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AIR CONDITIONING SYSTEM

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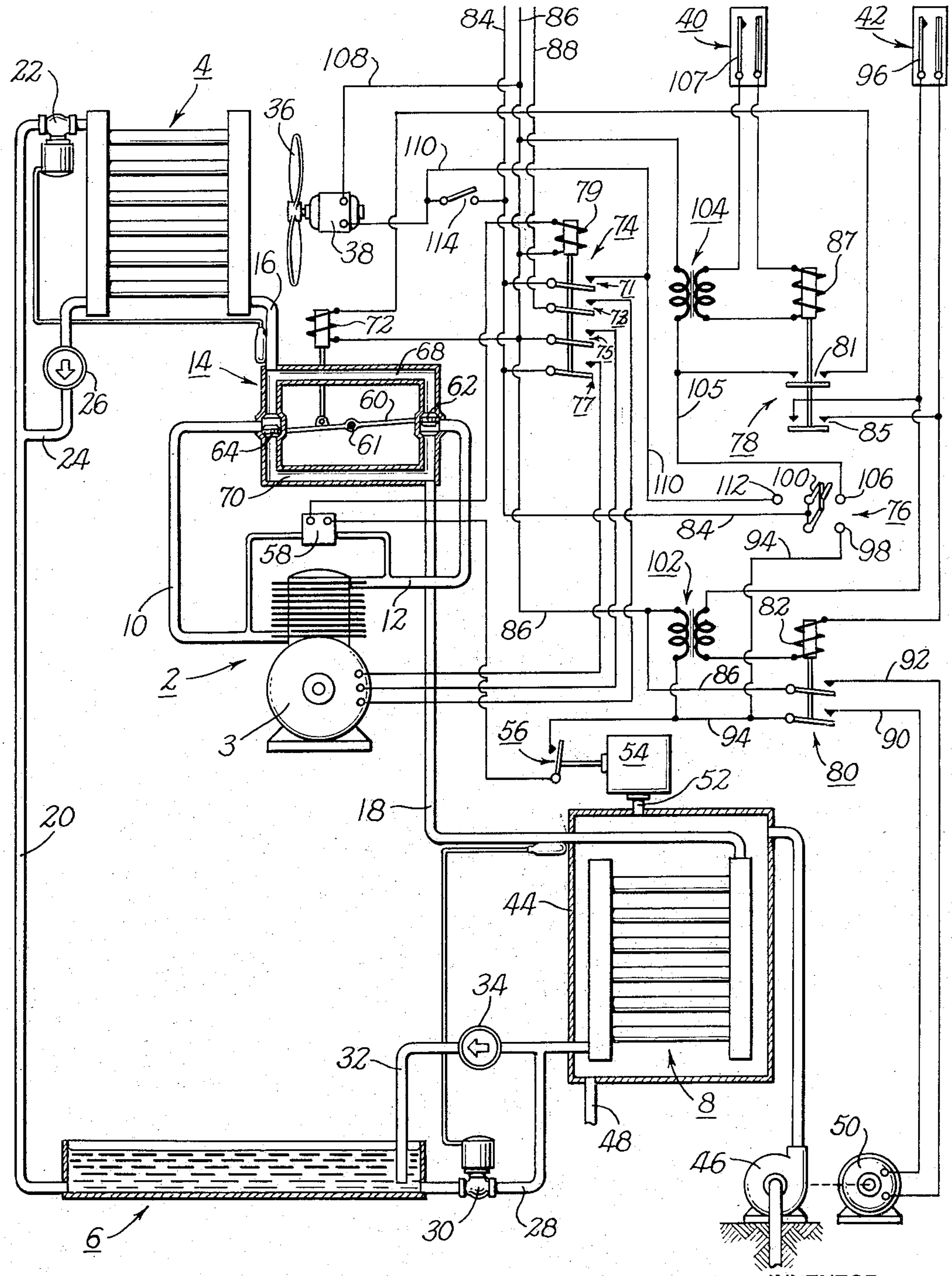

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AIR CONDITIONING SYSTEM

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This invention relates to air conditioning, and more in particular, to a system for selectively heating or cooling air passing to or within a conditioned space so as to control automatically the temperature during the cool or "winter" periods, and also during the warm or "summer" periods.

An object of this invention is to provide a fully automatic air conditioning system which overcomes many practical difficulties which have been encountered in the past with other systems. A further object is to provide such a system where the operation is carried on automatically with full assurance that no harm will result from improper manipulation of the controls and other circumstances which might be created.

A further object is to provide an air conditioning system utilizing a medium, such as well water, as a source of heat during the periods of winter operation and also as a heat-absorbing medium during the periods of summer operation, and wherein the inadequacy or total failure of supply of the well water or other medium will result in discontinuing the air conditioning operation. A further object is to provide for all of the above in such a manner as to insure efficient and dependable operation. These and other objects will be in part obvious and in part pointed out below.

In the drawings the single figure is a schematic representation of an illustrative embodiment of the invention.

Referring to the drawing, an air conditioning system is represented having: a compressor 2 driven by a motor 3; an evaporator-condenser unit 4; a receiver 6; and, a condenser-evaporator unit 8. Compressor 2 has an inlet 10 and an outlet 12 which are connected to a refrigerant flow-reversing valve 14. Units 4 and 8 act respectively as the evaporator and the condenser of the system during "summer" operation, and respectively as the condenser and the evaporator during "winter" operation. Evaporator-condenser unit 4 is connected to valve 14 through a pipe 16, and condenser-evaporator unit 8 is connected to the valve through a pipe 18. Receiver 6 is connected through a pipe 20 and an expansion valve 22 to the top of the evaporator-condenser unit 4; and, pipe 20 has an expansion valve 22 therein with its bulb in contact with pipe 16.

There is a reverse-flow by-pass pipe 24 which connects pipe 20 to the bottom of the evaporator-condenser unit 4, and which has a one-way valve 26 therein so that there is free flow from unit 4 to the receiver, but not in reverse. Thus, when unit 4 is acting as a condenser, the liquid refrigerant flows downwardly from the bottom of the unit to the receiver, but when unit 4 is acting as an evaporator, the upward flow from the receiver must be through the expansion valve 22. Receiver 6 is also connected in a somewhat similar manner to the condenser-evaporator 8 by a pipe 28 with an expansion valve 30 therein through which the liquid refrigerant must flow from the receiver during "winter" operation, and a by-pass pipe 32 with a one-way valve 34 therein through

which the liquid refrigerant flows to the receiver during "winter" operation.

The air being conditioned is directed over the evaporator-condenser unit 4 by a fan 36 driven by a motor 38, and the temperature of the conditioned air within the conditioned space is sensed by a heating or "winter" thermostat 40 and also by a cooling or "summer" thermostat 42. The condenser-evaporator unit 8 is enclosed within a water shell or tank 44 through which there is constant circulation of water during both "summer" and "winter" operations. The water is supplied by a pump 46 from a well, and flows from the tank through a restricted outlet 48. Pump 46 is driven by a motor 50 which is started automatically whenever there is a demand for either heating or cooling.

Connected to tank 44 by a pipe 52 is a switch-operating pressure unit 54 which closes an electric switch 56 when the pressure within the tank 44 is raised by the pumping of water into the tank. As will be explained more fully below, switch 56 is a master control switch, which is open whenever water is not being supplied to tank 44, but which closes whenever there is a satisfactory supply of water. The opening of this master control switch prevents the operation of the refrigeration system and therefore, the refrigeration system cannot be operated when there is not a satisfactory supply of water to cool or heat the condenser-evaporator unit 8. The motor compressor has a high and low cut-off switch unit 58 which stops the compressor motor 3 whenever the pressure of the compressed gas exceeds a predetermined high value, or when the suction pressure at the intake of the compressor falls below a predetermined value.

It has been indicated above that there is a flow-reversing valve 14, which is represented somewhat schematically, but which is constructed to give the refrigerant flow paths as referred to above and as will now be described in detail. Valve 14 has a reversing valve mechanism represented in the form of a lever 60 pivoted at 61 and carrying at the right a double-seat valve member 62, and at the left a similar valve member 64. When the lever 60 is in the normal rest position shown, valve member 62 has its top valve seat closing a port above it to a passageway 68; and, a port below the valve member is open thus connecting pipe 12 to a passageway 70. This causes the compressed gas from the compressor to flow through pipe 18 to the condenser-evaporator unit 8.

Valve member 64 is at this time positioned so as to close its lower port to passageway 70 and to open its upper port to passageway 68; and, this connects the intake pipe from the suction side of the compressor through passageway 68 and pipe 16 to the evaporator-condenser unit 4. Thus, when the compressor is in operation, refrigerant is withdrawn from unit 4, thereby causing this unit to operate as an evaporator and to cool the air blown over it by fan 36. The compressed refrigerant then flows to unit 8 which acts as a condenser so that the refrigerant condenses, and the liquid refrigerant flows through the one-way valve 34 and pipe 32 to receiver 6. The liquid refrigerant then flows from receiver 6 through pipe 20 and expansion valve 22 to unit 4 thus completing the refrigerant flow path during the cooling cycle. As indicated above, the expansion valve 22 is controlled automatically by its bulb, thus to maintain the desired operating conditions.

During the heating cycle, the reversing valve lever 60 is rocked clockwise by the energization of a solenoid 72. This moves valve member 64 up to close its top port and open its bottom port and moves valve member 62 down to close its bottom port and open its top port. This connects the refrigerant inlet pipe 10 through passageway 70 and pipe 18 to unit 8, and connects the refrigerant outlet pipe 12 through passageway 68 and pipe 16 to unit **4**. Thus, the compressed refrigerant flows from the compressor through pipe **12**, passageway **68** and pipe **16** to unit **4**, and it heats the air which is blown over it by fan **36**. The refrigerant condenses and in liquid form flows through one-way valve **26** and pipes **24** and **20** to receiver **6**.

The intake or low side of the compressor now is connected through pipe **10**, passageway **70** and pipe **18** to unit **8**, thus to cause unit **8** to act as an evaporator. Liquid refrigerant flows to unit **8** through pipe **28** and expansion valve **30** which has its control bulb on pipe **18**. The refrigerant evaporating in unit **8** withdraws heat from the surrounding water which is being pumped through tank **44**. Thus, the system withdraws heat from the water and delivers it to the air and operates as a "heat pump" or reverse cycle unit.

The electrical control systems includes: the heating or "winter" thermostat **40** and the cooling or "summer" thermostat **42**, referred to above; a compressor motor relay **74**; a manual double-throw switch **76** which is swung to the right for automatic operation of the system and to the left for the operation of the fan alone when no heating or cooling is desired; a heating relay **78** which is energized by the closing of the heating thermostat **40**; a pump motor relay **80** which is energized to start the pump; and, the master control pressure switch **56** referred to above.

This control system gives fully automatic operation when either heating or cooling is required, with the heating thermostat **40** controlling the heating operation and with the cooling thermostat **42** controlling the cooling operation. However, switch **76** may be operated to render the heating and cooling operations inoperative by throwing this switch from the right-hand "automatic" position to the left-hand "fan" position wherein the fan **36** operates continuously. As indicated above, the reversing valve **14** is in the position shown during the cooling operation, and it is reversed during the heating operation by the energization of solenoid **72**. The compressor motor relay **74** has four normally open switches **71**, **73**, **75** and **77**, which are all closed by the energization of solenoid **79** to supply power to the compressor motor **3**. The heating relay **78** has two normally open switches which are closed by the energization of a solenoid **87**, there being a heating switch **81** and a pump switch **85**.

Electrical power is supplied for the electric motors **3**, **38** and **50** and for the control system by three power lines **84**, **86** and **88**. The pump motor relay **80** has a pair of switches which are connected respectively to pump motor lines **94** and **86**, and which are closed simultaneously by the energization of a solenoid **82** to connect line **90** to a line **94** and connect line **92** to power line **86**. Line **94** is connected to a terminal **98** of switch **76** which has its double armature **100** connected to power line **84** for "automatic" operation. With switch **76** set for "automatic" operation, its armature is swung to the right so as to connect line **84** to line **94**, and the closing of relay **80** connects the pump motor across power lines **84** and **86**. Also connected across lines **94** and **86** is the primary winding of a relay power transformer **102** which has its secondary winding connected to a series circuit formed by solenoid **82** of relay **80** and the switch **96** of the cooling thermostat **42**; and, the pump switch **85** of the heating relay **78** is connected in parallel with switch **96**. Therefore, when the cooling thermostat switch **96** closes so as to call for cooling, or if switch **85** is closed so as to call for heating, solenoid **82** is energized and the switches of relay **80** are closed. As indicated above, this starts the pump motor **50** which is the first step toward operating the system.

Solenoid **87** of the heating relay **78** is connected to the secondary winding of a transformer **104**, the primary winding of which has one side connected to line **86** and the other side connected to a right-hand terminal **106** of switch **76**, and thence to line **84** when switch **76** is in the position for automatic operation. The circuit of solenoid **87** includes the switch **107** of heating relay **40** so that when switch **76** is positioned for automatic operation, the closing of the heating thermostat switch energizes solenoid **87** and closes the switches **81** and **85** of relay **78**.

The compressor motor relay **74** has its solenoid **79** connected at one side to line **86**, and the other side is connected in series with the high and low cut-off switch unit **58** and the water pressure switch **56** to line **94**. It has been indicated above that line **94** is connected to line **84** when switch **76** is positioned for automatic operation. The high and low cut-off switch unit **58** has two switches which are normally closed, one of which opens when the compressor outlet pressure is excessively high, and the other of which opens when the suction is excessively low. The water pressure switch **56** is normally open and is closed only when pump **46** is operating and has supplied sufficient water to the tank **44** to raise the pressure therein to a predetermined value. Therefore, with switch **76** positioned for automatic operation, the circuit of solenoid **79** is normally conditioned to energize this solenoid whenever the pump **46** is started.

It has been indicated above that pump **46** is started by a demand for either cooling or heating, and either of such demands may be effective to close the switches of relay **80** and start the pump motor. In this way the initial effect of a demand for either heating or cooling is to start the pump motor so as to supply water to tank **44**. The supplying of water to this tank then raises the pressure and closes switch **56**, and this closes the electric circuit outlined above and energizes solenoid **79**, and this closes the switches of the compressor motor relay **74**. The closing of these switches **73**, **75** and **77** starts the compressor motors and operates compressor **2**.

The paths of refrigerant flow for the heating and cooling cycles have been outlined above. However, it should be noted here that the flow-reversing valve **14** is positioned as shown for the "summer" or air-cooling operation, and the flow is reversed for the "winter" or heating operation. This flow reversal is effected by the energization of solenoid **72** which has one side connected to line **86** and the other side connected through switch **81** of the heating relay **78** and a line **105** to terminal **106** of switch **76** which is at this time connected to line **84** in the manner outlined above. In this way, the closing of the heating relay **78** reverses the refrigerant flow,

Fan motor **38** has one side connected through a line **108** to line **86**, and the other side is connected through a line **110** to switch **71** of relay **74**, and the other side of switch **71** is connected to line **84**. Therefore, the fan is operated whenever the compressor is operated for either heating or cooling. This same side of the fan motor is also connected through line **110** to the left-hand terminal **112** of switch **76**, which terminal is connected to line **84** when this switch is positioned for "fan" operation. Therefore, when switch **76** is positioned at the left for "fan" operation the fan motor is energized continuously so as to operate the fan and circulate air regardless of the temperature conditions. This permits the operation of the system for air circulation when neither heating nor cooling is desired. Line **110** is also connected to a manual switch **114**, the other side of which is connected to line **84**. Thus, the fan may be operated continuously by closing switch **114** even though switch **76** is set for automatic operation. Such continuous fan operation may be desirable when the conditions are such as to require a small amount of cooling occasionally with continuous air circulation.

The operation of the system described above may be fully automatic so as to maintain predetermined conditions over a wide range of the heating or cooling loads. Illustratively, the heating thermostat **40** may be set within an operating range of 68 degrees to 72 degrees F., while the cooling thermostat **42** is set within an operating range of 74 degrees to 85 degrees F. With such settings, the system will cool or heat automatically in accordance with the demand, without the necessity for any resetting or manipulations. During most periods of operation where heating is desirable, it is important that the fan be stopped when the heating is discontinued. However, during periods of cooling operation, and also under some circumstances where heating is being carried on, it is important to provide for the continuous operation of the fan. However, by providing for the starting and stopping of the fan simultaneously with the starting and stopping of the compressor, the system will carry on a basic pattern of efficient operation. The operator may then provide for the continuous fan operation when conditions make that desirable. Furthermore, the fan may be operated continuously without any heating or cooling.

From the standpoint of safety and efficiency of operation, it should be noted that the refrigeration system cannot be operated when there is not a satisfactory supply of water. Hence, if the pump motor should fail, or if the pump should, for any reason, not deliver a satisfactory amount of water, the refrigerator system will not operate. Therefore, the system cannot become damaged because of being operated with insufficient water. The electrical control system is also important from the standpoint of insuring high efficiency operation. The cooling thermostat **42** exerts the primary control, but control is taken from the cooling thermostat when there is a demand for heating. However, the utilization of a single pump control relay as the unit which is responsive to both thermostats insures efficient and dependable operation. This is particularly true when the starting of the pump initiates the starting of the refrigeration system. Where the operating ranges are as suggested in the example above, there will be no change directly from a cooling operation, or vice versa. However, even if such a change should take place, the system is adapted to continue to operate in a dependable and efficient manner.

It is thus seen that an air conditioning system and a mode of operation have been disclosed by which objects above set forth are accomplished.

I claim:

1. In an air conditioning system of the character described which includes a refrigeration system having a compressor and main motor therefor and a cooling or heating coil through which air is directed to subject the air to a desirable heat transfer operation and which includes a heat absorbing or dissipating unit through which a stream of water passes so as to provide a source of heat or so as to carry away heat as desired, a pump and driving motor to supply said stream of water, a reversing valve which has two positions in one of which a fluid flow is provided to cause said coil to act as a heating coil

and in the other of which a fluid flow is provided to cause said coil to act as a cooling coil, a solenoid unit which is energized to operate said reversing valve, a heating thermostat which is adapted to close when there is a demand for heating and to open when said demand is satisfied, a cooling thermostat which is adapted to close when there is a demand for cooling and to open when the demand is satisfied, circuit means which is adapted to energize said solenoid unit upon the closing of one of said thermostats, a normally open relay switch in parallel with said cooling thermostat, solenoid means to close said relay switch when said heating thermostat closes, circuit means which energizes said motor for said pump upon the closing of said cooling thermostat or said relay switch, a circulating fan for circulating air over said cooling or heating coil, a fan motor for driving said fan, circuit means including a main motor relay having a plurality of switches and a solenoid which is energized to close said switches, said circuit means connecting said main motor to power lines upon the closing of said switches and simultaneously starting said fan motor, an auxiliary switch which is closed to operate said fan motor independently of said motor relay, and circuit means for said motor relay including a pressure switch which is closed by the pumping of water under pressure by said pump and safety switches in series therewith which are opened by improper operating conditions of said compressor.

2. The system as described in claim 1, wherein said reversing valve is normally positioned to cause said refrigeration system to operate to cool air and which is reversed by the energization of said solenoid unit to cause said refrigeration system to heat air.

3. A system as described in claim 2, wherein said cooling and heating coil and said absorbing and dissipating unit each include one fluid passageway which is free of valves for the flow of refrigerant to and from said reversing valve, a receiver, a pair of check valves connected from said receiver respectively to said coil and said heat absorbing and dissipating unit, and a pair of expansion valves connected respectively in parallel with said check valves.

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