

Feb. 17, 1959

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2,873,585

AIR CONDITIONING SYSTEMS, COMBINED COOLING AND WARMING

Filed Oct. 12, 1954

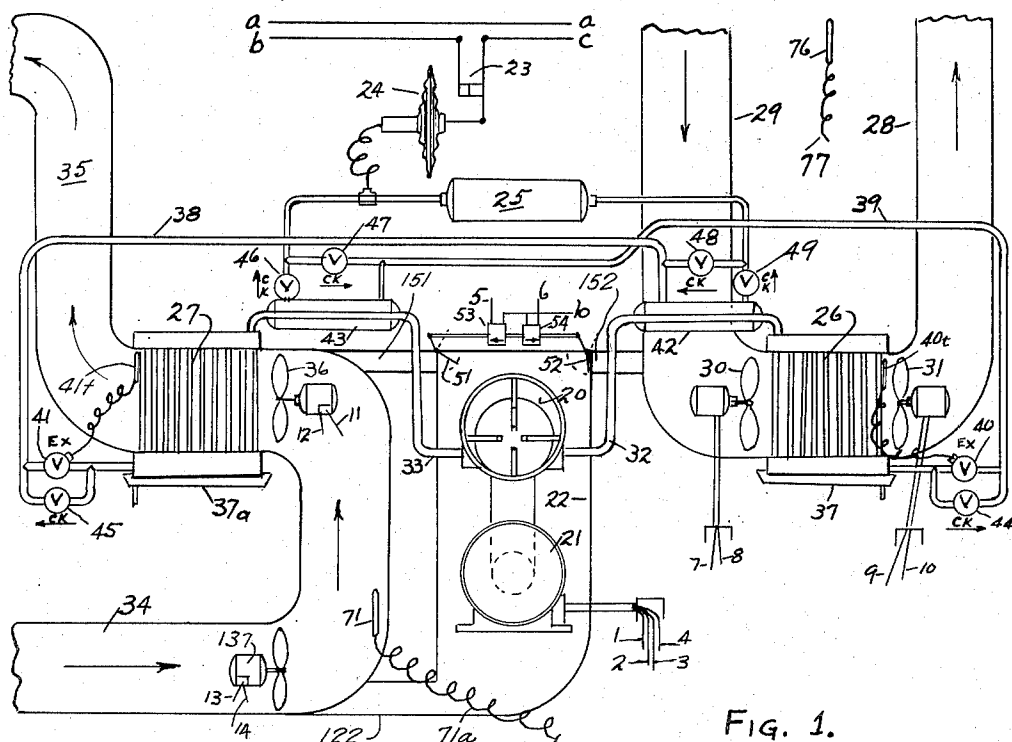


FIG. 1.

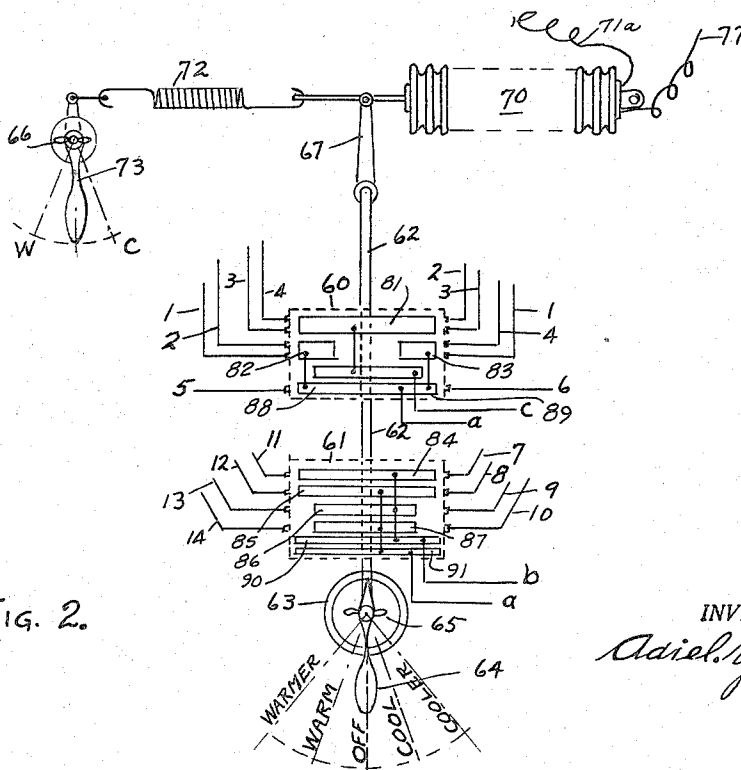


FIG. 2.

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1

2,873,585

## AIR CONDITIONING SYSTEMS, COMBINED COOLING AND WARMING

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Application October 12, 1954, Serial No. 461,707

5 Claims. (Cl. 62—179)

This invention relates to air conditioning systems employing a refrigeration cycle and means to reverse the refrigeration cycle to produce a heat engine cycle. Such reversible cycles have been proposed heretofore.

The object of this invention is to provide an improved means for reversing the cycle and controlling the cooling and heating produced by refrigeration equipment.

A further object of this invention is to provide an entirely automatic reversible cycle which may be reversed and controlled automatically or manually by one control member.

Another object is to provide a system in which all valve closures and openings necessary to reverse the cycle are accomplished automatically.

A still further object is to provide an automatic control for my reversible refrigeration cycle, one which may be manually overruled or manually operated through one single control means providing an off position, a cool position, and a cooler position, as well as warm and warmer positions.

Heretofore, it has been necessary to open and close valves manually in order to produce a reversible air conditioning system which functions both as an air cooler and an air warmer. The valves are usually capped to prevent leakage. This is scarcely an operation which might be imposed upon the general public to perform whereas I have provided means which any person could easily operate two or more times a day, if called upon to do so.

My system may be reversed from an air cooling to an air warming system, merely by turning one simple control knob. If thermostats or humidistats are employed, they may be manually overruled by turning said control knob.

I accomplish these objects and others as set forth in the following specification and drawings in which:

Figure 1 is a diagram showing my air conditioning system;

Figure 2 is a diagram showing the controls.

Figure 1 diagrammatically illustrates an air conditioning system employing an air cooled condenser and also a heat exchanger (refrigerant to air) which acts as the evaporator. Throughout the diagram, the simplest air conditioning elements are illustrated. They are arranged to work with a compressor 20, which will function as a compressor when driven in either direction, said compressor is driven by a reversible electric motor 21. Reverse switch 60 reverses this motor and compressor, thereby changes the direction of flow of the refrigerant. What was previously the refrigerant condenser becomes the refrigerant evaporator and what was the refrigerant evaporator becomes the refrigerant condenser. This reversal of flow necessitates the opening and closing of certain valves.

I have arranged my elements such that the reversal of flow automatically opens and closes check valves so that no valves need be opened or closed manually.

In this system, I have employed two sets of fans in

2

both the low temperature side and the high temperature side as a means of control. One or both fans may be operated thereby to change the amount of air being forced through the system, as will be explained later.

This air conditioning system may be made up of conventional elements used in the air conditioning art. Conventional elements are diagrammatically illustrated in both Figures 1 and 2 in which: *a* and *b* are electric power lines or wires, *c* indicates an electric line after passing through a pressure operated switch 23. 1 to 14 inclusive designate various electric wires numbered so that they may be connected to wires of like numbers to complete the electric circuits employed in these diagrams.

In Figure 1, at 20 is illustrated a reversible rotary compressor. At 21 is shown a reversible electric motor to drive the compressor 20. At 22, a closed compartment is shown containing compressor 20 and motor 21. 23 illustrates an electric switch operated by diaphragm bellows 24; excessive pressure in accumulator 25 will open switch 23.

At 26 is illustrated a heat exchanger to treat air to be delivered to the dwelling. At 27, a heat exchanger to treat air to be exhausted to the out-of-doors is shown. 28 is a duct to conduct air to the dwelling rooms. 29 is a duct to conduct air from the dwelling rooms (dwelling rooms not shown). 30 and 31 are fans to move air through ducts 28 and 29 and also heat exchanger 26.

At 34 is illustrated a duct to conduct air from the out-of-doors and at 35 a duct to conduct such air back to the out-of-doors. Air may be supplied to compartment 22 from duct 34 through a duct 122. A fan 35 is used to move air through ducts 34 and 35 and through heat exchanger 27. At 37 and 37a are illustrated drip pans to catch condensate. At 40 and 41, I have illustrated expansion valves to regulate the flow of refrigerant.

These expansion valves are provided with thermostatic controls illustrated at 40t and 41t. At 42 and 43 is illustrated auxiliary heat exchangers exchanging heat from refrigerant to refrigerant. 51 and 52 illustrate air valves connected to compartment 22 through ducts 151 and 152 to draw air from compartment 22 into either ducts 35 or ducts 28, as is desired.

At 53 and 54 are two solenoids to control valves 51 and 52 in response to and simultaneously with the operation of control switches 60 and 61, to be described later.

### Operation

**Cooling.**—Air flowing from the dwelling room through duct 29 is caused by fan 30 to pass over cold coils 26 and on through duct 28 back into the dwelling room. It is optional whether fan 31 is caused to run or not. Fan 31 is caused to run when more cooling effect is required.

During this cooling operation, compressor 20 as viewed in the diagram is turning counterclockwise, thereby to create a low pressure in tube 32, extracting refrigerant from evaporator 26 and delivering said refrigerant at high pressure through tube 33 to air cooled condenser 27.

Air is caused to flow through duct 34 from the out-of-doors through duct 35 by fan 36, plus fan 137 when fan 137 is employed. The high pressure refrigerant is cooled by the outside air through condenser 27. The refrigerant is conducted through check valve 45 and tube 38 to auxiliary heat exchanger 42 and through check valve 49 into accumulator 25. Further cooling of the condensed refrigerant takes place at heat exchanger 42. The use of heat exchangers 42 and 43 is optional; they merely increase the efficiency or the c. o. p. of the system.

Liquid refrigerant passes from accumulator 25 through check valve 47 and through tube 39 through expansion valve 40 into the evaporator 26, thus completing the refrigeration cycle necessary to cool the dwelling room.

When operating with the switch in the cool position,

3

one fan only is in use. Should the temperatures of tubes 26 decrease below a pre-determined point due to insufficient air passage, thermal element 40 will regulate expansion valve 40 to pass less refrigerant into the evaporator 26. Should the passage of less refrigerant create an over-pressure in accumulator 25, diaphragm bellows 24 will open switch 23, thereby to shut off motor 21 momentarily. The system is proportioned such that compressor 20 and motor 21 will be working at their optimum point when both fans 30 and 31 are employed.

While there are other means of regulating capacity of a cooling system, I have used this method as a simple illustration; likewise, the air cooled condenser employed is of the simplest nature requiring the least number of valves. However, it should be appreciated that a more elaborate system with more elaborate controls and more complex condensing system may be employed using the principles set forth herein, wherein certain elements are shunted when the flow is reversed, thereby eliminating the undesirable element for the operation presently functioning, to wit:

Expansion valve 41 has been automatically shunted out of the cooling operation just described. Likewise, the heat exchanger 43 has been shunted out of the operation just described by the action of the closing of check valves 46 and the opening of check valve 47.

In this illustration, I have now shown means for eliminating or shunting expansion valves and means for eliminating or shunting heat exchangers. In addition thereto, I am about to describe the means shown for changing the circulation of air over the motor 21 and the compressor 20.

During the cooling operation, heat given off by the motor and by the compressor is carried away into outdoor air. This is so because air valve 51 is open and air valve 52 is closed causing air passing from duct 34 through duct 122 and compartment 22 to flow through valve 51 and duct 151 into duct 35. Said air carries away the undesirable heat given off by these elements. During the warming operation which I am about to describe, solenoid 54 causes valve 51 to close and valve 52 to open. This is caused by the action of reverse switch 60. During the warming operation, heat given off by the motor and the compressor will be conducted through duct 152 into duct 28 and delivered to the dwelling.

This accomplishes two things. It utilizes the heat given off by these elements and also provides a desirable amount of fresh air to the dwelling. It should be understood that solenoid 53 is energized by the reverse switch when the compressor is running in the direction for cooling. Solenoid 53 is energized to close valve 52 and open valve 51. When the compressor is reversed for the warming operation, solenoid 54 is energized by the reverse switch to close valve 51 and open valve 52. These solenoids are energized by closing the proper connections as indicated by the wire numbering system used herein.

By these methods, I have provided means to close and open valves by the direction of flow of fluid and means to open and close air valves by means of solenoids, thereby to complete the several operations necessary to completely reverse the system.

*Warming.*—It is probably apparent that the warming operation is very similar to the cooling operation merely being the reverse thereof, in which compressed refrigerant is delivered to the heat exchanger 26 from the compressor 20, through tube 32 thus heating the tubes 26.

In short, I have provided means to convert a cooling system into a warming system by reversing the compressor and bringing about other changes automatically due to the direction of flow, thereby said reverse converts what was an evaporator into a condenser and converts a condenser into an evaporator.

The high pressure and high temperature refrigerant passes through tubes 26 and check valve 44, tube 39 into heat exchanger 43, where it is further cooled and through

4

check valve 46 into accumulator 25. The condensed refrigerant passes through check valve 48 into tube 38 through expansion valve 41 into tubes 27 where it is evaporated, cooling tubes 27 and the air passing thereover.

Attention is called to the fact that refrigerant cannot pass through check valve 45 since check valve 45 is closed to that direction of flow. Tubes 27 are chilled and the chill is carried to the outdoors by air passing through ducts 34 and 35 caused by the operation of fan 36, and fan 137 when desired. If only one fan is employed for the warm position, expansion valve 41 will be influenced by the thermal element 41 to limit the amount of refrigerant passing. Should too much pressure be built up in 25, pressure regulators 24 and 23 will stop the motor 21 momentarily. In the warmer control position, all fans 137 and 36, 30 and 31 are operating thereby to load the compressor to its optimum point. As previously described during this operation, solenoid 54 has opened valve 52 and closed valve 51.

*Controls.*—In Figure 2 are diagrammatically illustrated two drum type switches mounted on the same shaft 62; a control knob 63, or a control handle 64 is illustrated to revolve the shaft 62, therefore the switches 60 and 61. In the mid position as shown, all circuits are broken, no current being furnished to any of the motors or solenoids.

Each of the switches 60 and 61 includes a plurality of brushes or wipers connected to leads numbered 1 through 14 which are connected to correspondingly numbered leads in Figure 1. The brushes or wipers are engaged by contact strips 81 to 87 which are supported on rotatable cylindrical drums and which are connected to contact strips 88 to 91. Brushes or wipers *a*, *b* and *c* engage the strips 88 to 91 as shown to supply power to the different elements through the switches.

By moving handle 64 to one of the positions indicated, the drum switches are revolved to close the necessary circuits to operate the motors required as previously described.

So far, I have described the controls only as manual controls even though automatic controls may be employed. The manual control may be used to overrule the automatic control. Winged lock nut 65 may be used to lock the manual control in the position desired manually. However, when automatic control is desired, a thermostatic bulb 71 may be placed in duct 34 to be influenced by outdoor temperature. A similar bulb 76 may be placed in the dwelling room (not shown). Bellows 70 may be connected to bulbs 71 and 76 through tubes 71a and 77 to be influenced by the pressure caused by temperature in bulbs 71 and 76. High temperatures will create higher pressure in bellows 70, thereby to shift lever 67 counterclockwise, thereby to operate the switches 60 and 61.

The higher the pressure in bellows 70, the further to the left will be thrown lever 67 which revolves manual lever 64 to the right or to the cooler position, if it is not locked by nut 65.

As a manual adjustment, spring 72 and a manual control lever 73 are provided. In order to change the balance of forces existing in bellows 70, spring 72 may be tensioned to different degrees by revolving handle 73. Handle 73 may be locked in the desired position by winged lock nut 66. It should be appreciated that these controls are only diagrammatically shown. Switches other than drum type might be employed to better advantage and the thermostat control does not necessarily illustrate the desirable design, merely diagrammatically illustrates the principle employed.

The foregoing description and illustration sets forth one embodiment of my invention but my invention is not limited thereto; it is only limited by the scope of the following claims.

I claim the following as my invention:

1. An air warming and cooling system comprising a

5

reversible compressor, a pair of heat exchanger units connected in circuit with the compressor for circulation of a refrigerating medium in sequence therethrough, flow restricting means in the circuit adjacent each heat exchanger unit to cause expansion of refrigerating medium entering the unit, by-passes around the flow restricting means, check valves in the by-passes opening in opposite directions, a heat exchanger in the circuit adjacent to each heat exchanger unit to exchange heat between refrigerating medium entering the unit and leaving the unit, by-passes around the last named heat exchangers, check valves in the by-passes opening in opposite directions and means to reverse the compressor whereby each of the heat exchanger units will function alternately as an evaporator and a condenser.

2. An air warming and cooling system comprising a reversible compressor, a pair of heat exchanger units connected in circuit with the compressor for circulation of a refrigerating medium in sequence therethrough, flow restricting means in the circuit adjacent one end of each heat exchanger unit to cause expansion of refrigerating medium entering the units from said ends, ducts around the units respectively to direct circulation of air from different sources thereover, a motor driving the compressor, a third duct enclosing the motor and compressor, connections from the third duct to each of the first named ducts, valves controlling the connections, and control means to reverse the motor and simultaneously to operate the valves selectively to connect the third duct to the first named ducts.

3. An air warming and cooling system comprising a pair of heat exchanger units, a compressor connected in circuit with the units to circulate a refrigerating medium in sequence therethrough, a motor connected to the compressor, flow restricting means in the circuit adjacent one end of each heat exchanger unit to cause expansion of refrigerating medium entering the units from said ends means to reverse the sequence of circulation through the units whereby they function alternately as evaporators and as condensers, ducts enclosing the units to circulate air thereover respectively from a space to be conditioned and from atmosphere, a third duct enclosing the motor and compressor having an inlet communicating with atmosphere and a pair of outlets communicating with the

6

first named ducts respectively, valves controlling the outlets, and means to control the valves selectively to connect the third duct to the first named ducts.

4. An air warming and cooling system comprising a pair of heat exchanger units, a compressor connected in circuit with the units to circulate a refrigerating medium in sequence therethrough, flow restricting means in the circuit adjacent each heat exchanger unit to cause expansion of refrigerating medium entering the unit, by-passes around the flow restricting means, check valves in the by-passes opening in opposite directions, a motor connected to the compressor, means to reverse the sequence of circulation through the units whereby they function alternately as evaporators and as condensers, ducts enclosing the units to circulate air thereover respectively from a space to be conditioned and from atmosphere, a pair of air circulating fans in each duct, and control means to cause one or both of the circulating fans to operate thereby to control the quantity of air circulated through the ducts.

5. An air warming and cooling system comprising a pair of heat exchanger units, a compressor connected in circuit with the units to circulate a refrigerating medium in sequence therethrough, flow restricting means in the circuit adjacent each heat exchanger unit to cause expansion of refrigerating medium entering the unit, by-passes around the flow restricting means, check valves in the by-passes opening in opposite directions, a motor connected to the compressor, means to reverse the sequence of circulation through the units whereby they function alternately as evaporators and as condensers, ducts enclosing the units to circulate air thereover respectively from a space to be conditioned and from atmosphere, a pair of air circulating fans in each duct, a pair of temperature sensing devices responsive to temperature of the space and of the atmosphere respectively, and means jointly responsive to the temperature sensing devices to control operation of the fans.

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