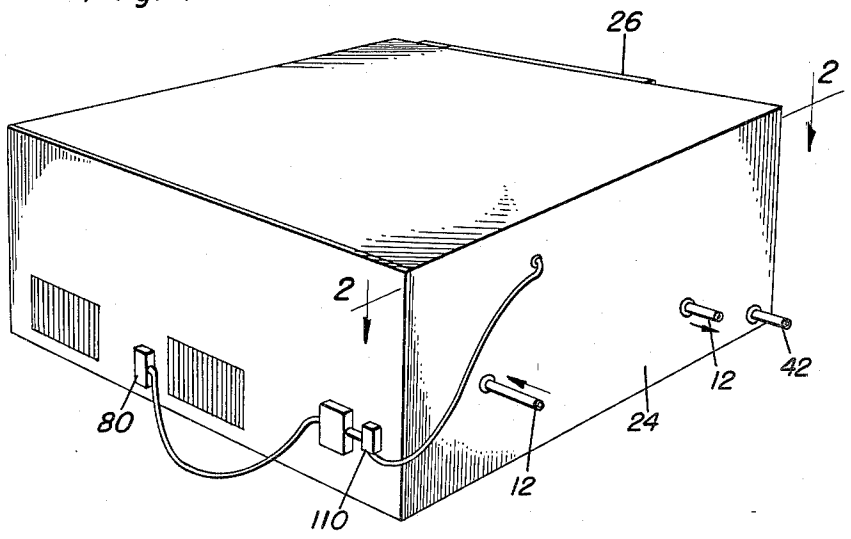
Oct. 11, 1955 J. G. HAILEY 2,720,088

AIR CONDITIONING UNIT

Filed June 26, 1953 2 Sheets-Sheet 1

Fig. 1



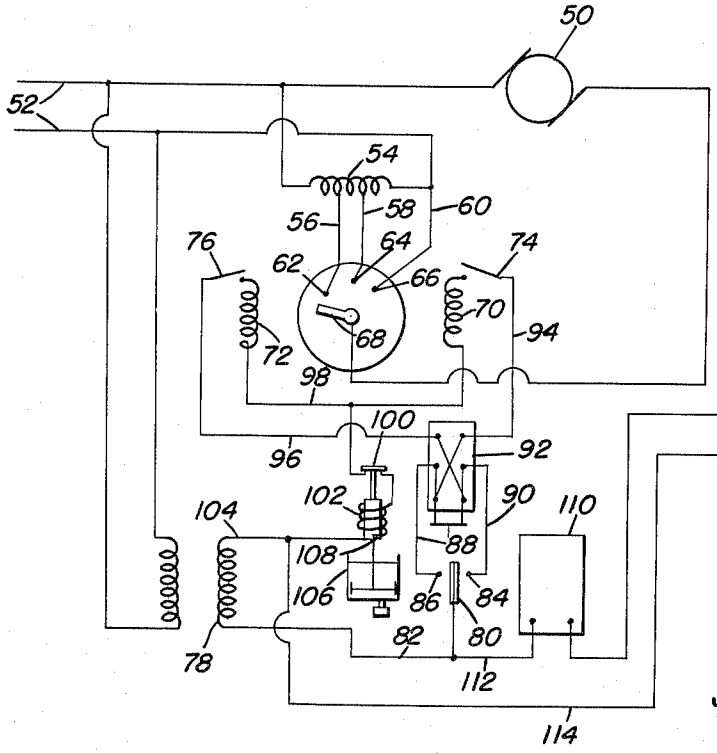


Fig. 4

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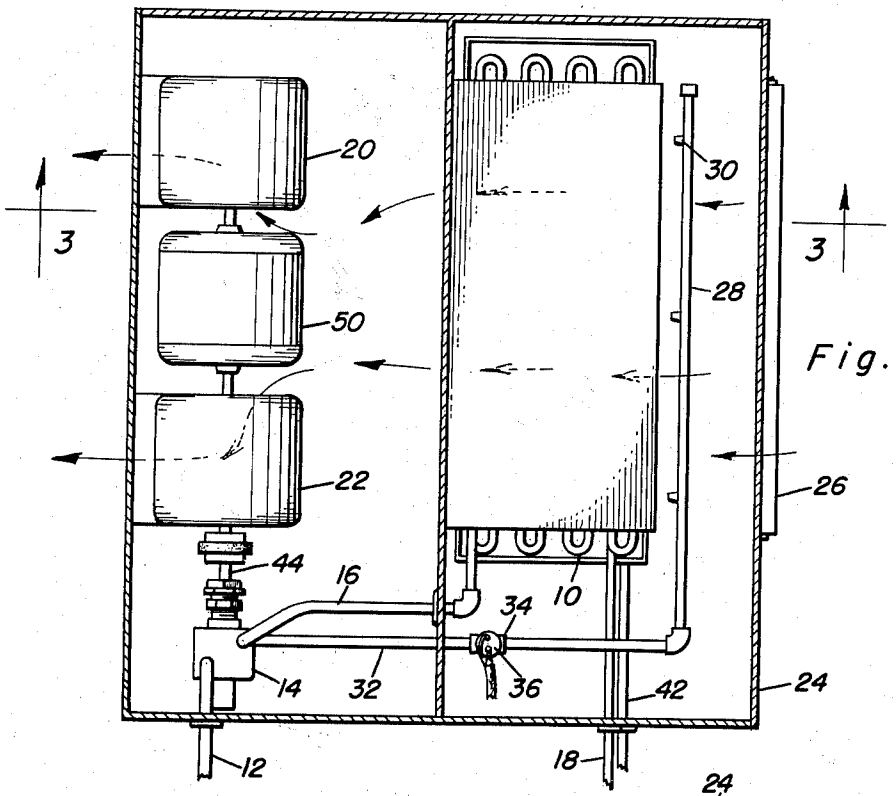


Fig. 2

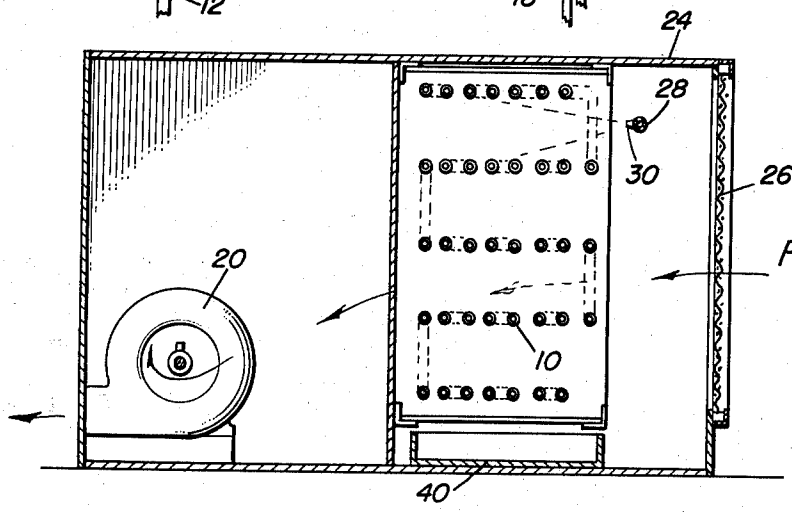


Fig. 3

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AIR CONDITIONING UNIT

James G. Hailey, Dallas, Tex.

Application June 26, 1953, Serial No. 364,380

5 Claims. (Cl. 62—6)

The present invention relates to an air conditioning unit and particularly to a unit for treating the air in any enclosed area to maintain its heat and moisture content at predetermined values of sensible heat and relative humidity.

In the application of air conditioning systems it has been customary to provide a heat exchanger device and provide a liquid circulating material to circulate absorbing liquid which may be either cooled or heated as the season may require. For example, when the temperature is above normal the circulated fluid will be subjected to refrigeration so that it will be cooled so that heat will be taken from the air passed through the heat exchanger and when the temperature is below normal the liquid will be heated so that the heat exchanger will deliver heat to the air passing through the heat exchanger.

In the heretofore known heat exchanger systems, it has been customary to provide a circulating fluid under pressure or particularly under differential pressure across the heat exchanger device so that there is a fixed pressure differential across the pipes of the heat transfer device and usually some sort of valve is supplied to control the amount of fluid passing through the heat exchanger. Various types of valves such as solenoid valves or motor driven valves have been applied to the fluid circulating system and such devices must be carefully regulated otherwise the closing of the valve will cause surging or impulses in the system which may produce undesirable noises or even disrupt the system.

Also, it has heretofore been customary to regulate the flow of air through the air conditioning unit by means of baffles or by-passes or a combination thereof so that the quantity of air passing through the unit will be varied so that the rate of transfer of energy and the air passing through the unit will be variable with variable air flow therethrough. The present invention especially relates to an air conditioning system in which water is circulated as the heat transfer medium, which system is of the order generally known as a closed system, that is, one having free circulation between the supply and the return sides of the system through a boiler, refrigeration storage tank, pressure tank or such, in which the system is kept full of water to a point above the highest convector or air treating unit connected to the system so that the convector coils of the air treating units are at all times subjected to a hydrostatic pressure which is balanced under the same pressure at the intake and discharge sides of the coils.

For simplicity of discussion the heat transferring medium will be referred to as water but such is to be understood to include water, brine, oil or any other energy absorbing liquid.

In the construction according to the present invention the heat exchanger device has the water circulated therethrough by means of a suitable variable speed pump while the air through the exchanger will likewise be impelled by means of a suitable variable speed impeller.

In order to secure constant relation between the circulation of water and the circulation of air through the exchanger the pump and the blower or other impeller will be directly connected together and driven by the same motor which will be varied in speed to vary the volume of air and volume or speed of water through the heat exchanger so that the quantity of heat transferred may be varied at will while the rate of transfer from the unit of water to a unit of air will remain substantially constant over the complete range of operation.

The control of the variable speed motor is accomplished by means of a supply circuit including a transformer with the voltage applied to the motor being controlled by means of a stepping relay which is in turn operated by a thermostat responsive to the temperature of the space to be conditioned so that the motor may be turned on and operated at any desired speed as long as the conditions in the space to be regulated should be changed. Rather, the device is provided with a reversing switch so that in the change of seasons the device may be changed from a cooler to a heater or vice versa as the conditions may warrant.

As is well known particularly during the heating season the air passing through an air conditioner frequently becomes unduly dry and to eliminate this a spray device has been applied to the heat exchanger for applying water thereon to replace the water withdrawn from the circulated air and a humidistat has been applied to control the operation or supply of water to the nozzles.

It is accordingly an object of the invention to provide an improved air conditioning unit.

It is a further object of the invention to provide an air conditioning unit in which the volume of air being treated may be varied at will.

It is a further object of the invention to provide an air conditioning unit in which the volume of air and water through a heat exchanger may be constantly varied so that the rate of energy transfer may be maintained constant over variable flow of air or water.

It is further object of this invention to provide an air conditioning system in which the flow of water through the heat exchanger may be controlled without the use of valves.

It is a further object of this invention to provide an air conditioning system in which the volume of air passing through the conditioner may be varied without the use of baffles, by-passes or the like.

It is a further purpose of this invention to provide a system whereby the rate of flow of air through the coils of the heat exchanger may be caused to vary evenly and accurately in constant heat relationship to the rate of heat transfer in the heat exchanger without the use of valves.

It is a further object of the invention to provide a closed heat circulating system in which the rate of flow is controlled by a pump associated with the exchanger.

It is a further object of this invention to provide a simple means for controlling the heat and moisture content of the air within any treated area.

Other objects and many of the attendant advantages of the present invention will be apparent from the following detailed description taken in conjunction with the accompanying drawing in which:

Figure 1 is a perspective view of the air conditioning unit according to the invention;

Figure 2 is a sectional plan view of the unit taken substantially on the plane indicated by the line 2—2 of Figure 1;

Figure 3 is a sectional elevation through the unit taken substantially on the plane indicated by the line 3—3 of Figure 2; and

Figure 4 is a schematic wiring diagram of the air conditioner.

In the exemplary embodiment of the invention a heat exchanger herein indicated as primarily a coil **10** is connected to a source of supply of heat absorbing medium by means of a supply pipe **12** which is connected to a fluid pump **14** which delivers fluid through a conduit **16** to the heat exchanger coil **10**. The heat absorbing medium is returned from the coil **10** by means of a return conduit **18** and preferably is continued through a refrigerator, heater or other heat energy changing device in what is known as a closed circuit. Although, it is evident that any suitable circuit may be utilized and the return fluid from the heat exchanger may be utilized in some other device and not recirculated.

The air to be treated in the air conditioning unit is drawn through the heat exchanger by means of suitable impellers such as the blowers **20** and **22** herein show as of the centrifugal type although obviously any suitable air impeller may be utilized. The air is drawn into the container **24** of the unit through a suitable filter **26** so that dirt, dust or other material in the air may be collected and prevented from recirculation.

In order to control the humidity of the air passing through the heat exchanger, a header **28** provided with a plurality of nozzles **30** is provided adjacent the heat exchanger and preferably the nozzles are so directed that a fluid passing through the nozzles will be distributed over the heat exchanger. Water will be supplied to the header **28** from any suitable source herein indicated as a pump **14**, although obviously any suitable source of water supply under pressure may be utilized. The flow of water through the conduit **32** is controlled by means of a valve **34** which will preferably be energized or operated by means of a solenoid **36**.

During certain intervals the coils **10** will cause condensation of the moisture in the air passing thereover so that the bulk of the moisture will be condensed and flow therefrom and for this reason a drip pan **40** is provided below the coils **10** to catch and retain any moisture condensed and falling therefrom and preferably a drain line **42** will be applied to the drip pan **40** to discharge any condensation received therein.

In order that the rate of flow of air over the heat exchanger and the rate of flow of the heat absorbing medium may be simultaneously controlled so that the rate of heat transferred between the air and a medium will be constant the blowers **20** and **22** and the pump **14** are driven simultaneously at a proportionate speed. Herein the blowers **20** and **22** and the pump **14** are shown as being placed on the same shaft and driven by a suitable variable speed motor **50**. For simplicity the motor **50** and each of the blowers **20** and **22** and the pump **14** are shown as being connected on the same shaft **44** although it is obvious that the various devices could be driven by gearing, belts or other suitable drives and the pump may be operated at a different speed but necessarily a proportionate speed with respect to the blowers to maintain a proper flow of fluid through the coils **10**. An electrical supply circuit **52** is connected to the motor **50** by means of a suitable transformer **54** herein indicated as of an auto transformer type although obviously any suitable transformer could be utilized.

The transformer **54** is provided with a plurality of taps **56**, **58** and **60** which terminate in switch terminals **62**, **64** and **66**. The terminals **62**, **64** and **66** are selectively engaged by means of a contact finger **68** operated by a stepping relay of the type manufactured under Patent No. 2,323,840 and which contains a positive stepping coil **70** and a negative or subtracting stepping coil **72**.

As is well known when the coil **70** is energized it will cause the contact finger **68** to move in the direction from no engagement over contact **62** to **66**, respectively, after which time it will operate a limit switch **74** so that no further stopping of positive stepping coil **70** will occur.

Likewise, when the coil **72** is energized it will cause reverse rotation of the finger **68** or in the direction of **66**, **64**, **62** to a disconnect point at which time it will energize a disconnect switch or limit switch **76** to prevent further reverse motion of the contact finger **68**. The stepping coils **70** and **72** are energized from the line **52** by means of a transformer **78** and energization of the coil **70** or **72** is controlled by means of the thermostatic switch **80** which is connected to one side of the solenoid from the transformer **78** and cooperates with fixed contacts **84** and **86** which are connected by means of conductors **88** and **90** through a reversing switch **92** so that either of the fixed contacts **84** or **86** may be connected at will in series circuit relation with the coil **70** or **72**.

The switch **92** being connected to the stepping coil **70** through the conductor **94** and limit switch **74** while the switch **92** is connected to the coil **72** through the conductor **96** and the limit switch **76**. The coils **70** and **72** are provided with a common return lead **98** which is connected through a contactor **100** and a solenoid coil **102** with a reverse terminal **104** of the transformer **78**.

The switch **100** is in the form of a time delay switch so that if the coil **102** is energized for a predetermined time the switch **100** will be opened to thus deenergize either the coil **70** or **72** which ever may be connected by the thermostat **80** and simultaneously deenergize the coil **102** so that the switch **100** will promptly close again. While any type of time delay device may be used, it is herein shown as a dash pot **106** provided and connected to the armature **108** of the coil **102** so that after a predetermined time or interval of energization of the coil **102** the dash pot will allow the armature **108** to move a sufficient distance to open the switch **100**.

A humidistat **110** is energized by the transformer **78** by means of the conductor **112** connected to the terminal **82** of the transformer **78** while the terminal **104** of the transformer **78** is connected through a conductor **114** to the electrical operating device **36** of the valve **34** so that when the humidistat closes its contacts the valve **34** will be opened by the operating mechanism **36**.

Assuming that the device is in the condition illustrated in Figure 4 in which the motor is completely disconnected and assuming that at the present instance the air conditioning demands are satisfied the operation of the device is as follows: Assuming that the air in the space being treated should become too warm the thermostat **80** would move into contact with the fixed contact **86** so that positive stepping coil **70** would be energized to move the finger **68** into engagement with contact **62** which would energize the motor **50** and cause the blowers **20** and **22** and the pump **14** to operate at the lowest speed. If the operation of the device at this speed for a predetermined interval has satisfied the cooling demand the thermostat **80** would move to its neutral position and deenergize the coil **70**. However, if such continued operation over a predetermined interval does not satisfy the cooling demand and the thermostat **80** remains in contact with the fixed contact **86** the solenoid coil **102** will cause the armature **108** to move upwardly sufficient to open the contact **100** so that the coil **70** will be deenergized and returned to its inoperative position. However, the deenergization of the coil **102** will allow the switch **100** to immediately close so that the coil **70** will again operate to move the contact finger to the next switch **64**. This would cause a more rapid operation of the blower and pump and consequently an increase in the actual amount of heat transferred although the rate of transfer per unit of air and water would remain constant.

If the thermostat **80** should again remain closed for the sufficient interval of time the relay **100** would again operate so that coil **70** would again operate to move the finger **68** into contact with the terminal **66** and simultaneously open the limit switch **74** so that no further positive stepping of the stepping relay can occur.

If after a predetermined interval the space should become too cool the thermostat **80** would move into engagement with the fixed contact **84** and energize the negative stepping coil **72** to move the contact finger from the contact **66** to the contact **64** and thus slow down the transfer of energy into the space being treated. Such negative stepping could recur repeatedly until the finger **68** moves into the position shown in Figure 4 at which time the limit switch **76** would be opened so that no further negative stepping could occur.

In the event the atmosphere being treated contained too much moisture it would condense on the coils **10** and fall into the drip pan **40** so that the excess moisture would be carried away. However, if the air being treated was too dry the humidistat **110** would close its contacts to energize the coil **36** to operate the valve **34** and allow water to be discharged through the nozzles **30** into the air conditioning unit so that sufficient moisture will be supplied to the air to satisfy the humidistat **110** after which it will open its contacts and close the valve **34**.

It will thus be apparent that the present invention provides an air conditioning unit in which the rate of flow of air and heat transfer medium may be varied over a wide range without the utilization of valves baffles or by-pass connections and such change will be made readily and easily without the necessity of expensive regulating equipment.

It will further be apparent that the present device will provide a constant transfer of energy per unit volume of air being treated and that the quantity of energy may be widely varied by simple and inexpensive means.

While for simplicity of exemplification the device has been indicated for summer use it will be apparent that by merely reversing the switch **92** and changing the circulating medium from the refrigerating to a heating device, the device will operate as well in winter as in summer so that the air can be conditioned either winter or summer as may be desired.

For purpose of exemplification a particular embodiment of the invention has been shown and described according to the best present understanding thereof. However, it will be apparent to those skilled in the art that changes and modifications may be made therein without departing from the true spirit and scope of the invention.

What is claimed as new is as follows:

1. An air conditioning system comprising a heat exchanger, an impeller for causing air flow through said heat exchanger, a pump for circulating a heat absorbing fluid through said heat exchanger, a variable speed motor connected in driving relation to said impeller and said pump and means for varying the motor speed in response to the condition of the treated air, a spray nozzle mounted adjacent to said heat exchanger, a connection for supplying water to said nozzle, a valve in said connection, and means response to the humidity of the treated air for controlling said valve.

2. An air conditioning system comprising a coil, means including a pump for circulating a heat absorbing fluid through said coil, means including a blower for circulating air over said coil, a variable speed motor operatively connected to said blower and to said pump, an electric circuit including a transformer for energizing said motor, a selector switch for selectively connecting said motor to said transformer, a stepping relay operative to actuate said selector switch, means including a temperature responsive switch for determining the operation of said stepping relay.

3. An air conditioning system comprising a coil, means including a pump for circulating a heat absorbing fluid through said coil, means including a blower for circulating air over said coil, a variable speed motor operatively connected to said blower and to said pump, an electric circuit including a transformer for energizing said motor, a selector switch for selectively connecting said motor to said transformer, a stepping relay operative to actuate said selector switch, a thermostatic selector switch determining the energization of said stepping relay, time delay means responsive to continued closure of said thermostatic switch to momentarily deenergize said stepping relay.

4. An air conditioning system comprising a coil, means including a pump for circulating a heat absorbing fluid through said coil, means including a blower for circulating air over said coil, a variable speed motor operatively connected to said blower and to said pump, means including a temperature responsive device for varying the speed of said motor, a nozzle directed toward said coil, a conduit communicating said pump to said nozzle to supply water to said nozzle, a valve controlling the flow of water to said nozzle and a humidistat for controlling said valve.

5. An air conditioning system comprising a coil, means including a pump for circulating a heat absorbing fluid through said coil, means including a blower for circulating air over said coil, a variable speed motor operatively connected to said blower and to said pump, an electric circuit including a transformer for energizing said motor, a selector switch for selectively connecting said motor to said transformer, a stepping relay operative to actuate said selector switch, a thermostatic selector switch determining the energization of said stepping relay, time delay means responsive to continued closure of said thermostatic switch to momentarily deenergize said stepping relay, a reversing switch operatively connected between said thermostatic selector switch and said stepping relay.

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