Feb. 17, 1953 A. S. FEINBERG 2,628,480

COMBINATION REFRIGERATION AND EVAPORATING COOLING UNIT

Filed April 8, 1952 5 Sheets-Sheet 1

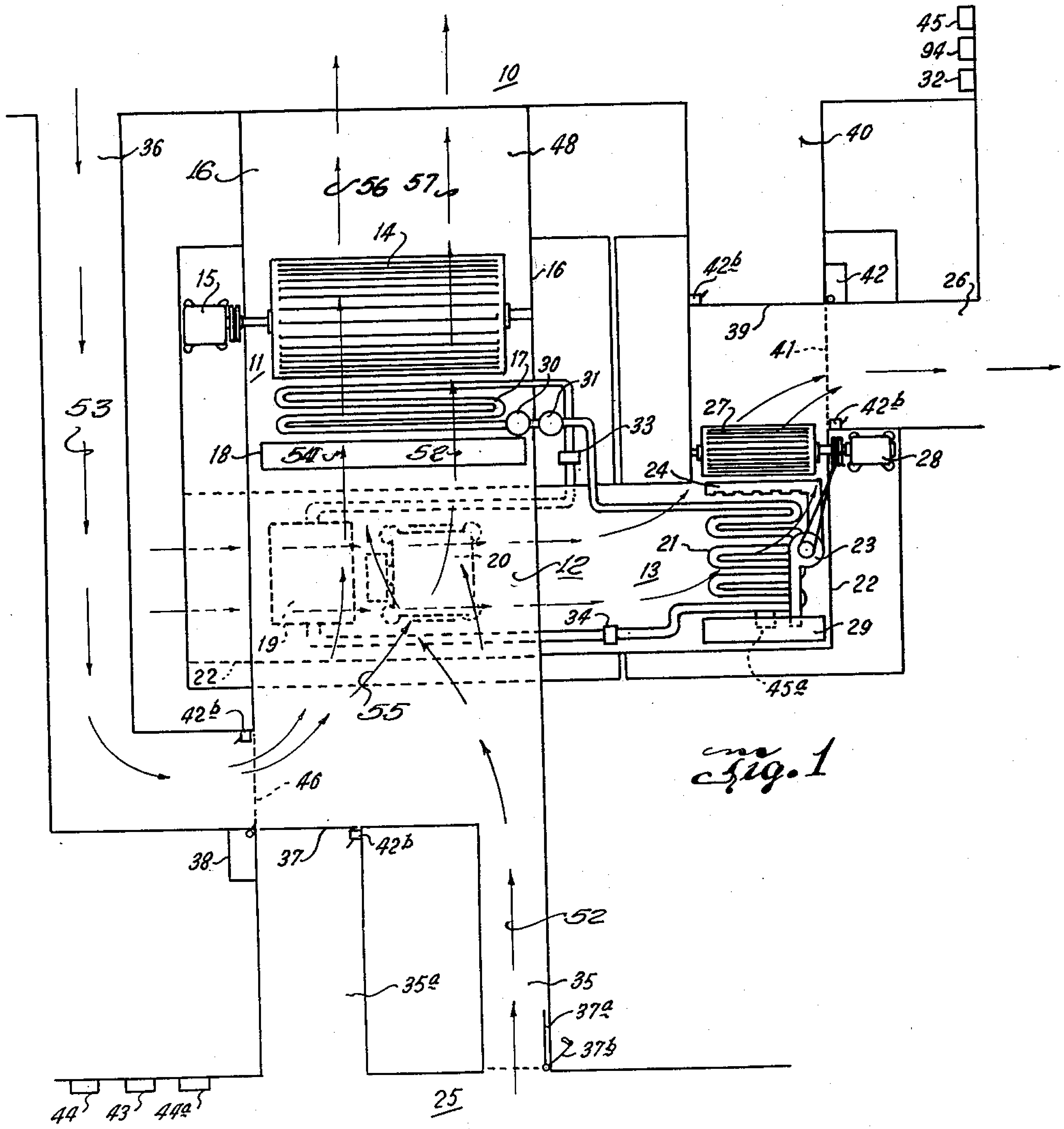

Fig. 1

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COMBINATION REFRIGERATION AND EVAPORATING COOLING UNIT

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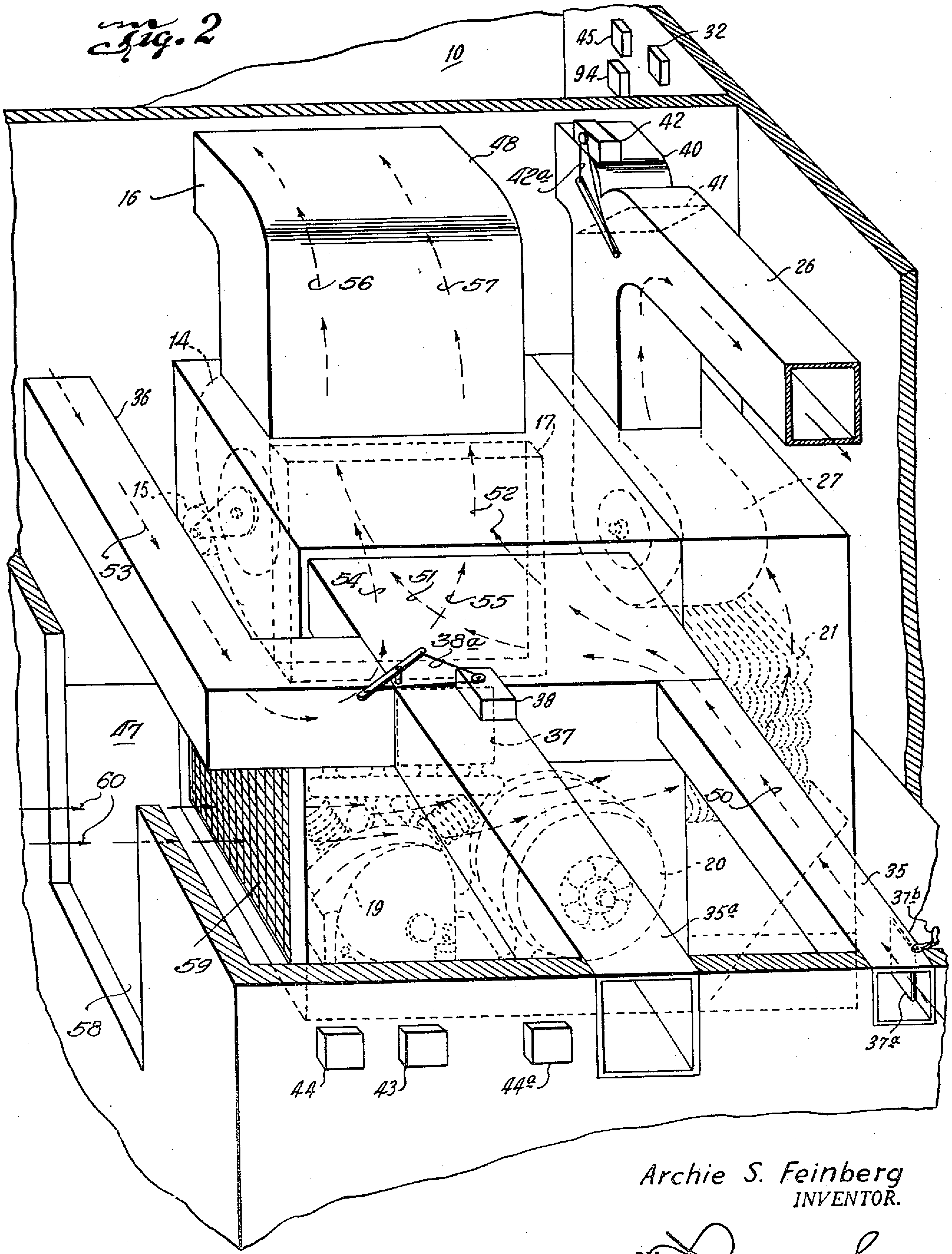
Fig. 2



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COMBINATION REFRIGERATION AND EVAPORATING COOLING UNIT

Filed April 8, 1952 5 Sheets-Sheet 3

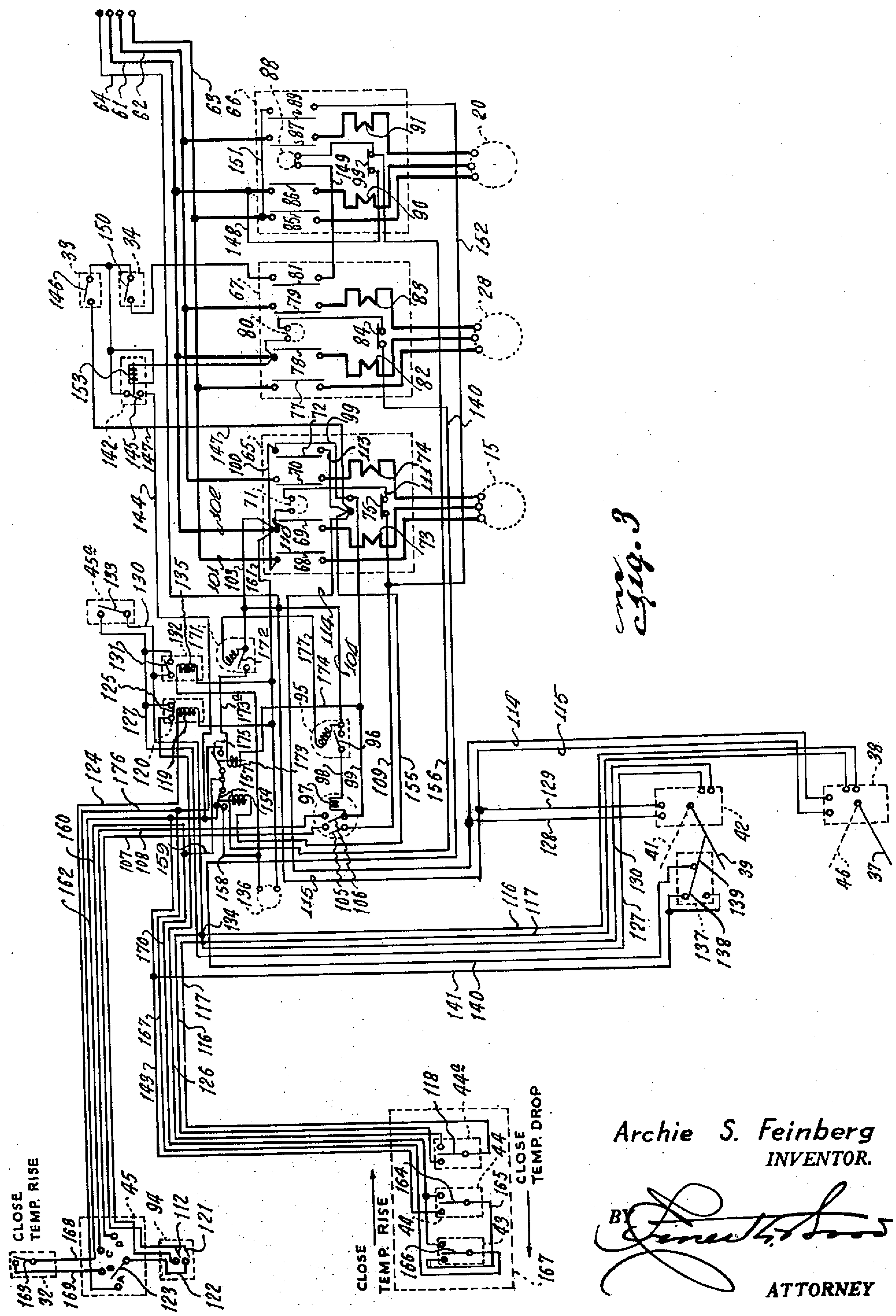

Fig. 3

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COMBINATION REFRIGERATION AND EVAPORATING COOLING UNIT

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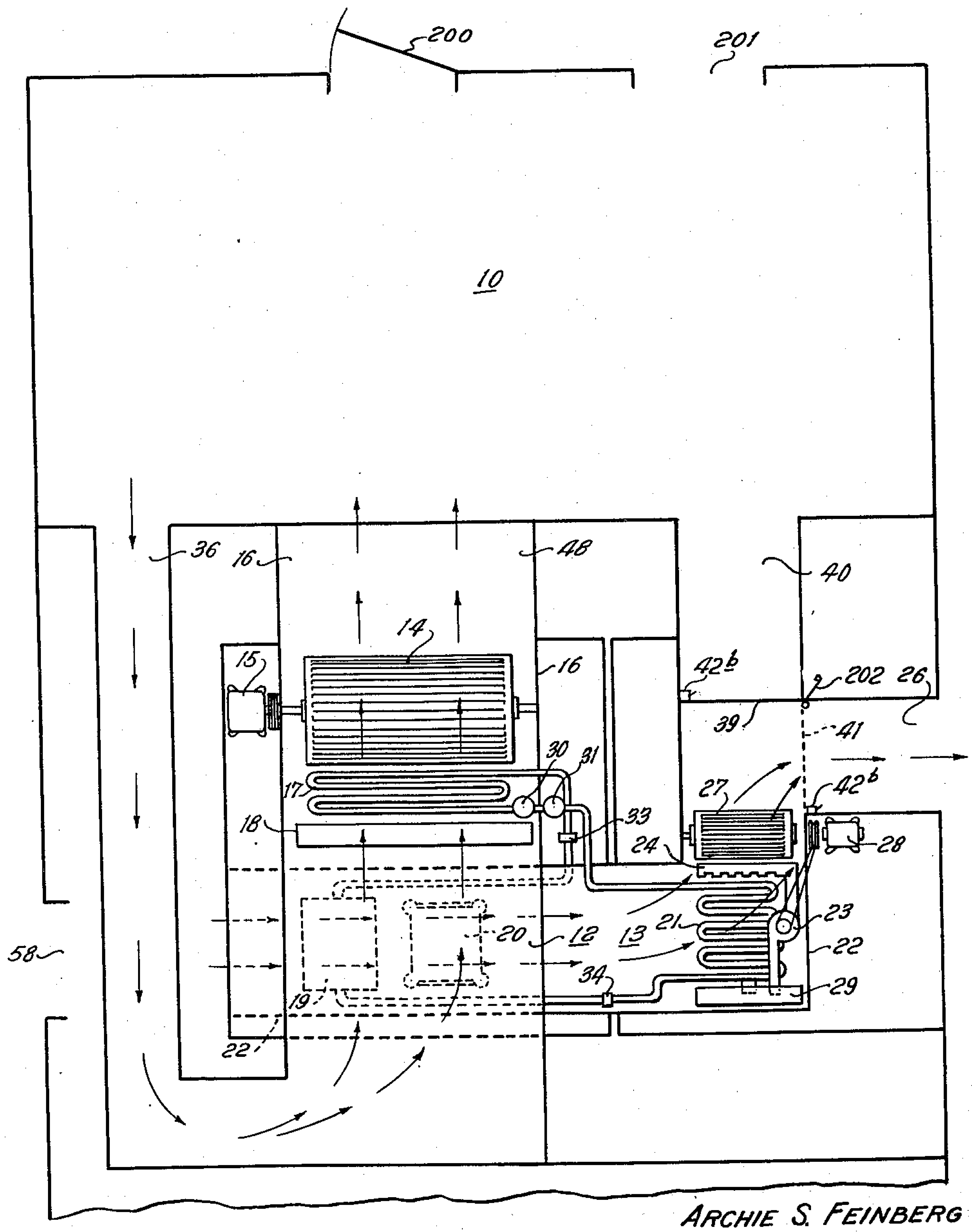
Fig. 4



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Feb. 17, 1953 **A. S. FEINBERG** **2,628,480**

COMBINATION REFRIGERATION AND EVAPORATING COOLING UNIT

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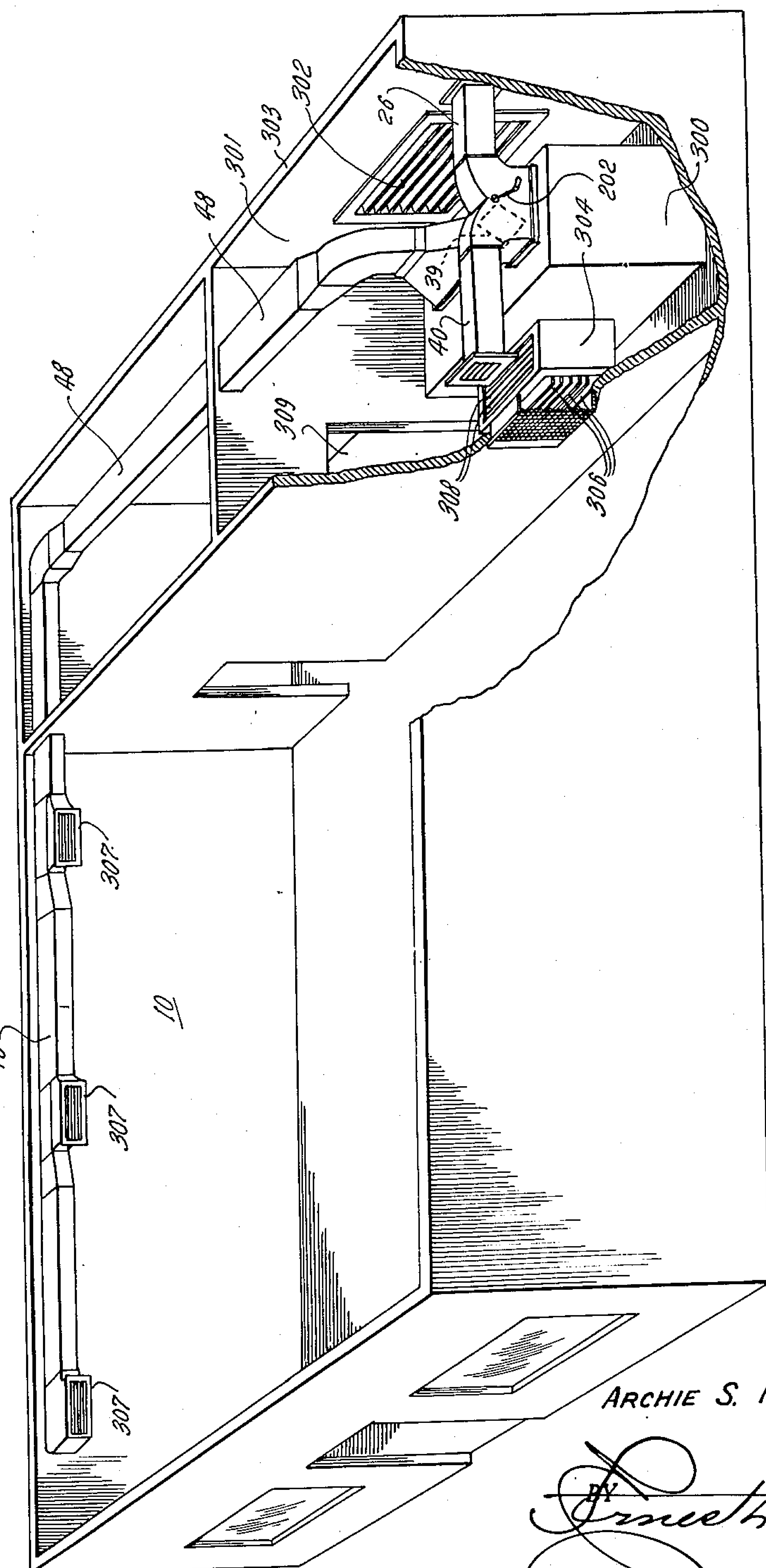
Fig. 5



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Patented Feb. 17, 1953 2,628,480

UNITED STATES PATENT OFFICE

2,628,480

COMBINATION REFRIGERATION AND EVAPORATING COOLING UNIT

Archie S. Feinberg, Dallas, Tex.

Application April 8, 1952, Serial No. 281,122

33 Claims. (Cl. 62—4)

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This invention relates to air conditioning apparatus and more particularly to such apparatus employing both refrigerating and evaporative cooling systems.

This application is a continuation-in-part of my co-pending application Serial No. 145,833, filed February 23, 1950, now abandoned.

The normal summer temperatures in the northern half of the United States seldom exceed 85 degrees Fahrenheit but the relative humidity of the atmosphere is usually relatively high. Refrigerating systems for air conditioning rooms and buildings are largely employed in this northern half of the United States because of the ability of these systems to dehumidify as well as to cool the treated air. Refrigerating systems, however, are costly to operate since large amounts of power are needed to compress and liquefy the refrigerant gas employed in these systems. Prolonged periods of compressor operation are made necessary even during periods when the outdoor atmospheric temperature is as low as 78 to 79 degrees Fahrenheit by the increase in temperature of the air in the air conditioned space due to the heat released in the air conditioned space by human occupants and lights and other heat emitting appliances. This "human occupancy heat load," as it is termed in the industry, necessitates operation of the compressor even though the outdoor atmospheric temperature and relative humidity conditions may be such as to be entirely comfortable to human beings. Human occupancy of the air conditioned space not only raises the temperature of the air within the air conditioned space but also raises the relative humidity since water vapor is released by the human occupants through perspiration thus increasing their discomfort. The operation of a refrigeration system is uneconomical during periods when the outdoor atmospheric conditions are comfortable to human beings. The "human occupancy heat load" can be more economically removed by moving fresh air from the outdoors into the air conditioned space and expelling outdoors the air which has been heated and humidified by the human occupants of the space. The temperature of the outdoor air may have to be lowered a relatively small degree to allow for the gradual warming of the air in its passage through the air conditioned space due to the heat emitted by the human occupants and heat emitting appliances so that the temperature of the air in no part of the air conditioned space will exceed a predetermined value. This small cooling of

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the outdoor air can be accomplished very economically by evaporative cooling.

Control of the temperature and humidity in the conditioned space by evaporative cooling and continuous exchange of air within the air conditioned space is feasible only during periods when the dry bulb temperature of the outside air is about 86 degrees Fahrenheit or less and the wet bulb temperature is about 79 degrees Fahrenheit or less. When these atmospheric conditions do not obtain a refrigerating system is needed to cool the air within the air conditioned space. It is desirable, therefore, for economical and satisfactory operation of an air conditioning apparatus that it provide a refrigerating system for use when outdoor temperatures are above 85 degrees Fahrenheit and an evaporative cooling system for use when outdoor temperatures are 85 degrees or lower. By using air conditioning systems having both systems, the periods of costly operation of the refrigerating system are greatly reduced since it operates only during the relatively few and short periods when the dry bulb temperature of the outdoor air exceeds 85 degrees Fahrenheit or the wet bulb temperature exceeds 79 degrees Fahrenheit. The air conditioning apparatus must also be capable of continuously displacing a greater volume of air during the time the evaporative cooling system is in operation than is necesasry during the time the refrigerating system is in operation. Moreover, in order to meet the needs of varying internal and external conditions the controls of the air conditioning apparatus should provide for automatic changeover from operation of one system to operation of the other system upon a predetermined change in internal and external conditions as well as for selective choice of operation of either system.

Accordingly, it is an object of my invention to provide a new and improved air conditioning apparatus.

It is another object of my invention to provide a new and improved air conditioning apparatus having a refrigerating system for conditioning air when the outdoor air temperature exceeds a predetermined value and an evaporative cooling system for conditioning air when the outdoor temperature is less than a predetermined value.

It is another object of my invention to provide a new and improved air conditioning apparatus having a refrigerating system including an evaporative condenser provided with a blower and water spray system and having an evaporative cooling system employing the blower and water spray system of the evaporative condenser of the refrigerating system.

It is another object of my invention to provide a new and improved air conditioning apparatus having a refrigerating system, and an evaporative cooling system, and being provided with means for automatically operating the refrigerating system when the outdoor air temperature exceeds a predetermined value and for automatically operating the evaporative cooling system when the temperature falls below a predetermined value.

It is another object of my invention to provide a new and improved air conditioning apparatus provided with a refrigerating system and an evaporative cooling system and with controls for automatic changeover from operation of one system to operation of the other system upon predetermined changes in internal and external conditions.

It is still another object of my invention to provide a new and improved air conditioning apparatus provided with a refrigerating system and an evaporative cooling system and with controls for selective choice of operation of either system.

It is another object of the invention to provide a new and improved air conditioning apparatus having a refrigerating system for conditioning air when the outdoor temperature exceeds a predetermined value and a system for increasing the volume of flow of air from the outdoor atmosphere when the outdoor temperature is less than the predetermined value.

Briefly stated, my new and improved air conditioning apparatus comprises a refrigerating system and an evaporative cooling system. The refrigerating system is provided with a compressor for compressing a refrigerant gas, an evaporative condenser coil in which the compressed gas is cooled and liquefied, a spray system for cooling the evaporative condenser coil by spraying water on the coil, a condenser blower for moving air past the evaporative condenser coil and removing to the outdoors the heat released by the refrigerant gas in cooling and liquefying the refrigerant, a cooling coil in which the liquefied gas is allowed to evaporate and expand, and a conditioner blower for moving recirculated and fresh outdoor air past the cooling coil to be cooled and dehumidified by the absorption of heat by the refrigerant gas and into the air conditioned space. The evaporative cooling system employs the spray system and the condenser blower associated with the evaporative condenser coil and includes a duct to move air cooled by evaporation of the spray to the conditioned air space and a damper which selectively directs the flow of the air past the spray to the air conditioned space or to the outdoors. In operation the refrigerating system is employed when the outdoor temperature exceeds a predetermined value and the damper is positioned to direct the air moved past the spray to the outdoors. The only air entering the air conditioned space is moved past the cooling coil by the conditioner blower. The latter air may be partly recirculated air or may be wholly fresh air moved from the outdoors.

During this period the compressor operates as needed. When the temperature falls below a predetermined value, the compressor is maintained inoperative but the conditioner blower remains in operation to move air from the outdoors into the air conditioned space. The condenser blower associated with the evaporative condenser coil is also maintained in operation and moves air from the outdoors through the water spray where its temperature is lowered by evaporative cooling and into the air conditioned space, the damper being moved to direct the flow of air from the outdoors to the air conditioned space. During the operation of the evaporative cooling system all blowers may move air from the outdoors and into the air conditioned space moving a great volume of air through the air conditioned room to remove the human occupancy emitted heat. Only a portion of the air is cooled since the air moved by the cooling coil blowers is not cooled, the compressor being inactive. Controls are provided for automatically controlling the operation of all dampers, compressors, and motors of the air conditioning apparatus to insure that the refrigerating system operates when the temperature of the outdoor air exceeds a predetermined value and that the evaporative cooling system operates when the temperature falls below a predetermined value.

In a modified form of the invention, all of the air moved by the conditioner blower is drawn from the conditioned space. In this case, the inflow of outdoor air through doors or windows into the conditioned space is relied upon to provide the proper proportion of fresh air to recirculated air during normal operation of the refrigerating system. When the outdoor temperature does not exceed the predetermined value, the condenser blower is employed, as in the first described embodiment, to increase the rate of flow of outdoor air into the conditioned space.

For a better understanding of my invention, reference may be had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing:

Figure 1 is a schematic diagram of the air conditioning apparatus with all electric circuits omitted;

Figure 2 is a diagrammatic perspective of the air conditioning apparatus of Figure 1 installed for operation and with all electric circuits omitted;

Figure 3 is a diagrammatic illustration of the control circuits of the air conditioning apparatus of Figures 1 and 2; and,

Figure 4 is a schematic diagram of a modified form of the air conditioning apparatus; and,

Figure 5 is a perspective view of a building, with the top removed and some walls broken away, provided with another modified form of the air conditioning apparatus.

Referring now especially to Figure 1, the principle of operation of a preferred embodiment of my invention is disclosed as employed to maintain comfortable temperature and humidity conditions in the conditioned space 10 which may be a room, a series of rooms, or an entire building. The air conditioning apparatus comprises a refrigerating system and an evaporative cooling system.

Refrigerating system

The refrigerating system comprises a cooling section 11, a compressor section 12, and an evaporative condenser section 13 as in conventional refrigerating systems. Air is forced into the space 10 by a blower 14 operated by a prime mover, such as an electric motor 15. The air is drawn through a duct 16 in which is disposed a cooling coil 17 which is maintained at a low temperature by the evaporation of a refrigerating gas, such as ammonia or Freon. Heat is absorbed by the refrigerating gas from the air drawn past the cooling coil 17 and the temperature of the air forced into space 10 is lowered. A certain amount of the water vapor contained in the air is condensed on cooling coil 17 and drains into drain pan 18. Removal of this water vapor dehumidifies the air forced into space 10 and renders air conditions more comfortable for human occupants of space 10.

The evaporated refrigerating gas is compressed by the compressor 19 which is driven by a prime mover, such as an electric motor 20. The compressed refrigerant gas then moves to the condenser coil 21 where the heat of compression and the latent heat of condensation are removed by evaporative cooling and the refrigerant gas is liquefied. Condenser coil 21 is disposed in an air duct 22 and is cooled by the evaporation of water sprayed over coil 21 by a water pump 23 through a spraying means, such as a spray pipe 24. Air is moved from the outdoors 25 past compressor 19, compressor motor 20, and condenser coil 21 to remove the heat emitted by motor 20, compressor 19, and the heat of compression and condensation of the refrigerating gas in condenser coil 21. After moving past condenser coil 21, the air is humid as well as warm since a portion of the water sprayed over condenser coil 21 is evaporated upon coming in contact with the warm condenser coil 21. The air is moved through duct 22 and out into the outdoors 25 through an air duct 26 by condenser blower 27 driven by a prime mover, such as an electric motor 28. Electric motor 28 also drives water pump 23 which pumps water from pan 29 which collects the water sprayed by spray pipe 24 which has not been evaporated. Water may be supplied to pan 29 by any conventional means, not shown, so that water will always be present in pan 29.

It will be apparent that heat is extracted by the evaporating refrigerant gas in cooling coil 17 from the air moving through air duct 16 into space 10, the refrigerating gas then being compressed by compressor 19 and liquefied in condenser coil 21. The heat extracted by the evaporating refrigerant gas in cooling coil 17 is released by the refrigerant gas in condenser coil 21 to the air moving past condenser coil 21 and is passed to the outdoors with the air moving through duct 26. The degree of cooling of the air moving through duct 16 depends on the amount of refrigerating gas allowed to evaporate in cooling coil 17 per unit of time and this depends in turn on the amount of the liquefied refrigerating gas allowed to flow from condenser coil 21 to the expansion valve 30 where the liquefied refrigerant gas evaporates, cools in evaporating, and passes into the cooling coil 17. In order to maintain a predetermined temperature in space 10, the flow of liquefied refrigerating gas to expansion valve 30 is controlled by a conventional solenoid valve 31 which is controlled by a thermostat 32 located in space 10. If the temperature of the space 10 tends to rise, thermostat 32 will cause solenoid valve 31 to allow more liquefied refrigerant gas to pass to expansion valve 30, more heat will be absorbed from the air passing through duct 16, and the temperature of the air in space 10 will be lowered.

Operation of compressor motor 20 is controlled by a low pressure switch 33 and a high pressure switch 34 for automatically maintaining proper refrigerating gas pressures in cooling coil 17 and condenser coil 21. Compressor motor 20 is started automatically whenever the pressure of the refrigerant gas in cooling coil 17 exceeds a predetermined value and is stopped whenever the pressure in the cooling coil 17 falls below a predetermined value or whenever the pressure of the refrigerant gas in condenser coil 21 exceeds a certain predetermined value. Switches 33 and 34 insure that a sufficient amount of the refrigerant gas is always in a liquid state and also prevent the building up of an excessively high pressure in condenser coil 21 and an excessively high or excessively low pressure in cooling coil 17.

As shown in Figures 1 and 2, all the air moved past cooling coil 17 may be drawn from the outdoors 25 through ducts 35 and 35*a* or part of the air may be moved from the outdoors 25 through duct 35 and part of the air may be moved from space 10 through duct 36. The position of recirculation damper 37 determines whether only fresh air from the outdoors is moved into space 10 or whether a portion of the air in space 10 is recirculated through duct 36. In the position of recirculation damper 37 shown in Figures 1 and 2, both fresh air and recirculated air is being moved into space 10. A damper 37*a* provided with a handle 37*b* may be provided in duct 35*a* to close duct 35*a* when no fresh air and only recirculated air is to be moved into space 10. This may be desired when the outdoor air is intensely hot to avoid excessive operation of the refrigerating system. Damper 37 is moved by any suitable prime mover such as electric damper motor 38 which may be linked to damper 37 in any conventional manner such as the sprocket and chain means 38*a* illustrated in Figure 2.

It will be noted that duct 36 is roughly four times the size of duct 35 in cross section. This disparity in size causes the air moved by conditioner blower 14 to be about 80 percent recirculated air and about 20 percent fresh air when damper 37 is positioned to allow a minimum of fresh air to be moved into space 10. This ratio of recirculated air to fresh air is usually employed in operation of refrigerating systems for air conditioning.

Evaporative cooling system

The evaporative cooling system of my air conditioning apparatus makes use of air duct 22, water pump 23 and spray pipe 24, condenser blower 27, and motor 28 of the refrigerating system. If the condenser coil 21 is not heated by the action of the refrigerating gas compressed by compressor 19, air moved by condenser blower 27 through the water spray caused by spray pipe 24 is cooled by the evaporation of the sprayed water since the evaporating water absorbs heat from the air. In order to move the air cooled by the water spray produced by spray pipe 24 into space 10, I provide a condenser damper 39 and an air duct 40 communicating with space 10 and also with duct 22, when damper 39 is moved to the broken line position 41 of Figure 1. Condenser damper 39 is actuated by any suitable prime mover such as electric damper motor 42 and is linked to motor 42 by any conventional means, such as the sprocket and chain means 42*a*. Damper motors 38 and 42 are of the geared-down type conventionally employed for this purpose and will move their respective dampers 37 and 39 in either direction depending on the manner in which their controls are operated. Damper motors 38 and 42 will move the dampers 37 and 39 until the dampers are stopped by obstructions such as stops 42*b*. Condenser damper 39 is actuated by any suitable prime mover, such as electric damper motor 42 and is linked to motor 42 by any conventional means such as the sprocket and chain means 42*a*.

In operation of the air conditioning apparatus, it is desirable that the refrigerating system function only when the dry bulb temperature of the outdoor air exceeds a predetermined value, say 85 degrees Fahrenheit. It is also desirable that it function even when the dry bulb temperature is 85 degrees or less if the wet bulb temperature of the outside air, which is an indication of the humid condition of the air, exceeds a certain predetermined value, say 79 degrees Fahrenheit. Thermostats 43 and 44*a* responsive to dry bulb temperature and a thermostat 44 responsive to wet bulb temperature are positioned to measure the outside dry and wet bulb temperatures. Thermostats 32, 43, 44, 44*a* and 45*a* are employed to control automatically the operation of the air conditioning apparatus and a detailed description of their associated controls will be given later.

If it is desired to maintain a temperature of 75 degrees in space 10 and the outside temperature is below 75 degrees, it is not necessary to cool the air introduced into space 10 but a certain circulation of air is necessary to maintain comfortable conditions within space 10. A selector switch 45 may be employed to cause only conditioner motor 15 to run. Since the temperature of the outdoor air is below 75 degrees, a maximum of recirculated air and a minimum of the cold outdoor air must be moved through air duct 16. The automatic control associated with thermostat 44*a* causes damper motor 38 to move recirculation damper 37 to the position shown in Figure 1.

When the dry bulb temperature of the outside air is higher than 75 degrees but not higher than 85 degrees Fahrenheit and its wet bulb temperature is less than 79 degrees, the evaporative cooling system is placed in operation by the automatic controls. Damper motors 38 and 42 move dampers 37 and 39 into the broken line positions 46 and 41, respectively, and motors 15 and 28 are energized. No recirculated air is allowed to move through air duct 36, fresh outdoor air only moving through ducts 16 and 40 into space 10. Since compressor motor 20 is not energized, the air moving through duct 16 is not cooled. The only cooling taking place is by evaporation of water in air duct 22. During this phase of the operation of the air conditioning apparatus, a maximum volume of air is moved into and through space 10 since both blowers 14 and 27 are moving air into space 10.

When the outdoor dry bulb temperature exceeds 85 degrees or the wet bulb temperature exceeds 79 degrees the refrigerating system is automatically brought into operation. Compressor motor 20 is energized and compressor 19 begins to compress the refrigerant gas, the cooling coil 17 therefore causes the air moving through air duct 16 to be cooled. At the same time damper motors 38 and 42 are energized and move dampers 37 and 39, respectively, to the solid line positions illustrated in Figure 1. A maximum amount of air is recirculated through air duct 36 and the air moved by blower 27 is moved outdoors through duct 26, this air now being warm and moist due to the heat it has absorbed in passing past condenser coil 21. Thermostat 32 now controls solenoid valve 31 to control the degree to which the air flowing through air duct 16 is cooled.

If the dry bulb temperature of the outdoor air now falls below 85 degrees while the wet bulb temperature is lower than 79 degrees, motor 20 is deenergized and motors 38 and 42 are energized to move dampers 37 and 39 to the dashed line positions 46 and 41, respectively, the energization of the damper motor 42 is delayed by the action of thermostat 45*a*, however, to allow the water in pan 29 to cool to 79 degrees to avoid blowing warm humid air into air space 10. The automatic controls to be described below also stop motor 28 every time damper 39 is to be moved since condenser blower 27 moves a large volume of air at a great speed. Damper motor 42 would have to be quite large and powerful to move damper 39 against the blast of air caused by condenser blower 27. To avoid use of a large damper motor 42 and to preclude damage to damper 39, condenser blower 27 is stopped each time damper 39 is moved.

Figure 2 illustrates diagrammatically an actual installation of the air conditioning apparatus illustrated schematically in Figure 1. The apparatus is located in a small room 47 adjacent air conditioned space 10. Air ducts 35, 35*a* and 26 lead directly to the outdoors. Duct 26 is so located that the air it discharges cannot find its way into air ducts 35 and 35*a* since the air discharged by duct 26 is warmer and more humid than the outdoor air. Fresh air is brought in through ducts 35 and 35*a* and flows through the cooling coil 17, through conditioner blower 14, here shown as discharging into duct 48 which leads into space 10. The path of flow of the fresh air is indicated by lines 50, 51, and 52. The recirculated air flows through duct 36, cooling coil 17, conditioner blower 14, and duct 48. The path of flow of the recirculated air is indicated by lines 53, 54 and 55. The combined flow of fresh and recirculated air is indicated by lines 56 and 57. The air employed to cool the condenser coil 21 when the refrigerating system is in operation flows in through a window 58 or other aperture in room 47, and moves through grill 59 of the air conditioning apparatus past compressor 19, compressor motor 20, condenser coil 21, spray pipe 24, through condenser blower 27, and to the outdoors through duct 26. The path of flow of this air is indicated by line 60. When the evaporative cooling system is in operation, this air follows the same path except that condenser damper 39 blocks duct 26 and allows the air to flow through duct 40 into space 10.

Automatic control system

In order to obtain maximum efficiency of operation of my air conditioning apparatus under varying conditions of temperature and humidity I have provided an automatic control system to operate the various components of my apparatus.

The conditioner motor 15, the compressor motor 20, and the condenser motor 28 are connected in parallel across a four wire three phase supply circuit having leads 61, 62, 63 and a neutral lead 64. Starting contactors 65, 66, and 67 are provided for motors 15, 20 and 28 respectively.

Contactor 65 comprises contacts 68, 69 and 70 which connect motor 15 to leads 63, 61 and 62, respectively when the actuating coil 71 of contactor 65 is energized to start motor 15. An auxiliary contact 72, whose function will be described below, is also actuated simultaneously with contacts 68, 69 and 70 when actuating coil 71 is energized. Contactor 65 is provided with a conventional thermal overload relay which comprises heater coils 73 and 74 connected in series with contacts 69 and 70 respectively, when the latter are in their actuated positions. The heater coils 73 and 74 allow the thermal overload contact 75 to open the circuit of actuating coil 71 when excessive currents are drawn by conditioner motor 15. Since the contact 75 opens the circuit of coil 71, coil 71 is deenergized and contacts 68, 69 and 70 return to the non-actuated positions illustrated in Figure 3 and contitioner motor 15 is stopped.

Contactor 67 similarly comprises three contacts 77, 78 and 79 which connect condenser motor 28 to leads 63, 61 and 62, respectively when the actuating coil 80 is energized to start motor 28. An auxiliary contact 81, whose function will be described below, is also actuated simultaneously with contacts 77, 78 and 79 when actuating coil 80 is energized. Contactor 67 is also provided with a conventional thermal overload relay comprising heater coils 82 and 83 connected in series with contacts 78 and 79, respectively, when the latter are in their actuated positions. Heater coils 82 and 83 operate thermal overload contact 84 to open the circuit of actuating coil 80 and stop condenser motor 28 when condenser motor 28 draws currents of overload intensity.

Contactor 66 similarly comprises three contacts 85, 86 and 87 which connect compressor motor 20 to leads 63, 61 and 62 respectively, when the actuating coil 88 is energized to start compressor motor 20. An auxiliary contact 89, whose function will be described below, is also actuated simultaneously with contacts 85, 86 and 87 when actuating coil 88 is energized. Contactor 68 is also provided with a conventional thermal overload relay comprising heater coils 90 and 91, connected in series with contacts 86 and 87, respectively, when the latter are in their actuated positions. Heater coils 86 and 87 operate thermal overload contact 93 to open the circuit of actuating coil 88 and stop compressor motor 20 when compressor motor 20 begins to draw current of overload value.

In order to provide automatic operation of the air conditioning apparatus, I provide thermostats 32, 43 and 44*a* which are responsive to temperatures of air as measured by a dry bulb thermometer and which will be referred to hereinafter as "dry bulb thermostats" to distinguish them from thermostat 44 which is responsive to the temperature of air as measured by a wet bulb thermometer and which will be referred to hereinafter as a "wet bulb thermostat." I also provide a thermostat 45*a* located in the water pan 29 and responsive to the temperature of the water in pan 29. Thermostat 32 is preferably located at a position in space 10 where it will be exposed to air having a temperature equal to the average temperature of the air within space 10.

It is sometimes desirable to run only the conditioner blower 14 to maintain a certain circulation of air within the air conditioned space 10 without cooling any air. At other times it may be desired to run either solely the refrigerating system or the evaporative cooling system of my apparatus. Lastly, it is usually desirable to operate either the refrigerating system or the evaporative cooling system as dictated by the temperature and humidity conditions of the outdoor air and to have the change from one system to the other made automatically.

In order to allow a choice to be made of any of the above four methods of operating the air conditioning apparatus, I provide a four position selector switch 45. When the switch is in position A, only the conditioner blower 14 will operate; when in position B, either the refrigerating system or the evaporative cooling system will operate, the automatic controls dictating the choice of the system to operate; when in position C, solely the evaporative cooling system will function, and when in position D, solely the refrigerating system will function.

A double pole single throw toggle switch 94 is located adjacent selector switch 45 and must be closed before the air conditioning apparatus will operate. In addition, a time clock 95 which operates a contact 96 may be used to insure that the air conditioning apparatus will operate only during a stated period of the day, for example between 8:00 a. m. and 5:00 p. m. During this period time clock 95 will maintain contact 96 in actuated position connecting relay winding 97 across leads 61 and 63 through conductors 99 to 104. When relay winding 97 is energized it moves contacts 105 and 106 to their actuated positions connecting conductors 107 and 108 to conductors 109 and 99, respectively.

Conditioner blower only operation

Assuming now that time clock 95 has moved contact 96 to actuated position, that as a result contacts 105 and 106 are in their actuated positions, and that selector switch 45 is in A position to permit the operation only of conditioner blower 14, closing of toggle switch 94 will connect contactor coil 71 across leads 61 and 63 through conductors 102, 110, 111, thermal overload contact 75, conductor 109, contact 105, conductor 107, blade 112 of toggle switch 94, and conductors 108, 99, 100, and 101. Since contactor coil 71 is energized, contacts 68, 69, 70 and 72 are actuated and conditioner motor 15 now operates to drive conditioner blower 14.

It is desirable that a minimum of fresh air be brought in from the outdoors when the outdoor temperature is below 75 degrees in order to prevent the air in space 10 from becoming too cold. Conditioner damper 37 must, therefore, be brought to the position shown in Figure 1 in order to allow a maximum of air to be drawn from space 10 and recirculated through air ducts 36 and 16 back into space 10. Damper motor 38 is connected across neutral lead 64 and lead 63 through conductors 101, 100, contact 72, and conductors 113, 114 and 115 at the same time motor 15 is connected across leads 61, 62 and 63. Damper motor 38 is controlled by conductors 116 and 117 which causes damper 37 to move to the position shown in Figure 1 when they are short circuited by contact 118 of thermostat 44*a*. Since the thermostat 44*a* short circuits conductors 116 and 117 when the outdoor temperature is below 75 degrees, damper 37 will always be in the position shown in Figure 1 when the outdoor temperature is below 75 degrees, allowing maximum recirculation of the air from space 10 and allowing a minimum of fresh air to be brought into space 10 from the outdoors 25.

At the same time that actuator coil 71 is energized, the coil 119 of circuit breaker relay 120 is also energized since it is connected across leads 63 and 61 through conductors 100 and 99, contact 106, conductor 108, blade 121 of switch 94, conductor 122, the rotary contact 123 of selector switch 45 and conductor 124. When coil 119 is energized, contact 125 disconnects conductors 126 and 127 so that conductors 117 and 116 will not be short circuited when contact 118 of thermostat 44*a* connects conductor 117 to conductor 126 when the temperature of the outdoor air rises above 75 degrees. Damper 37 therefore will move to the dashed line position 46 where is will allow a maximum of fresh air to be moved into space 10 when the temperature is 75 degrees or higher.

Damper controls

The control circuits of damper motor 42 are closely associated with the control circuits of damper motor 38 and they will be described in conjunction with the description of damper motor 38. Damper motor 42, like damper motor 38, is connected across neutral lead 64 and lead 63 when actuating coil 71 is energized. Damper motor 42 is connected across leads 64 and 63 through conductor 100, contact 72, and conductors 114, 128 and 129. Damper motor 42 is controlled by conductors 127 and 130. Damper 39 is moved to the position indicated in Figure 1 when conductors 127 and 130 are short circuited either by the contact 131 of damper position relay 132 or by the contact 133 of thermostat 45*a*. When the outdoor temperature is above 75 degrees, contact 118 of thermostat 44*a* connects conductor 117 to conductor 126. If at the same time contact 125 of circuit breaker relay 120 is in its non-actuated position, conductors 127 and 126 are also connected. Since conductors 116 and 130 are permanently connected at common connection 134, the control conductors 116 and 117, and 127 and 130 of damper motors 38 and 42, respectively, are connected in parallel. The internal resistance of each damper motor 38 or 42 being relatively great, neither acts as a short circuit for the control conductors of the other. Contacts 131 and 133, therefore, short circuit both control conductors 116 and 117 and conductors 127 and 130 when either is moved to its actuated position and both dampers 37 and 39 are moved to the dashed line positions 46 and 41, respectively, shown in Figure 1. In this position damper 37 will not permit air to be recirculated from space 10. Damper 39, when in the position 41, will direct the air moved by blower 27 into space 10. It will be noted that both dampers 37 and 39 will be moved simultaneously except when the outdoor temperature is less than 75 degrees or contact 125 of relay 120 is in its actuated position.

The actuating coil 135 of damper position relay 132 is connected across the solenoid coil 136 of the solenoid valve 31 to insure that damper 37 will be in position to allow a maximum recirculation of air to space 10, and to insure that damper 39 will be in position to divert all air moving past condenser coil 21 to the outdoors when the refrigerating system will of necessity be in operation since actuation of solenoid coil 136 will allow refrigerant gas to enter cooling coil 17 and low pressure switch 33 will cause compressor motor 20 to operate. In order to avoid operation of damper motors 38 and 42 each time the solenoid coil 136 is energized, thermostat 45*a* is placed in water pan 29. As long as the temperature of the water in pan 29 is above 79 degrees, contact 133 will remain in its actuated position connecting conductors 127 and 130 and dampers 37 and 39 will remain in the positions shown in Figure 1. The period during which the solenoid coil is not energized should be made short enough that the refrigerating system will operate again before the water in pan 29 cools below 79 degrees. The water in pan 29 will then be sprayed over condenser coil 21 and again heated by the compressed and liquefying refrigerant gas. However, if the water in pan 29 should cool to less than 79 degrees before solenoid coil 136 is again energized, dampers 37 and 39 will move to positions shown by dashed lines 46 and 41, respectively, and a moment's delay will occur between the time solenoid coil 136 is again energized and the time compressor 19 again is operated by motor 20. This delay is caused by switch 137 whose function will be described presently.

If damper 39 is moved from one position to another while condenser motor 28 and condenser blower 27 are in operation, the movement of damper 39 is impeded by the pressure of the air driven by blower 27. A large damper motor 42 will have to be employed to overcome this pressure and insure smooth movement of damper 39. I provide a damper position switch 137 which deenergizes contactor coil 80 of starting contactor 67 and stops condenser motor 28 and blower 21 each time damper 39 changes position. Switch 137 is provided with a pivoted blade 138 having an insulated end 139 engaging damper 39. At the initiation of movement of damper 39, insulated end 139 is engaged by damper 39 causing blade 138 to open the circuit of contactor coil 80 by disconnecting conductor 140 from conductor 141. As damper 39 approaches the end of its travel, conductors 140 and 141 are again connected by blade 138 and contactor coil 80 is again energized to start condenser motor 28 and operate condenser blower 27. Since actuator coil 88 of compressor motor 20 is energized through contact 81 of starter contactor 67, operation of compressor 19 is also interrupted or delay each time damper 39 changes its position.

Condenser and compressor control

The condenser motor 28 and the compressor motor 20 are controlled through their starting contactors 67 and 66, respectively, by low pressure relay 33 which is opened when the pressure in the cooling coil 17 falls below a predetermined value and which is closed when the pressure in cooling coil 17 rises above a predetermined value, a high pressure relay 34 which is normally closed and which is opened when the pressure in condenser coil 21 reaches a predetermined high value, a single pole relay 142, and damper position switch 137.

The actuating coil 80 of condenser motor 28 is connected across leads 63 and 61 through thermal overload contact 84, conductor 140, blade 138 of damper position switch 137 when damper 39 is in either of its opposite positions, conductors 141, 143 and 144, contact 145 of relay 142 when it is in its actuated position, contact 146 of low pressure relay 33 when it is in its actuated position, conductors 147 and 113, contact 72 of starter contactor 65, and conductor 100. Contact 145 is actuated to closed position when its actuating winding 153 is connected across leads 63 and 61 when contacts 72 and 146 are both closed through conductors 100, contact 72, and conductors 113 and 147. Condenser motor 28 therefore operates whenever the pressure in cooling coil 17 rises to above a predetermined value and contact 146 is actuated, provided that damper 39 is in either of its opposite positions.

When contactor coil 80 is energized, it actuates contact 81 of the starting actuator 67 connecting contactor coil 88 across leads 61 and 63 through conductor 148, thermal overload contact 93, conductor 149, contact 81, contact 150 of high pressure relay 34, contact 146, conductors 147 and 113, contact 72 and conductor 100. Compressor motor 20 will therefore operate whenever conditioner motor 15 and condenser motor 28 operate provided the low pressure relay contact 146 and the high pressure relay contact 150 are both in closed positions.

It is desirable that the compressor motor continue to operate until it is turned off by the opening of contact 146 of the low pressure relay even though during its operation either toggle switch 94 or time clock 95 contact 96 is opened to stop operation of the air conditioning apparatus in order to prevent a relatively high pressure in cooling coil 17 which may lead to malfunctioning of the refrigerating system as will be explained below. The contact 89 of contactor 66 connects contactor coil 71 of conditioner motor 15 across leads 61 and 63 through conductors 151 and 152, thermal overload contact 75, and conductor 110. The conditioner motor 15 and condenser motor 28 will therefore continue to operate even though switch 94 or contact 96 is opened until the contact 146 of low pressure switch 33 opens.

If the pressure in condenser coil 21 exceeds a predetermined value while contact 146 is still in its closed position, contact 150 of high pressure switch 34 will open deenergizing contactor coil 88 and stopping compressor motor 20. Condenser motor 28, however, will continue to operate so that condenser coil 21 will be cooled by the water sprayed by pump 23 and by the air blown by blower 27 to reduce the pressure. When the pressure falls below the predetermined value, contact 150 will close again and compressor motor 20 will also operate again until either contact 146 of the low pressure switch 33 or the contact 150 of the high pressure switch 34 will open.

When contact 146 of low pressure switch 33 opens, both compressor motor 20 and condenser motor 28 are stopped since actuating winding 153 of relay 142 is deenergized and contact 145 is opened.

Refrigerating system operation only

If the rotary blade 123 of selector switch 45 is moved to position D, only the refrigerating system will operate. It is sometimes necessary to operate only the refrigerating system even though the outdoor temperature conditions call for operation of the evaporative cooling system. This is true of peak "human occupancy heat load" conditions when an abnormally large amount of heat is released in space 10. Such conditions exist occasionally in most air conditioned spaces.

When rotary blade 123 is in position D, and switch 94 and contacts 105 and 106 are maintained in their actuated positions by time clock 95 and its associated coil 97, conductors 107 and 108 are connected and contactor coil 71 is energized starting conditioner motor 15. When conditioner motor 15 is in operation, actuating coil 154 is connected across leads 63 and 61 through conductor 100, contact 72, conductor 113, thermal overload contact 93 and conductor 148. Contact 157 will therefore be actuated and will connect conductors 158 and 159. Solenoid coil 136 will then be connected across leads 63 and 61 through conductors 100 and 99, contact 106, conductor 108, switch blade 121, conductor 122, switch blade 123, conductors 160 and 159, contact 157, and conductors 158 and 161. Actuating coil 135 of damper position relay 132 will be energized simultaneously with the energization of solenoid coil 136 and dampers 39 and 37 will move to, or remain in, the positions suitable for operation of the refrigerating system, as shown in Figure 1.

The energization of solenoid coil 136 opens solenoid valve 31 allowing the refrigerant gas to enter cooling coil 17 and the pressure of the refrigerant gas in cooling coil 17 will therefore be raised. Contact 146 of low pressure relay 33 will therefore be actuated and condenser motor 28 and compressor motor 20 will begin to operate. All controls other than low pressure switch 33 and high pressure switch 150 are by-passed by moving rotary switch blade 123 of the selector switch 45 to position D. Condenser motor 28 and compressor motor 20 will therefore be stopped only if the pressure of the refrigerating gas in cooling coil 17 or in evaporative condenser coil 21 exceed predetermined values. The refrigerating system of the air conditioning apparatus will therefore function until either time clock 95 opens contact 96, switch 94 is opened, or the rotary switch blade 123 of selector switch 145 is moved from position D.

Evaporative cooling operation only

The efficiency of the refrigerating system may be seriously impaired at times by abnormal wind conditions which cause the warm and humid air discharged to the outdoors by duct 26 to be returned to the condenser coil air duct 22 and by the mechanical failure of components of the refrigerating system. Slipping of the belts which link motor 28 to blower 27 and water pump 23, low water supply in water pan 29, clogging of the filter screen usually provided in the intake of the water pump 23, clogging of the outlet apertures of spray pipe 24, and corrosion of condenser coil 21 are examples of mechanical failures which lower the efficiency of the refrigerating system. Until the wind conditions change or the malfunctioning components of the refrigerating system are repaired it will be necessary to employ only the evaporative cooling system of the air conditioning apparatus. By moving rotary switch blade 123 of selector switch 45 to position C, only the evaporative cooling system will be allowed to operate.

With rotary switch blade 123 in position C and switch 94 as well as contacts 105 and 106 in closed position, actuator coil 71 is connected across leads 61 and 63 and conditioner motor 15 is caused to operate. At the same time, actuating coil 80 is connected across leads 61 and 63 through thermal overload contact 84, conductor 140, switch blade 138 of relay 137, conductors 141, 143, 162, 108, contact 106, and conductors 99 and 100. Condenser motor 28 will therefore also be placed in operation. The position of damper 37 will depend on the outdoor temperature as determined by thermostat 44*a* and on the temperature of the water in pan 29 as detected by thermostat 45*a*. The position of damper 37 will be determined in the same manner as it is determined when the rotary switch blade 123 is in position A and only the conditioner motor 15 is operated. When the outdoor temperature is below 75 degrees, conductors 116 and 117 are connected by contact 118 of thermostat 44*a*, and damper 37 moves to or remains in the position shown in Figure 1 to permit a minimum of fresh air and a maximum of recirculated air to be brought into space 10. When the outdoor temperature is 75 degrees or higher, contact 118 connects conductors 117 and 126 and conductors 116 and 117 will be connected only when contact 133 of thermostat 45*a* is actuated. Contact 133 will close only when the temperature of the water in pan 29 exceeds 79 degrees. When this condition occurs when the outdoor temperature is 75 degrees or higher, dampers 37 and 39 are moved to the position shown in Figure 1 since contact 133 will move to closed position short circuiting conductors 127 and 130 and conductors 116 and 117. If the temperature of the outdoor air is less than 75 degrees only damper 39 will move to the position shown in Figure 1. The normal position of damper 39 during the time rotary switch blade 128 is in position D is that indicated by the dashed line 41 of Figure 1. Condenser blower 27 will therefore move fresh air into space 10 unless the temperature of the water in pan 29 exceeds 79 degrees.

It will be noted that when rotary switch blades 123 is in either position A or C, solenoid coil 136 cannot be energized. However, a certain amount of refrigerant gas will seep through the valves of compressor 19 and through the solenoid valve 31 into cooling coil 17. Moreover, some refrigerant gas which is dissolved in the oil always present to greater or lesser extent in cooling coil 17 will vaporize when the temperature of the cooling coil 17 rises. The refrigerant gas will tend to collect in the compressor as the pressure in cooling coil 17 increases and will cause malfunction of compressor 19. In order to avoid such malfunction, compressor motor 20 and condenser motor 28 will be allowed to operate each time the pressure in cooling coil 17 exceeds a predetermined value and contact 146 of the low pressure switch 33 is actuated. Since solenoid valve 31 will remain closed, the compressor motor 20 will operate only the very short time needed to pump the refrigerant gas which has seeped into cooling coil 17 into condenser coil 21. Conditioner motor 15 will operate continuously when rotary switch blade 123 is in position A or C so that the actuator coil 88 of starting conductor 66 of compressor motor 20 will be connected across leads 61 and 63 each time contact 146 is moved to actuated position through conductor 148, thermal overload contact 93, conductor 141, contacts 81, 150 and 146, conductors 147 and 113, contact 72 and conductor 100. In this manner the pressure of the refrigerant gas in coil 17 is kept below a certain predetermined value regardless of the position of rotary switch blade 123 but the time of operation of compressor 19 is kept very short when blade 123 is in positions A or C in order to minimize as much as possible the periods of costly operation of compressor 19.

Automatic operation

When rotary switch blade 123 is in position B and switch 94 and contacts 105 and 106 are in their closed positions, either the refrigerating or the evaporative cooling system will operate depending on the outdoor temperature and humidity conditions. The refrigerating system will be in operation whenever the outdoor dry bulb temperature is above 85 degrees or when the outdoor wet bulb temperature is above 79 degrees. The evaporative cooling system will operate when the outdoor dry bulb temperature is between 75 and 85 degrees and the outdoor wet bulb temperature is below 79 degrees. Finally only conditioner blower 14 will operate if the outdoor dry bulb temperature is below 75 degrees and the temperature of the air in space 10 is below 75 degrees.

If we assume now that the outdoor temperature is below 75 degrees as determined by thermostat 44*a* and the indoor temperature is below 75 degrees, contact 163 of room thermostat 32 is in its open position and contact 118 of thermostat 44*a* connects conductors 116 and 117 so that damper 37 is moved to the position shown in Figure 1 closing off air duct 35*a* and opening air duct 36 to allow a maximum of air to be recirculated into space 10 and to allow only a minimum of fresh air to be moved into space 10 through air duct 35. At this time only conditioner motor 15 will be operating. If the dry bulb outdoor temperature remains below 75 degrees and the temperature in space 10 rises above 75 degrees, contact 163 of room thermostat 32 will move to its closed position connecting actuating coil 80 across leads 61 and 63 through thermal overload contact 84, conductor 140, switch blade 138 of switch 137, conductor 141, contact 164 of wet bulb thermostat 44, conductor 165, contact 166 of dry bulb thermostat 43, conductors 167 and 168, contact 163, conductor 169, switch blade 123, conductor 122, switch blade 121, conductor 108, contact 106, and conductors 99 and 100. Condenser motor 28 and condenser blower 27 will therefore operate moving air cooled by the water sprayed by spray pipe 24 into space 10. Damper 39 will be in the position shown by dashed line 41 of Figure 1 since both contacts 131 and 133 will be in their open positions. When the temperature in space 10 falls below 75 degrees contact 163 will move into its open position and condenser motor 28 will stop operating.

If the outdoor dry bulb temperature now rises above 75 degrees, but does not exceed 85 degrees and the wet bulb temperature is below 79 degrees, contacts 164 and 166 will maintain their positions but contact 118 will move to connect conductor 117 to 126 and cause damper motor 38 to move damper 37 to the dashed line position 46 of Figure 1 since conductors 116 and 117 will no longer be short circuited, both contact 131 and contact 133 being open since solenoid coil 136 is not energized and the water in pan 29 has a temperature lower than 79 degrees. If the temperature in space 10 exceeds 75 degrees but does not exceed 85 degrees, the condenser motor 28 and condenser blower 27 will blow air cooled by the water sprayed by pipe 24 into space 10 since damper 39 will be in the position indicated by dashed line 41. Both blowers 14 and 27 will now be moving fresh air from the outdoors into space 10 insuring a relatively great and continuous change of air in space 10. If the temperature in space 10 should fall to 75 degrees, contact 163 will open and condenser motor 28 and condenser blower 27 will cease operating. The evaporative cooling system will therefore never permit the temperature in space 10 to fall below 75 degrees as long as the outdoor temperature is 75 degrees or above.

When the outdoor dry bulb temperature exceeds 85 degrees and the temperature in space 10 exceeds 75 degrees contact 166 will connect conductor 167 to conductor 170 at the same time breaking the connection of conductors 165 and 167. Solenoid coil 136 will now be connected across leads 63 and 61 through conductors 100 and 99, contact 106, conductor 108, switch blade 121, conductor 122, rotary switch blade 123, conductor 169, contact 163, conductors 168 and 167, contact 166, conductors 170 and 159, contact 157, and conductors 158 and 161. At the same time actuating coil 135 of damper position relay 132 is energized short circuiting conductors 127 and 130 and causing dampers 37 and 39 to move to the positions shown in Figure 1. Damper 37 will allow a minimum of fresh air to enter space 10 and damper 39 will cause all air moved by condenser blower 27 to be blown outdoors. As soon as damper 39 has terminated its movement condenser motor 28 and compressor motor 20 will begin to operate provided that contact 146 of low pressure switch 33 is in its actuated position. Contact 146 will be in this actuated position whenever solenoid coil 136 is energized since the pressure in cooling coil 17 will rise due to admission of refrigerant gas by solenoid valve 31. When the temperature in space 10 falls below 75 degrees, contact 163 will move to its open position and solenoid coil 136 will be deenergized. Solenoid valve 31 therefore closes and contact 131 of damper position relay 132 moves to its open position. Dampers 37 and 39 do not move, however, since the water in pan 29 has been raised in temperature to more than 79 degrees by the heat absorbed from condenser coil 21 and contact 133 of thermostat 45*a* will connect conductors 127 and 130. The temperature of the water will normally remain above 79 degrees during the operation of the refrigerating circuit. Should an abnormal condition arise and allow the temperature of the water to fall below 79 degrees, dampers 37 and 39 will move to positions 46 and 41, respectively.

Upon the next energization of solenoid coil 136, the dampers 37 and 39 will revert to their original positions. When solenoid coil 136 is deenergized, condenser motor 28 and compressor motor 20 will continue to operate until the pressure in cooling coil 17 has been brought down by compressor 19 and contact 145 of low pressure switch 33 moves to open position. When contact 146 moves to open position motors 28 and 20 stop and remain inoperative until solenoid coil 136 is again energized and contact 146 moves to closed position.

The refrigerating system will operate even when the outdoor dry bulb temperature is below 85 degrees and contact 116 does not connect conductors 167 and 170 if the wet bulb temperature of the outdoor air is above 79 degrees. In this case, conductor 170 is connected to conductor 167 through contact 164 which moves to the right when the wet bulb temperature rises above 79 degrees, conductor 165 and contact 166 of thermostat 43 which is in its leftmost position since the dry bulb temperature is below 85 degrees. Solenoid coil 136 will, therefore, be energized if contact 163 of the room thermostat 32 is in its closed position and the refrigerating system will be in operation even though the dry bulb outdoor temperature is below 85 degrees. When the outdoor dry bulb temperature is 85 degrees or higher, the wet bulb thermostat 44 does not exert any control over the energization of solenoid coil 136 since conductors 167 and 170 are directly connected by contact 166 of thermostat 43.

If the refrigerating system is in operation and the dry bulb outdoor temperature drops below 85 degrees while the wet bulb temperature is below 79 degrees and the temperature in spaced 10 is above 75 degrees, contact 166 breaks the connection between conductors 167 and 170 and solenoid coil 136 and actuating coil 135 of damper position relay 132 are deenergized. Compressor motor 20 will continue in operation until contact 146 of low pressure switch 33 moves to its open position and deenergizes actuator coil 89 and actuating coil 153 of circuit breaker 142. Compressor motor 20 will stop but condenser motor 28 will remain unchanged even though contact 131 of damper position switch 132 will be open because contact 133 of thermostat 45*a* will remain closed since the temperature of the water in pan 29 will be above 79 degrees. Condenser motor 28 and condenser blower 27 will therefore continue to move air past condenser coil 21 and to the outdoors until the temperature of the water drops to 79 degrees or below. This insures that the air which moves past condenser coil 21 is expelled to the outdoors until the temperature of the condenser coil 21 and of the water ceases to heat or humidify the air brought in from the outdoors. When the temperature of the water drops to 79 degrees or lower, due mainly to the evaporative cooling of the water sprayed by pipe 24 and movement of air caused by blower 27, contact 133 will move to open position and dampers 37 and 39 will move to dotted line positions 46 and 41, respectively to allow a maximum of fresh air to be brought into space 10. When damper 39 begins to move it actuates switch 137 and will cause condenser motor 28 to cease operation until damper 39 reaches the position indicated by dashed line 41. It will be understood that this interruption of operation of condenser motor 28 will occur each time damper 39 moves from one position to the other.

The time lag between cessation of operation of the refrigeration system and the commencement of operation of the evaporative cooling circuit allows the changeover to take place without an abrupt change in temperature within space 10. During the period of operation of the refrigerating system the temperature of the air within space 10 is maintained at 75 degrees. The outdoor temperature now falling slightly below 85 degrees, the outdoor air which will be moved into space 10 by blower 14 will have a temperature of about 85 degrees which will cause a temperature change of about 10 degrees. During the 10 to 20 minutes required for the changeover from operation of the refrigeration system to operation of the evaporative cooling system, the conditioner blower 14 will continue to recirculate air and to introduce a certain amount of outdoor air having a temperature of about 85 degrees into space 10. While the refrigerant gas in cooling coil 17 will lower the temperature of this air while the compressor 19 is operating even though solenoid valve 31 is closed, the drop in temperature will decrease with the passage of time from the closing of solenoid valve 31. When dampers 37 and 39 finally change their positions to allow maximum amounts of fresh air to be brought in from the outdoors, the temperature differential between the outdoor air and the air in space 10 will be relatively small. In addition, the temperature of the water now having fallen to 79 degrees, the temperature of the air moved by blower 27 is lowered by evaporative cooling decreasing the temperature differential still further. The change in temperature in space 10 will therefore be relatively gradual and the increased circulation of air in space 10 due to the additional air now moved into space 10 by blower 27 will maintain the temperature and humidity conditions in space 10 comfortable to the human occupants.

Actuating winding 154 is energized when contactor coil 71 is energized and remains energized as long as conditioner motor 15 is in operation except when thermal overload contact 93 of compressor motor 20 is opened due to some malfunction of the refrigerating system. In the latter event, contact 157 disconnects conductor 158 from conductor 159 and solenoid coil 136 will not be energized until contact 93 is again moved to closed position. When contact 157 is in its non-actuated position, it connects conductors 159 and 162 and insures that the evaporative cooling system will function if rotary switch blade 123 is in either position B, C, or D. Since compressor 19 is no longer operating, low pressure switch 146 will ordinarily close and connect actuator coil 80 across leads 61 and 63 through contact 84, conductor 149, switch blade 138, conductors 141, 143, 162, and 144, contacts 145, 146, conductors 147 and 113, contact 72 and conductors 100 and 101. Dampers 37 and 39 will remain in their positions until the temperature of the water in pan 29 drops below 79 degrees when contact 133 will move to its open position and dampers 37 and 39 will move to positions 46 and 41, respectively to allow a maximum of fresh air to be moved into space 10. Contact 131 will be open whenever solenoid coil 136 is deenergized and will therefore not prevent this movement of dampers 37 and 39.

In many installations the air conditioning apparatus will be subjected to a peak "human occupancy heat load" at night when the outdoor temperature and humidity conditions call for operation of the evaporative cooling system. In these installations a time clock 171 may be employed to maintain a contact 172 in closed position throughout the peak load period. When the contact 172 is in closed position an actuating coil 173 is connected across leads 61 and 63 through conductor 103, contact 172, and conductors 173*a*, 174, 99 and 100. Coil 173 closes a contact 175 which connects conductors 167 and 170 to by-pass or shunt thermostat 43 when rotary switch blade 123 is in position B. Solenoid coil 136 is connected across leads 61 and 63 through conductors 161 and 158, contacts 157 and 175, conductors 176 and 168, contact 163 when the temperature in space 10 is above 75 degrees, conductor 169, switch blade 123, conductor 122, switch blade 121, conductor 108, contact 106, and conductors 99 and 100. Since solenoid coil 136 will be energized whenever contact 163 moves to closed position, the refrigerating system will be in operation regardless of the outdoor temperature. Time clock 171 may be connected across leads 61 and 64 through conductors 103 and 177.

In the above description, the varying thermostats were described as operating when certain specific temperatures of air or water obtained. It will be obvious that these thermostats may be set to operate when predetermined values of temperature of the air or water are reached. The optimum temperature values at which the thermostats should be set may be obtained empirically for each installation of the air conditioning apparatus.

An important advantage of my new and improved air conditioning apparatus is its versatility of operation which permits use of different components of the apparatus to meet the demands placed on the apparatus by variations in both internal and external conditions. The selector switch 45 allows operation of conditioner blower 14 by itself, the independent operation of either the refrigerating system or the evaporative cooling system, and the automatic operation of either the refrigerating system or the evaporative cooling system as the external and internal conditions reach or fail to reach predetermined conditions of temperature and humidity.

Another important advantage of the air conditioning apparatus is its economy of operation which restricts the relatively costly operation of the refrigerating systems to the periods when only refrigerative cooling will insure comfortable conditions of temperature and humidity and which employs the relatively inexpensive evaporative cooling system at all times when evaporative cooling of the air will provide comfortable temperature and humidity conditions in space 10.

A further advantage of my air conditioning apparatus is that it provides a cooling system for use when the refrigerating system becomes inoperative due to mechanical failures. If the condenser motor 28 and water pump 23 are in operative condition, the evaporative cooling system may be employed during the period when the refrigerating system is being restored to operative condition so that some cooling of the air in space 10 can always be provided.

Figure 4 illustrates a modified form of the air conditioning apparatus. For clarity of explanation, the components of the apparatus illustrated in Figures 1 and 4 have been given like reference numerals. In the modified form of the air conditioning apparatus illustrated in Figure 4, all of the air moved by the conditioner blower 14 is drawn from the conditioned space 10 through the duct 36, the ducts 35 and 35*a* and the dampers 37 and 37*a* of the apparatus of Figure 1 not being provided. In such installation, the fresh air needed for mixing with the recirculated air from the air conditioned space is drawn through the door 200 or the window 201 of the space 10. The damper 39 is shown provided with a handle 202 for manual operation although a damper motor can be provided as in the previously described embodiment. The electrical circuit diagram has not been illustrated since any circuit which will provide for selectively operating both the condenser blower 27 and the conditioner blower 14 when the refrigerating apparatus is kept inoperative is satisfactory. Manual switches may be used instead of the automatic temperature controlled switches previously described.

In operation, when the outdoor air temperature exceeds a certain predetermined temperature, the refrigerating apparatus is turned on and air is moved by the conditioner blower from the conditioned space 10 through the duct 36 over the cooling coils 17 for cooling and back into the conditioned space. Fresh air is admitted to the conditioned space through the door 200 which is usually opened periodically as people enter the conditioned space or through a window 201 which may be opened to any desired degree. During such operation, the damper 39 is in the solid line position and the air driven by the condenser blower 27 after moving past the compressor 19, compressor motor 20, condenser coil 21 is expelled through the duct 26 to the outdoors. This is the conventional operating method of refrigerating air conditioning apparatus.

When the temperature falls below a predetermined temperature, the refrigerating system is stopped by conventional controls so that no refrigerant gas is admitted into the cooling coils 17. The conditioner blower and the condenser blower are allowed to continue to operate but the damper 39 is moved to the broken line position so that the air drawn by the condenser blower from the outdoors through the window 58 is moved into the conditioned space through the duct 40 thus increasing greatly the rate of flow of air into the conditioned space. This air will be cooled by the evaporation of water sprayed by the spray pipe 24 over the condenser coils 21.

If the temperature and humidity conditions are suitable, it may be desired merely to increase the rate of flow of fresh air into the air conditioned space without cooling any portion of the air by evaporative cooling. This may be accomplished by disconnecting the water pump 23, in either of the two embodiments of the invention, from the motor 28 by slipping off the pulley belt driving the water pump. Of course, other transmission devices may be employed if desired. For example, a clutch of any conventional type may be connected between the water pump and the motor 28 to facilitate the disconnection of the water pump from its driving means.

Figure 5 illustrates still another modified form of the air conditioning apparatus. For clarity of explanation, similar components of the apparatuses illustrated in Figures 1 and 5 have been given like reference numerals. In the modified form of the air conditioning apparatus illustrated in Figure 5, the cooling coil 17, the condenser coil 21, the conditioner blower 14, the condenser blower 27 and the motors to drive these elements, and all other elements of the refrigerating apparatus are contained in the housing 300. The housing 300 has a grill in one end, not shown in Figure 1, which is similar to the grill 59 shown in Figure 1, through which air is drawn by the condenser blower 27 into the housing from the room 301 in which the housing is located. Fresh air from the outdoors can move into the room 301 through a window or grill 302 in the wall 303 of the building.

A register 304 connecting the housing 300 and the wall 305 separating the room 301 from the conditioned space 10 is provided with adjustable louvers 306 which may be opened or closed to either permit or prevent air to be drawn from the conditioned space 10 by the conditioner blower 14 over the cooling coil 17 and back into the conditioned space 10 through the duct 48 which is shown provided with a plurality of registers 307 disposed in the conditioned space 10.

The register 304 is also provided with a plurality of adjustable louvers 308 which may be opened or closed to either permit or prevent air to be drawn from the room 301 by the conditioner blower 17 and back into the conditioned space 10 through the duct 48. The register 304 is old in the art and, therefore, the details of its construction are not described. Suffice it to say that the louvers 306 and 308 may be closed or opened to any desired degree by suitable control handles on the sides of the register hidden in the drawing.

In this installation, fresh air needed for mixing with the recirculated air from the air conditioned space is drawn from the outdoors through the register 302 in the wall 303 into the room 301, from the room 301 between the louvers 308 into the register 304, and thence into the housing 300.

In operation, when the outdoor air temperature exceeds a certain predetermined temperature, the refrigerating apparatus is turned on and air is moved by the conditioner blower from the conditioned space between the louvers 306, which are in at least partly open position, through the register 304 over the cooling coils 17 in the housing 300 for cooling and back into the conditioned space through the duct 48. Fresh air is drawn from the room 301, which communicates with the outdoors through the register 302, between the louvers 308, which are also in at least partly open position, through the register 304 into the housing 300, over the cooling coil 17 and then into the conditioned space through the duct 48. The doorway 309 is closed, of course, by a door, not shown, during operation of the apparatus. During such operation, the damper is in the position shown and the air moved by the condenser blower 27 from the room 301 over the various heat producing elements of the refrigerating apparatus and the condenser coil 21 is expelled to the outdoors through the duct 26. This is the conventional operating method of refrigerating air conditioning apparatus. The outlet of duct 26 may be so positioned that none of the warm air it conducts is likely to move back into the room 301 through the register 302.

When the temperature falls below a predetermined temperature, the refrigerating system is stopped by any suitable controls so that no refrigerant gas is admitted into the cooling coil. The louvers 306 are moved into closed position so that recirculation of air from the conditioned space 10 is stopped. The conditioner blower and the condenser blower are allowed to continue to operate but the damper 39 is moved by means of the handle 39 to a position in which it closes the duct 26 and opens the duct 40, so that air drawn by the condenser blower from the outdoors through the register 302 into the housing 300 through a grill, not shown, since it is located in a side of the housing hidden in Figure 5, and through the duct 40 into the conditioned space thus greatly increasing the rate of flow of air into the conditioned space. The air moved by the condenser blower will be cooled by the evaporation of water sprayed over the condenser coil of the refrigerating apparatus. As in the previously described forms of the invention, the water spraying of the condenser coil can be stopped by disconnecting the water pump from the motor which drives it.

While I have illustrated and described preferred embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of my invention and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What is claimed is:

1. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange elements, a first duct means communicating with a conditioned space, a second duct means communicating with the outdoor atmosphere, a first damper means for closing off said first duct means, a first blower means for drawing air from said conditioned space through said first duct means and from the outdoor atmosphere through said second duct means to form a primary mixture, said first blower means moving said primary mixture over one of said heat exchange elements and into said conditioned space, said primary mixture being cooled in its passage over said one of said heat exchange elements, spray means for spraying water over the other of said heat exchange elements, a second blower means for drawing air from the outdoor atmosphere over the other of said heat exchange elements, and a third duct means communicating with the outdoor atmosphere for moving the air drawn by second blower means back to the outdoor atmosphere; an evaporative

cooling system comprising said second blower means, said spray means, and a fourth duct means for moving the air drawn by said second blower means from the outdoor atmosphere and through the water sprayed by said spray means to said conditioned space; and second damper means closing off said third duct means when in one position and closing off said fourth duct means when in a second position, said first and third duct means being open when said refrigerating system is in operation and being closed when said evaporative cooling system is in operation, said first and second blower means operating during the operation of said evaporative cooling system and during the operation of said refrigerating system.

2. In the air conditioning apparatus of claim 1: a first motor means for operating said first damper means; a second motor means for operating said second damper means; and means responsive to the temperature and humidity conditions of the outdoor atmosphere for placing said refrigerating system in operation when predetermined values of temperature and humidity of the outdoor atmosphere are exceeded and for placing said evaporating cooling system in operation when said predetermined values are not exceeded, said last mentioned means controlling said first and second motor means to close said first and third duct means when said evaporative cooling system is placed in operation and to open said first and third duct means when said refrigerating system is placed in operation.

3. In the air conditioning apparatus of claim 2: means responsive to the temperature of the water sprayed by said spray means and associated with said second motor means for closing said fourth duct means when the temperature of said water exceeds a predetermined value.

4. In the air conditioning apparatus of claim 3: means responsive to the movement of said second damper means for stopping operation of said second blower means when said second damper means is being moved from one position to another.

5. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange elements, a first duct means communicating with a conditioned space, a second duct means communicating with the outdoor atmosphere, a first damper means for closing off said first duct means, a first blower means for drawing air from said conditioned space through said first duct means and from the outdoor atmosphere through said second duct means to form a primary mixture, said first blower means moving said primary mixture over one of said heat exchange elements and into said conditioned space, said primary mixture being cooled in its passage over said one of said heat exchange elements, spray means for spraying water over the other of said heat exchange elements, a second blower means for drawing air from the outdoor atmosphere over the other of said heat exchange elements, and a third duct means communicating with the outdoor atmosphere for moving the air drawn by second blower means back to the outdoor atmosphere; an evaporative cooling system comprising said second blower means, said spray means, and a fourth duct means for moving the air drawn by said second blower means through the water sprayed by said spray means to said conditioned space; second damper means associated with said third and fourth duct means, said second damper means closing off said third duct means when in one position and closing off said fourth duct means when in a second position, said first and third duct means being open when said refrigerating system is in operation and being closed when said evaporative cooling system is in operation, said first blower means operating during the operation of said evaporative cooling system and during the operation of said refrigerating system; a first motor means for operating said first damper means, a second motor means for operating said second damper means, and means responsive to the temperature and humidity conditions of the outdoor atmosphere for placing said refrigerating system in operation when predetermined values of temperature and humidity of the outdoor atmosphere are exceeded and for placing said evaporating cooling system in operation when said predetermined values are not exceeded, said last mentioned means controlling said first and second motor means to close said first and third duct means when said evaporative cooling system is placed in operation and to open said first and third duct means when said refrigerating system is placed in operation; and means responsive to the movement of said second damper means for stopping operation of said second blower means when said damper means is being moved from one position to another.

6. In an air conditioning apparatus, a refrigerating system comprising a pair of heat exchange elements, a first duct means communicating with a conditioned space, a second duct means communicating with the outdoor atmosphere, a first damper means for closing off said first duct means, a first blower means for drawing air from said conditioned space through said first duct means and from the outdoor atmosphere through said second duct means to form a primary mixture, said first blower means moving said primary mixture over one of said heat exchange elements and into said conditioned space, said primary mixture being cooled in its passage over said one of said heat exchange elements, spray means for spraying water over the other of said heat exchange elements, a second blower means for drawing air from the outdoor atmosphere over the other of said heat exchange elements, and a third duct means communicating with the outdoor atmosphere for moving the air drawn by second blower means back to the outdoor atmosphere; an evaporative cooling system comprising said second blower means, said spray means, and a fourth duct means for moving the air drawn by said second blower means through the water sprayed by said spray means to said conditioned space; second damper means associated with said third and fourth duct means, said second damper means closing off said third duct means when in one position and closing off said fourth duct means when in a second position, said first and third duct means being open when said refrigerating system is in operation and being closed when said evaporative cooling system is in operation, said first blower means operating during the operation of said evaporative cooling system and during the operation of said refrigerating system; a first motor means for operating said first damper means; a second motor means for operating said second damper means; and means responsive to the temperature and humidity conditions of the outdoor atmosphere for placing said refrigerating

system in operation when predetermined values of temperature and humidity of the outdoor atmosphere are exceeded and for placing said evaporating cooling system in operation when said predetermined values are not exceeded, said last mentioned means controlling said first and second motor means to close said first and third duct means when said evaporative cooling system is placed in operation and to open said first and third duct means when said refrigerating system is placed in operation; and means responsive to the temperature of the outdoor atmosphere and associated with said first motor means to move said first damper means to open said first duct means when the temperature of the outdoor atmosphere falls below a predetermined low value and to move said first damper means to close said first duct means when the temperature of the outdoor atmosphere rises above said predetermined low value temperature.

7. The air conditioning apparatus of claim 6: and means responsive to the temperature of the air within said conditioned space for arresting operation of said second blower means when the temperature of the air within said conditioned space falls below a predetermined low value and for starting operation of said second blower means when the temperature of the air within said conditioned space rises above said predetermined low value.

8. The air conditioning apparatus of claim 1: and manually operated switch means operatively associated with said refrigerating and evaporative cooling systems for permitting selective choice of operation of either of said systems.

9. The air conditioning apparatus of claim 1: and automatic control means operatively associated with said refrigerating and evaporative cooling systems and responsive to predetermined temperature and humidity conditions of the outdoor atmosphere for selectively operating either of said systems.

10. The air conditioning apparatus of claim 9: and manually operated switch means operatively associated with said refrigerating and evaporative cooling systems and said automatic control means for permitting automatic and manually selective choice of operation of either of said systems.

11. In an air conditioning apparatus: a refrigerating system comprising a cooling coil a condenser coil, compressor means connected between said coils for exhausing a refrigerant gas from said cooling coil into said condenser coil, valve means between said condenser coil and said cooling coil for controlling the flow of said refrigerant gas from said condenser coil to said cooling coil, a first duct means communicating with a conditioned space, a second duct means communicating with the outdoor atmosphere, a first damper means having two operative positions associated with said first and second duct means, said first damper means closing off said first duct means when in one of said two operative positions and opening said first duct means when in the other of said two operative positions, a first blower means for moving air past said cooling coil, said first blower means circulating air from said conditioned space and from said outdoor atmosphere over said cooling coil and into said conditioned space when said first damper is in one of said two operative positions, said first blower means circulating air only from the outdoor atmosphere over said cooling coil and into said conditioned space when said first damper means is in the other of said two operative conditions, said air being cooled in passing over said cooling coil when said valve means permits refrigerant gas to move from said condenser coil to said cooling coil, means for spraying water over said condenser coil, a second blower means for drawing air from the outdoor atmosphere over said condenser coil, and a third air duct means communicating with the outdoor atmosphere for moving air drawn from the outside atmosphere by said second blower means back to said outdoor atmosphere; an evaporative cooling system comprising said second blower means, said water spray means, and a fourth air duct means communicating with said conditioned space for moving air moved by said second blower means through the water sprayed over said condenser coil into said conditioned space; and a second damper means having two operative positions operatively associated with said third and fourth duct means, said second damper means closing said third duct means when in one of said two operative positions and closing said fourth duct means when in the other of said two operative conditions, said first damper means being in said other of its two operative positions and said second damper means being in said one of its two operative positions when said refrigerating system is in operation, said first damper means being in said one of its two operative positions and said second damper means being in said other of its two operative positions when said evaporative cooling system is in operation.

12. In the air conditioning apparatus of claim 11: a first motor means for operating said first damper means, a second motor means for operating said second damper means; and means responsive to predetermined conditions of temperature and humidity of the outdoor atmosphere for maintaining said refrigerating system in operation when the temperature and humidity of the outdoor atmosphere exceed predetermined values and for maintaining said evaporative cooling system in operation when the temperature and humidity of the outdoor air do not exceed said predetermined values, said last mentioned means controlling said first and second motor means to close said first and third duct means and open said fourth duct means when said evaporative cooling system is in operation and to open said first and third duct means and close said fourth duct means when said refrigerating system is in operation.

13. In the air conditioning apparatus of claim 12: means responsive to the temperature of the water sprayed by said spray means and operatively associated with said second motor means for closing said fourth duct means when the temperature of said water exceeds a predetermined value.

14. In the air conditioning apparatus of claim 13: means responsive to the movement of said second damper means for stopping operation of said second blower means when said second damper means is being moved by said second motor means from one of its two operative positions to the other.

15. In the air conditioning apparatus of claim 14: means operatively associated with said compressor and said first and second motor means for placing said evaporative cooling system in operation when said compressor fails to function when the temperature and humidity of the outdoor temperature exceeds said predetermined values.

16. In an air conditioning apparatus: a refrigerating system comprising a cooling coil, a condenser coil, compressor means connected between said coils for exhausing a refrigerant gas from said cooling coil into said condenser coil, valve means between said condenser coil and said cooling coil for controlling the flow of said refrigerant gas from said condenser coil to said cooling coil, a first duct means communicating with a conditioned space, a second duct means communicating with the outdoor atmosphere, a first damper means having two operative positions associated with said first and second duct means, said first damper means closing off said first duct means when in one of said two operative positions and opening said first duct means when in the other of said two operative positions, a first blower means for moving air past said cooling coil, said first blower means circulating air from said conditioned space and from said outdoor atmosphere over said cooling coil and into said conditioned space when said first damper means is in said one of said two operative positions, said first blower means circulating air only from the outdoor atmosphere over said cooling coil and into said conditioned space when said first damper means is in the other of said two operative conditions, said air being cooled in passing over said cooling coil when said valve means permits refrigerant gas to move from said condenser coil to said cooling coil, means for spraying water over said condenser coil, a second blower means for drawing air from the outdoor atmosphere over said condenser coil, and a third air duct means communicating with the outdoor atmosphere for moving air drawn from the outside atmosphere by said second blower means back to said outdoor atmosphere; an evaporative cooling system comprising said second blower means, said water spray means, and a fourth air duct means communicating with said conditioned space for moving air drawn by said second blower means into said conditioned space; and a second damper means having two operative positions operatively associated with said third and fourth duct means, said second damper means closing said third duct means when in one of said two operative positions and closing said fourth duct means when in the other of said two operative conditions, said first damper means being in said other of its two operative positions and said second damper means being in said one of its two operative positions when said evaporative cooling system is in operation, said first damper means being in said one of its two operative positions, said second damper means being in said other of its two operative positions when said refrigerating system is in operation, a first motor means for operating said first damper means, a second motor means for operating said second damper means; and means responsive to predetermined conditions of temperature and humidity of the outdoor atmosphere for maintaining said refrigerating system in operation when the temperature and humidity of the outdoor temperature exceed predetermined values and for maintaining said evaporative cooling system in operation when the temperature and humidity of the outdoor air do not exceed said predetermined values, said last mentioned means controlling said first and second motor means to close said first and third duct means and open said fourth duct means when said evaporative cooling system is in operation and to open said first and third duct means and close said fourth duct means when said refrigerating system is in

operation; and means responsive to the movement of said second damper means for stopping operation of said second blower means when said second damper means is being moved by said second motor means from one of its two operative positions to the other.

17. In an air conditioning apparatus: a refrigerating system comprising a cooling coil, a condenser coil, a compressor means connected between said coils for exhausting a refrigerant gas from said cooling coil into said condenser coil, valve means between said condenser coil and said cooling coil for controlling the flow of said refrigerant gas from said condenser coil to said cooling coil, a first duct means communicating with a conditioned space, a second duct means communicating with the outdoor atmosphere, a first damper means having two operative positions associated with said first and second duct means, said first damper means closing off said first duct means when in one of said two operative positions and opening said first duct means when in the other of said two operative positions, a first blower means for moving air past said cooling coil, said first blower means circulating air from said conditioned and from said outdoor atmosphere over said cooling coil and into said conditioned space when said first damper means is in said other of said two operative positions, said first blower means circulating air only from the outdoor atmosphere over said cooling coil and into said conditioned space when said first damper means is in said one of said two operative conditions, said air being cooled in passing over said cooling coil when said valve means permits refrigerant gas to move from said condenser coil to said cooling coil, means for spraying water over said condenser coil, a second blower means for drawing air from the outdoor atmosphere over said condenser coil, and a third air duct means communicating with the outdoor atmosphere for moving air drawn from the outside atmosphere by said second blower means back to said outdoor atmosphere; an evaporative cooling system comprising said second blower means, said water pump means, and a fourth air duct means communicating with said conditioned space for moving air drawn by said second blower means into said conditioned space; a second damper means having two operative positions operatively associated with said third and fourth duct means, said second damper means closing said third duct means when in one of said two operative positions and closing said fourth duct means when in the other of said two operative positions, said first damper means being in said other of its two operative positions and said second damper means being in said one of its two operative positions when said evaporative cooling system is in operation, said first damper means being in said one of its two operative positions and said second damper means being in said other of its two operative positions when said refrigerating system is in operation; a first motor means for operating said first damper means; a second motor means for operating said second damper means; and means responsive to predetermined conditions of temperature and humidity of the outdoor atmosphere for maintaining said refrigerating system in operation when the temperature and humidity of the outdoor atmosphere exceeds predetermined values and for maintaining said evaporative cooling system in operation when the temperature and humidity of the outdoor air do not exceed said predetermined values, said

last mentioned means controlling said first and second motor means to close said first and third duct means and open said fourth duct means when said evaporative cooling system is in operation and to open said first and third duct means and close said fourth duct means when said refrigerating system is in operation; and means operatively associated with said first motor means responsive to the temperature of the outdoor air and operative when said evaporative cooling system is in operation to move said first damper means to open said first duct means when the temperature of the outdoor atmosphere falls below a predetermined low value and to close said first duct means when the temperature of the outdoor atmosphere rises above said predetermined low value.

18. The air conditioning apparatus of claim 17: and means responsive to the temperature of the air within said conditioned space and operative when said evaporative cooling system is in operation for arresting operation of said second blower means when the temperature of the air within said conditioned space falls below a predetermined low value and for starting operation of said second blower means when the temperature of the air within said conditioned space falls below a predetermined low value and for starting operation of said second blower means when the temperature of the air within said conditioned space rises above said last mentioned predetermined low value.

19. The air conditioning apparatus of claim 11: and manually operated switch means operatively associated with said refrigerating and evaporative cooling systems for permitting selective choice of operation of either of said systems.

20. The air conditioning apparatus of claim 11: and automatic control means operatively associated with said refrigerating and evaporative cooling system and responsive to predetermined temperature and humidity conditions of the outdoor atmosphere for selectively operating either of said systems.

21. The air conditioning apparatus of claim 9: and manually operated switch means operatively associated with said refrigerating and evaporative cooling system and said automatic control means for permitting automatic and manually selective choice of operation of either of said systems.

22. In the air conditioning apparatus of claim 11: and pressure responsive switch means connected between said cooling coil and said compressor and operatively associated with said compressor for maintaining said compressor in operation when the pressure of said refrigerant in said cooling coil exceeds a predetermined value.

23. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange units, a first blower means for moving air over one of said heat exchange units and into a conditioned space, said air being cooled in moving over said one of said heat exchange units, a cooling means for removing heat from the other of said heat exchange units comprising a second blower means and a water spray means, said water spray means forming a water spray over said other of said exchange units, said second blower means moving air from the outdoor atmosphere over said other of said heat exchange units and back to the outdoor atmosphere; and an evaporative cooling system comprising said spray means, said second blower, and means for directing the air moved by said second blower means from the outdoor atmosphere through said water spray to said conditioned space when said evaporative cooling system is in operation, said first blower means being in operation during the operation of said refrigerating system and said evaporative cooling system.

24. The air conditioning apparatus of claim 23: and manually operable means for selectively placing either of said systems in operation.

25. The air conditioning apparatus of claim 23: and automatic control means responsive to predetermined values of temperature and humidity of the outdoor air for selective operation of either of said systems.

26. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange units, a first blower means for moving air from a conditioned space and from the outdoor atmosphere over one of said heat exchange units and into said conditioned space, said air being cooled in moving over said one of said heat exchange units, a cooling means for removing heat from the other of said heat exchange units comprising a second blower means and a water spray means, said water spray means forming a water spray over said other of said heat exchange units, said second blower moving air from the outdoor atmosphere over said other of said heat exchange units and back to the outdoor atmosphere; and an evaporative cooling system comprising said spray means, said second blower, and means for directing the air moved by said second blower from the outdoor atmosphere through said water spray to said conditioned space when said evaporative cooling system is in operation; and means operatively associated with said first blower for allowing said first blower to move air from the outdoor atmosphere only into said conditioned space when said evaporative cooling system is in operation.

27. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange units, a first blower means for moving air from a conditioned space and from the outdoor atmosphere over one of said heat exchange units and into said conditioned space, said air being cooled in moving over said one of said heat exchange units, a cooling means for removing heat from the other of said heat exchange units comprising a second blower for moving air from the outdoor atmosphere over said other of said heat exchange units and back to the outdoor atmosphere; and means for increasing the volume of air moved from the outdoor atmosphere into said conditioned space when said refrigerating system is not in operation, said last mentioned means including said second blower and means for directing the air moved by said second blower from the outdoor atmosphere into said conditioned space.

28. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange units, a first blower means for moving air from a conditioned space and from the outdoor atmosphere over one of said heat exchange units and into said conditioned space, said air being cooled in moving over said one of said heat exchange units, a cooling means for removing heat from the other of said heat exchange units comprising a second blower for moving air from the outdoor atmosphere over said other of said heat exchange units and back to the outdoor atmosphere; and means for increasing the volume of air moved from the outdoor atmosphere into said conditioned space when said refrigerating system is not in operation, said last mentioned

means including said second blower and means for directing the air moved by said second blower from the outdoor atmosphere into said conditioned space; and means operatively associated with said first blower for allowing said first blower to move air only from the outdoor atmosphere into said conditioned space when said refrigerating system is not in operation.

29. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange elements, a first duct communicating with a conditioned space, a first blower for moving air from the outdoor atmosphere over one of said heat exchange elements and through said first duct into said conditioned space, said air moved over said one of said heat exchange elements being cooled in its passage over said one of said heat exchange elements, spray means for spraying water over the other of said heat exchange elements, and a second blower for moving air from the outdoor atmosphere over said other of said heat exchange elements and back to said outdoor atmosphere; a second duct communicating with said conditioned space; and means for directing the air moved by said second blower from the outdoor atmosphere into said second duct and thereby into said conditioned space whereby said blowers may simultaneously move air only from the outdoor atmosphere into said conditioned space.

30. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange elements, a first and second duct communicating with a conditioned space, a first blower for moving air from said first duct and from the outdoor atmosphere over one of said heat exchange elements and through said second duct into said conditioned space, said air moved by said first blower being cooled in its passage over said one of said heat exchange elements, spray means for spraying water over the other of said heat exchange elements, and a second blower for moving air from the outdoor atmosphere over said other of said heat exchange elements and back to said outdoor atmosphere; a third duct communicating with said conditioned space; means for directing the air moved by said second blower from the outdoor atmosphere into said third duct and thereby into said conditioned space; and means for closing said first duct whereby said blowers may simultaneously move air only from the outdoor atmosphere into said conditioned space.

31. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange units, a first blower means for moving air from a conditioned space over one of said heat exchange units and back into said conditioned space, said air being cooled in moving over said one of said heat exchange units, a cooling means for removing heat from the other of said heat exchange units comprising a second blower means and a water spray means, said water spray means forming a water spray over said other of said heat exchange units, said second blower moving air from the outdoor atmosphere over said other of said heat exchange units and back to the outdoor atmosphere; and an evaporative cooling system comprising said spray means, said second blower, and means for directing the air moved by said second blower from the outdoor atmosphere through said water spray to said conditioned space when said evaporative cooling system is in operation, said first and second blowers operating simultaneously when said evaporative cooling system is in operation.

32. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange units, a first blower means for moving air from a conditioned space over one of said heat exchange units and back into said conditioned space, said air being cooled in moving over one of said heat exchange units, a cooling means for removing heat from the other of said heat exchange units comprising a second blower for moving air from the outdoor atmosphere over said other of said heat exchange units and back to the outdoor atmosphere; and means for increasing the volume of air moved into said conditioned space when said refrigerating system is not in operation, said last mentioned means including said second blower and means for directing the air moved by said second blower from the outdoor atmosphere into said conditioned space.

33. In an air conditioning apparatus: a refrigerating system comprising a pair of heat exchange elements, a first duct and a second duct communicating with the conditioned space, a first blower for moving air from the conditioned space through said first duct over one of said heat exchange units and back to said conditioned space through said second duct, the air moved over said one of said heat exchange elements being cooled in its passage over said one of said heat exchange elements, spray means for spraying water over the other of said heat exchange elements, and a second blower for moving air from the outdoor atmosphere over said other of said heat exchange elements and back to said outdoor atmosphere; a third duct communicating with said conditioned space; and means for directing the air moved by said second blower from the outdoor atmosphere into said third duct and thereby into said conditioned space.

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