May 16, 1961 R. H. FOLSOM 2,984,087

AIR CONDITIONING UNIT

Filed Sept. 8, 1959

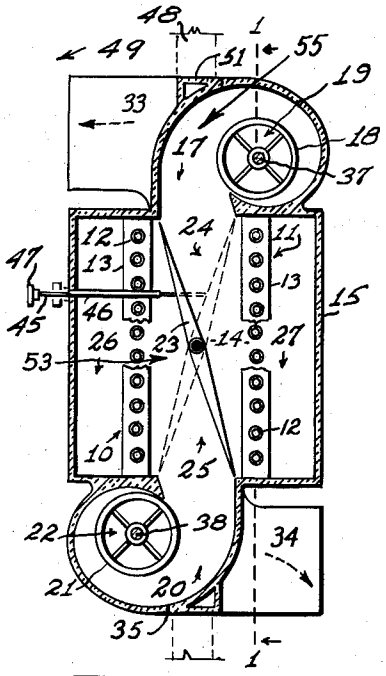

Fig. 3.

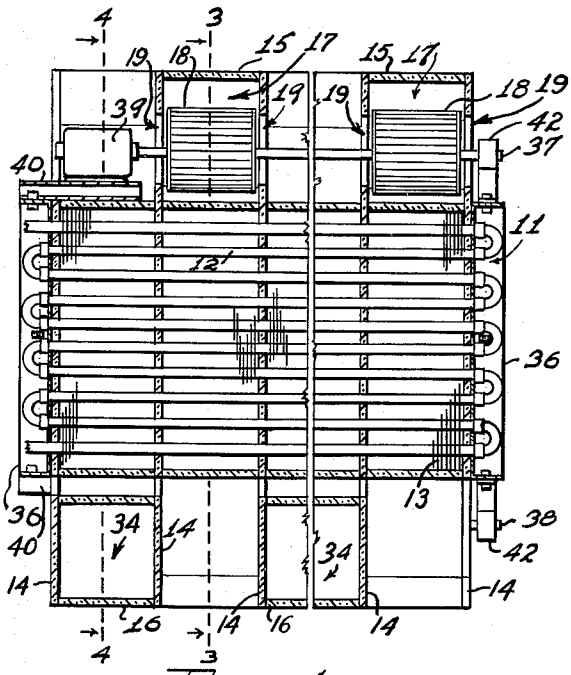

Fig. 1.

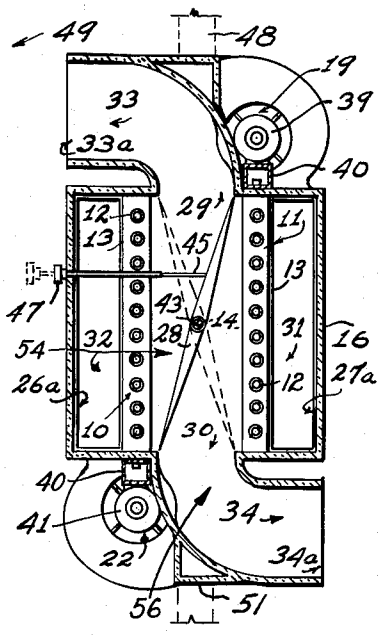

Fig. 4.

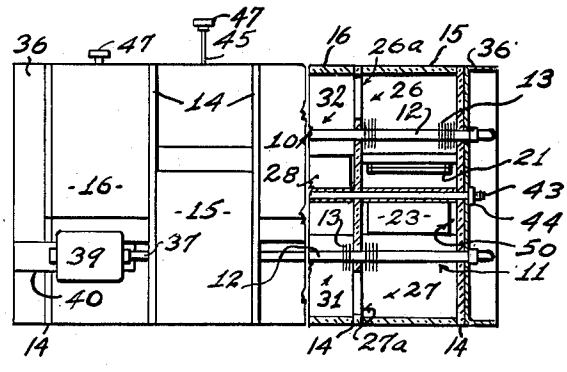

Fig. 2.

INVENTOR:

Robert H. Folsom

United States Patent Office 2,984,087
Patented May 16, 1961

2,984,087

AIR CONDITIONING UNIT

Robert H. Folsom, Los Angeles, Calif.
(15129 Hartsook St., Sherman Oaks, Calif.)

Filed Sept. 8, 1959, Ser. No. 838,636

10 Claims. (Cl. 62—325)

This invention relates to air conditioning units or plants of the type described in United States Patent No. 2,188,811 issued to me January 30, 1940, in which type of plant or unit the air to be conditioned is moved selectively over either the evaporator or the condenser while the air to be discarded is moved over the other coil. Plants or units of this type tend to be quite bulky particularly in larger sizes since the bulk increases approximately as the square of the capacity.

One of the objects of this invention is to provide air conditioning units of the class described in which the bulk increases approximately directly with the capacity.

To meet existing market conditions a manufacturer of air conditioning equipment is required to manufacture a variety of sizes of units. It is another object of this invention to provide that larger sizes of air conditioning units may be made largely from a plurality of standardized parts used in smaller units.

When a relatively large number of persons are present in a space being conditioned, or when there is considerable smoking, more of the outside air will be required to be conditioned and moved into the interior than at other times. An object of the invention is to provide air conditioning plants of the class described which while particularly adapted for recirculating and conditioning indoor air can be caused to positively supply predetermined amounts of conditioned outside air while positively exhausting corresponding amounts of indoor air.

Zone control, particularly in the heat pump type of air conditioning plants or units is one of the more important objects of this invention which provides that a unit embodying a single evaporator and a single condenser can serve two or more zones and can provide for each zone, independently of the other zones, either (*a*) cooling with recirculated air, (*b*) heating with recirculated air, (*c*) cooling with new air, (*d*) heating with new air, (*e*) dehumidifying and reheating with recirculated air, or (*f*) dehumidifying and reheating with new air.

Also it is an important object of this invention to provide, even where zone control is not required, a unit which will deliver two or more streams of conditioned air, each so individually conditioned that a space can be selectively conditioned by (*a*), (*b*), (*c*), (*d*), (*e*) or (*f*) or by combinations thereof.

In extremely cold weather the temperature differentials between adjacent parts of an air conditioning unit of the class described may be well in excess of 100 degrees F. and effective insulation and its installation becomes a problem particularly in a package type of unit which is to be installed in a home and sometimes directly in the living room. This invention has for an object to provide a type of construction for air conditioning units of the class described whereby much heat-insulating and sound-deadening material may be used in place of moisture accumulating, frost accumulating, noisy metal.

Other objects of the invention include simplicity, adaptability to mass production, flexibility of control, and a fundamental arrangement of coils, blowers, ducts

and dampers adapting the units for a wide variety of installations and locations with respect to the building or space being conditioned as well as with respect to the compressor used in plants and units of the class described for drawing refrigerant vapor from the evaporator to produce cooling and compressing the vapor into the condenser to there produce heat.

One practical embodiment of the invention is illustrated by the accompanying drawings in which:

Figure 1 is a vertical sectional view of this embodiment as seen on the line **1—1** of Figure 3 looking in the direction of the arrows.

Figure 2 is a plan view of the embodiment showing uppermost parts removed to reveal underlying parts.

Figure 3 is a sectional view seen on the line **3—3** of Figure 1 looking in the direction indicated by the arrows.

Figure 4 is a sectional view seen on the line **4—4** of Figure **1** looking in the direction indicated by the arrows.

The numeral **10** indicates a conventional condenser or condenser coil while the numeral **11** indicates a conventional evaporator or evaporator coil. Each coil is shown as being of the same size as the other and positioned in spaced parallel relationship with each other with the tubes **12, 12** horizontally disposed and the heat-transfer fins **13, 13** arranged vertically with respect to the tubes. It will be understood that a compressor (not shown) is connected to draw refrigerant vapor from the evaporator coil **11** and to compress it into the condenser coil **10**. The operating temperature taken on by each coil is governed by indoor air temperature, outdoor air temperature, and, the amount of air moved over each coil.

The evaporator is large enough to pass the relatively large amounts of outdoor winter air required to be passed over it in the heating season for efficient heat pump operation while it makes a particularly quiet and efficient cooling and dehumidifying coil when approximately half the maximum amount of indoor air is passed over it in the cooling season. Likewise the condenser is large enough to pass the large amount of warm outdoor air required to be passed over it in the cooling season while it becomes a particularly quiet and very efficient air heating coil when about half that amount of indoor air is moved over it in the heating season.

At suitably spaced intervals longitudinally of the coils there are provided spaced divider fins **14, 14**, etc., the present embodiment being shown as having five in number, each common to and supported jointly by all tubes **12, 12**. These divider fins extend both laterally and perpendicularly beyond the limits of the heat-transfer fins **13, 13**. Two encompassing walls **15, 15**, and two encompassing walls **16, 16**, are alternately arranged and fitted snuggly and right-angularly between corresponding divider fins. Encompassing walls **15, 15**, each co-operate with corresponding divider walls to enclose two spaced sets of inlet passages, generally indicated by the numerals **55, 55**, the respective parts of which are about to be designated and described. Encompassing walls **16, 16**, each co-operate with corresponding divider walls to enclose two spaced sets of outlet passages, generally indicated by the numerals **56, 56**, the respective parts of which are about to be designated and described.

The numeral **17** indicates a scroll chamber at the uppermost part of a set of inlet passages **55** while a blower wheel **18** is, operatively positioned in the scroll chamber and alined with axially opposed openings **19, 19**. The numeral **20** indicates a scroll chamber at the lowermost part of a set of inlet passages **55** while a blower wheel **21**, is operatively positioned in the scroll chamber and alined with axially opposed openings **22, 22**. Each blower wheel and the corresponding scroll chamber is designed

to discharge directly into a common damper space **53** which is between the two blower wheels when considered vertically and between the evaporator and condenser when considered transversely and between a pair of divider fins **14, 14**, when considered longitudinally of the complete embodiment and which this space is divided by a diagonal damper **23** into an inlet passage **24** leading from scroll chamber **17** and a second inlet passage **25** leading from scroll chamber **20**. The set of inlet passages being described further includes an inlet transfer passage **26** on that side of the condenser opposed to the damper chamber **53**, as well as an inlet transfer passage **27** on that side of the evaporator opposed to the damper chamber **53**.

The aforesaid set of outlet passages **56** includes a damper chamber **54** between corresponding parts of the two coils and which is divided by a diagonally disposed damper **28** into an upper outlet passage **29** and a lower outlet passage **30**. The set of air outlet passages also includes an outlet transfer passage **31** for the evaporator **11** and an outlet transfer passage **32** for the condenser. Each of the divider fins **14, 14**, etc., acts to separate a set of inlet passages **55** from a set of outlet passages **56** is provided with a full sized opening **26***a* to connect inlet passage **26** with outlet passage **32** and this divider fin **14** is also provided with a similar opening **27***a* connecting inlet transfer passage **27** with outlet transfer passage **31**.

Outlet passage **29** continues to an upper outlet passage or duct **33** while outlet passage **30** continues to a lowermost outlet passage or duct **34**. The encompassing wall **16** which cooperates with corresponding divider walls **14, 14**, to enclose the set of outlet passages **56** is interrupted at **33***a* and **34***a* to there provide outlet openings.

The combination of a set of inlet passages **56** and a set of outlet passages together with two dampers **23** and **28** and two blower wheels **18** and **21** provides, in the embodiment illustrated, that which is known herein as a zone unit. A single zone unit will provide an operative unit or plant of the class described altho a multiplicity of zone units is preferable. A nine ton (refrigeration basis) unit made up of nine zone units, as an example, will show substantially the same production cost as a single nine ton zone unit and yet have a bulk of only about one-third that of the single unit while offering great flexibility of control.

The embodiment illustrated shows two zone units or rather two sets of inlet passages and associated parts and two sets of outlet passages and associated parts. Accordingly, in the drawings, the numerals **17, 18, 19, 19, 20, 21, 22, 22, 23, 24, 25, 26, 27, 26***a* and **27***a* are repeated to designate respective parts of a second set of inlet passages and associated parts while the numerals **28, 29, 30, 31, 32, 33, 34, 33***a* and **34***a* are repeated to designate respective parts of a second set of outlet passages and associated parts.

While conventional metal construction can be used for the divider fins **14, 14**, etc. and the encompassing walls **15, 15** and **16, 16** I propose to make the divider fins **14, 14**, etc., from heat-insulating and sound-deadening sheets of cellular plastic, such as styrene or urethane foam, while the encompassing walls **15, 15** and **16, 16** are molded from similar material. Where this relatively thick and light weight material is used the encompassing walls are fitted snuggly between divider fins and are readily retained by a suitable cement (not shown) or suitable mechanical fasteners (not shown). Also the encompassing walls are readily made in sections and butted together as at **35**.

In order that this non-structural material shall carry no load other than the slight aerodynamic load to which it is subject there is provided a pair of boxed headers **36, 36**, each common to the evaporator tubes and the condenser tubes and thru which corresponding tube ends are passed and secured in the conventional manner. Thus the metal headers and the metal tubes combine to form a strong structural skeleton for other parts of the unit.

The two upper blower wheels **18, 18** are mounted coaxially on a single shaft **37** while the two lower blower wheels **21, 21** are also mounted on a single shaft **38**. Shaft **37** is driven by a motor **39** mounted on a bracket **40** supported by one of the end plates or headers **36**. Shaft **38** is driven by a motor **41** mounted on another bracket **40**. Insofar as all parts are concerned Figure 2 of the drawings could just as well be known as a bottom view of the embodiment looking upward. The other end of each shaft is carried by a bracketed bearing **42, 42**, also carried by the corresponding header so that there is no direct contact between plastic scrolls and the blower wheels and shafts contained within the scrolls. The clearance usually allowed between a double inlet blower wheel and the sidewalls of a blower scroll is sufficient to allow for expansion differentials which might set up between a coil and the blower shaft immediately above or below it.

Note that the design of each scroll is slightly modified from the conventional to suitably offset openings **19, 19** and **22, 22** to avoid their being eclipsed by ducts **33, 33** and **34, 34**. While all intermediate fins **14, 14**, etc. of a complete embodiment have the material which forms the side walls of scroll chambers as well as the material which forms the side walls of outlet ducts, the divider fin **14** which is at one extreme end of a unit does not require material to make one side wall of two scrolls while the divider fin **14** which is at the other extreme end of an assembly does not require the material to make one side wall of two ducts. It is the absence of this last named material which makes room for the motors **39** and **41** where a blower scroll is absent.

The several dampers, **23, 23** and **24, 24**, two for each zone unit, are mounted to oscillate individually on a single tubular shaft **43**. This shaft extends centrally of an assembly from end to end from header to header and is secured thereto at each of its ends as at **44** to further increase structural stability of a unit. As will be more particularly explained hereinafter, and as is understood from the teachings of the aforesaid Letters Patent, switch from heating to cooling, or vice versa, is done by moving both dampers of a zone unit from one position to the opposite position while to switch from all recirculated air to all fresh air is a matter of moving only the inlet damper **23**. While in some installations all inlet dampers **23, 23** can be connected to be actuated simultaneously and all outlet dampers **28, 28** can also be so interconnected, it is preferable for better control, and quite essential for full zone control within the scope of this invention, to have each damper individually movable. While well known electromechanical means (not illustrated) can be applied for full automatic control of the several dampers I have, for purpose of simplicity of explanation, shown each damper as individually movable from full line position to broken line position, and vice versa, by means of a spring steel wire **45, 45** passing frictionally thru a guide tube **46, 46** and terminating outwardly in a push-pull button **47, 47**. The guide tube is soldered or otherwise secured to a fin **13** of the condenser where it is free from frost.

Operation of any individual zone unit is generally as follows: An embodiment such as illustrated may be set in the roof of a building so that upper blower wheels are out-of-doors and the lower blower wheels are indoors. Again it may be set in a floor of a building so that the lower blower wheels are out-of-doors and the upper blower wheels are indoors. In Figures 3 and 4, however, the embodiment is shown as installed like a "window" unit in the wall **48** of a building or space **49** to be conditioned. Integral pads **51** provide flat surfaces for snug fits with wall **48**. The lower blower wheel **21** thus handles indoor or recirculated air while the upper blower wheel handles outside air. The lower

outlet duct 34 vents to the out-of-doors while the upper duct 33 returns conditioned air back to the interior. Best practice indicates that the indoor blower wheel 21 be driven at a lower speed than outdoor wheel 18 so that the former is quieter and moves only approximately half as much air as does wheel 18. Outside air of a predetermined minimum amount should be mixed with recirculated air and conditioned and sent to the interior. Accordingly damper 23 is provided with appreciable clearance as at 50. With dampers 23 and 28 set in full line position indoor air enters openings 22, 22 and blower wheel 21 from whence it enters scroll chamber 20 and inlet passage 25 where it is directed by damper 23 over the corresponding surfaces of condenser 10 and into inlet transfer passage 26. From here the partially heated indoor air goes thru opening 26*a*, which tends to evenly feed the air into outlet transfer passage 32 and over those portions of the condenser surfaces corresponding to the transfer passage 32. At this point it is to be noted that, by comparison with the usual single-pass condenser the coil is only one-half as deep but twice as long. After passing over condenser surfaces for a second time the now fully heated limited amount of recirculated indoor air passes into outlet passage 29 where the outlet damper 28 directs this air to duct 33 and out thru outlet opening 33*a* to the space being conditioned.

Meanwhile blower wheel 18 sends larger amounts of outside air thru scroll chamber 17 and into the inlet passage 24 where damper 23 directs this air over corresponding of the surfaces of the evaporator 11 into inlet transfer passage 27 thru opening 27*a* into outlet transfer passage 31 and back over the evaporator surfaces corresponding to transfer passage 31. Finally this air enters outlet passage 30 where damper 28 directs it thru outlet duct 34 and the outlet 34*a* whereby it returns to the out-of-doors at a point remote from where outside air is taken in. Since blower wheel 18 moves more air than blower wheel 21 the combined static pressure and velocity pressure on the outdoor side of damper 23 causes a predetermined amount of this outside air to pass thru the clearance 50 and to mix with recirculated indoor air being conditioned; this mixing taking place before the indoor air passes over the condenser surfaces in the first pass.

During certain conditions when indoor air is being heated by compressed vapor which was generated in the evaporator and compressed by the compressor (not shown) into the condenser, frost accumulates on the surfaces of the evaporator. Periodically during the heating operation, it is proposed to momentarily discontinue operation of the compressor and the outdoor blower wheels whereupon some warm recirculated air passes thru the clearance space 50 into chamber 24. While a small amount will seek to escape via the now idle wheel 18 mulch of it will more readily pass twice over evaporator surfaces to escape via outlet passage 30 and outlet opening 34*a*, thus melting frost from the evaporator surfaces and evaporating and carrying away the resultant water. To switch from heating of recirculated air to cooling and dehumidifying of recirculated air both dampers 23 and 28 are moved to broken line position. Now indoor blower wheel 21 again sends indoor air to inlet passage 25 and here the damper 23 now directs this indoor air over the evaporator surfaces into inlet transfer passage 27 then thru opening 27*a* into the outlet transfer passage 31 from where it passes over evaporator surfaces for a second time whereupon damper 23 directs this air into duct 33 to return to the interior. Meanwhile the higher pressure against damper 23 at the outdoor side causes some outdoor air to mix with the recirculated indoor air to be conditioned.

For heating all outside air for delivery into the interior, combined with exhausting indoor air, damper 23 is set in broken line position so that outdoor air is fed to the condenser while indoor air is fed to the evaporator. However outlet damper 28 remains in the usual position for heating (full line position) so that heated air from the condenser is directed back to the interior while air which has given up heat to the evaporator and is to be discarded is sent back to the out-of-doors.

For cooling all outside air inlet damper 23 is moved to full line position so that outdoor air is directed over the evaporator while the outlet damper is in broken line position to direct cooled air to the conditioned space via duct 33.

Figures 1 and 4 of the drawings show a break in the right end of the embodiment to indicate that in addition to two zone units actually shown there may be more. Where more than two zone units are provided to serve a single space in mild weather one zone unit may be on cooling and dehumidifying to control indoor dew point, a second zone unit may be heating while another may be handling all new air and either heating or cooling same as required. Where it is anticipated that one zone unit of a multi-zone unit is to handle all new air it is preferable that the outdoor air blower of that unit be originally designed, or throttled, so that it handles no more air than does the indoor blower.

As against using a multi-zone unit in a single zone or room each duct 33, 33 may be extended by conventional ducting (not shown) to a corresponding room or zone, or, where a large number of zone units are embodied in a single plant, each room may be served with one or more zone units according to the size of the room and the maximum anticipated number of occupants. Where a zone is served by only one zone unit a variety of conditions can be met by constantly changing the positions of the two corresponding dampers to give varying amounts of heated air, cooled and dehumidified air and outdoor air respectively. Constant changing of a zone unit from heating to cooling and from cooling to heating and from recirculated air to new air and back again, presents no problem since the path of the refrigerant is not changed and there are no sudden temperature changes on the part of the coils.

In the foregoing I have been specific as to construction and arrangement of parts, also as to proportions, materials, number of parts, operating methods, control methods, locations of indoor blowers and outdoor blowers, etc., etc., but only by way of making a practical disclosure of my invention and one practical embodiment thereof and not by way of defining limits to the scope of the invention which is of a broader nature as shown by the appended claims.

I claim:

1. In an air conditioning unit of the class described an air cooling evaporator coil and an air heating condenser coil in spaced parallel relationship, encompassing walls enclosing said coils and providing respectively a coextensive damper space between the coils, a coextensive air transfer space for the evaporator on the side thereof opposed to the damper space and a coextensive air transfer space for the condenser on the side thereof opposed to the damper space, transverse divider walls acting to divide the damper space into an alternate arrangement of air inlet damper chambers and air outlet damper chambers respectively and further acting to divide each transfer space into an alternate arrangement of air inlet transfer passages and air outlet transfer passages respectively with each of the air outlet transfer passages connected to receive air from the corresponding air inlet transfer passage, air inlet dampers one for and in each air inlet damper chamber acting to divide same into an indoor air inlet passage communicating with the evaporator coil and an outdoor air inlet passage communicating with said condenser, and air outlet dampers one for and in each air outlet damper chamber dividing same into an indoor air outlet passage communicating with said evaporator and an outdoor air outlet passage communicating with said condenser.

2. The air conditioning unit as in claim 1 and in which said air inlet dampers are each movable to a second position to there establish communication between the indoor air inlet passage and the condenser and between the outdoor air inlet passage and the evaporator.

3. The air conditioning unit as in claim 1 and in which said air outlet dampers are each movable to a second position to there establish communication between the indoor air outlet passage and the condenser and between the outdoor air outlet passage and the evaporator.

4. The air conditioning unit as in claim 1 and in which each air inlet damper is movable, independently of the others, to a second position to establish communication between the indoor air inlet passage and the condenser and between the outdoor air inlet passage and the evaporator.

5. The air conditioning unit as in claim 1 and in which each air outlet damper is movable, independently of the others, to a second position to establish communication between the indoor air outlet passage and the condenser and between the outdoor air outlet passage and the evaporator.

6. The air conditioning unit as in claim 1 and in which the divider walls and the encompassing walls are jointly extended beyond the indoor air inlet passages to there form indoor air inlet blower scrolls one for and delivering to each indoor air inlet passage.

7. The air conditioning unit as in claim 1 and in which the divider walls and the encompassing walls are jointly extended beyond the outdoor air inlet passages to there form outdoor air inlet blower scrolls one for and delivering to each outdoor inlet air passage.

8. The air conditioning units as in claim 1 and in which the divider walls and the encompassing walls are composed of non-metallic heat-insulating material and jointly extended beyond the indoor air inlet passages to there form indoor air inlet blower scrolls one for and delivering to each indoor air inlet passage; the unit further including blower wheels one operatively positioned in each scroll, a common shaft on which all blower wheels are mounted and bearings for said shaft supported out of physical contact with said walls.

9. The air conditioning unit as in claim 1 and in which the divider walls and the encompassing walls are composed of non-metallic heat-insulating material and jointly extended beyond the outdoor air inlet passages to there form outdoor air inlet blower scrolls one for and delivering to each outdoor air inlet passage; the unit further including blower wheels one operatively positioned in each scroll, a common shaft on which all blower wheels are mounted and bearings for said shaft supported out of physical contact with said walls.

10. The air conditioning unit as in claim 1 and in which each coil comprises tubes and fins mounted on said tubes and in which unit each divider wall is mounted on and supported by all tubes; the encompassing walls and divider walls being jointly extended beyond the air inlet passages and there forming air inlet blower scrolls one for and delivering to each air inlet passage.

References Cited in the file of this patent

UNITED STATES PATENTS

2,188,811	Folson	Jan. 30, 1940
2,216,427	Arnold	Oct. 1, 1940
2,466,383	Cody	Apr. 5, 1949