanging relation with said unit and then discharging it into a space to be conditioned; a slot nozzle through which said discharge occurs, said nozzle discharging the air in a direction and at a velocity which will induce air circulation in the space to be conditioned, and the nozzle including a part movable to adjust the area of its slot; a variable-speed motor connected to drive said fan; a controller operable to change the speed of the motor; and a connection between the movable part of the nozzle and said controller such that the motor is slowed when the nozzle opening is reduced.

7. In an air conditioner, the combination of a cooling unit; a fan for circulating air in heat-exchanging relation with said unit and then discharging it into a space to be conditioned; restricting means through which said discharge occurs, said restricting means discharging the air at a velocity to induce air circulation in the space to be conditioned; means for varying the weight of air per unit of time which is discharged through the restricting means into the space to be conditioned; and means responsive to said varying means for maintaining said discharge velocity substantially constant.

8. In a refrigerative air conditioner for a space to be conditioned, the combination of a condenser; an evaporator; a main housing enclosing the condenser and evaporator, said housing having a partition segregating said condenser and evaporator; dual fan means mounted in said housing on opposite sides of said partition for circulating cooling air through said condenser to an external space and air to be conditioned through said evaporator to said space to be conditioned; and means for varying the air delivery rate of said fans while maintaining the velocity of said air at the point of discharge into said conditioned space substantially constant.

References Cited in the file of this patent

UNITED STATES PATENTS

2,185,387	Weiland	Jan. 2, 1940
2,343,121	Eberhart	Feb. 29, 1944
2,753,699	Gannon	July 10, 1956